Validation of a rating scale for bedside cognitive assessment

Annerine Roos

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Study leader: Dr Frans J. Hugo

Co-studyleader: Prof Willie M.U. Daniels

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature:

Date:

SUMMARY

Numerous tests exist for the assessment of general cognitive functioning. Most of these tests were developed within the discipline of psychology. Neuropsychological tests are very useful, but have some limitations. Administration of the tests is limited to a psychologist, is very time-consuming in that it can take 3-8 hours to administer and often need specialized equipment. At the other end of the continuum are very brief screening tests. General practitioners, psychiatrists and occupational therapists, in addition to psychologists, also use these tests. Although useful, the short tests only provide limited information. An intermediate level test streamlining the assessment process between the very short and longer neuropsychological tests is therefore introduced by this study.

The Bedside Cognitive Assessment Battery (BCAB) was developed in 1995 and are since used, at Tygerberg Hospital's Memory Clinic, to assess patients and teach students. The test comprehensively assesses the six main classes of cognitive functioning, namely attention and concentration, speech, memory, motor functioning, perceptual functioning and executive functioning. Approximately 35-45 minutes is required for administration and training is needed to administer the BCAB. No specialized equipment is needed for administration. The battery can therefore be used at the bedside, in the office or at old age homes.

The aims of this study were to validate the BCAB for use with people aged eighteen years and older, and provide normative values for use in clinical settings. The test was revised in 1997 and 2001, and extensively so in 2002, but was never formally evaluated for validity. Well-known single tests were used to compile the BCAB. Most of these tests have proven validity and reliability, but only for foreign populations. In addition, some items were reformulated and others created by the researchers. The introduction of normative values would also be useful to assist in the delineation of cognitively intact and impaired individuals. This study succeeded in providing a table of normative values.

One-hundred-and-sixty Afrikaans and English participants, and fourteen Xhosa participants were assessed in their mother tongue language. This project thus also introduced a Xhosa version of the BCAB. The purpose of the Xhosa version was to address the lack of culturally relevant cognitive assessment instruments. Results were evaluated for the effects of the variables' language, gender, age and education. The effect of language was most noticeable in the Xhosa group. Gender did not affect results as dramatically as age and especially, education. These significant effects on the aforementioned variables have been described in

previous reports. The BCAB is thus relevant and useful as a detector of mild to moderate impairment. It can also be used to identify specific impairment. This can narrow down the investigation of psychologists, thus saving time and money. In addition, medical and non-medical staff can use the BCAB.

Some limitations were also identified. The sample used may limit the generalization of results. Some test items also need revision, along with further validation studies. Clinicians are therefore advised to use the BCAB only in addition to complete clinical examinations when making decisions regarding a patient's cognitive status. The BCAB appears to be a valid tool for bedside assessment. However, this study could only set the stage for further research, especially studies concerned with establishing normative values.

OPSOMMING

Verskeie toetse bestaan vir die evaluering van algemene kognitiewe funksionering, waarvan die meeste ontwikkel is binne die sielkunde. Neuro-sielkundige toetse is baie bruikbaar, maar het sekere beperkings. Administrasie van die toetse is beperk tot sielkundiges, maar tydrowend weens 'n tydsduur van drie tot agt uur, en verg dikwels gespesialiseerde toerusting. Aan die ander kant is heelwat kort siftings-toetse beskikbaar. Algemene praktisyns, sielkundiges en arbeidsterapeute, asook sielkundiges, gebruik dit. Hoewel bruikbaar, bied die kort toetse beperkte inligting. 'n Intermediêre vlak toets om die evaluerings-proses tussen kort en langer neuro-sielkundige toetse te integreer word met hierdie studie beoog.

Die Bedkant Kognitiewe Evaluasie Battery (BKEB) is in 1995 ontwikkel en gebruik in die Geheue-kliniek van die Tygerberg Hospitaal om pasiënte te evalueer en studente op te lei. Die toets is gerig op die omvattende evaluering van die ses hoof-klasse van kognitiewe funksionering. Hierdie klasse omvat aandag en konsentrasie, spraak, geheue, motoriese funksionering, perseptuele funksionering en uitvoerende funksionering. Sowat 35 tot 45 minute word benodig vir administrasie terwyl opleiding vereis word vir die neem van die toets. Geen gespesialiseerde toerusting is nodig nie. Die battery kan dus by die bedkant, in die kantoor of in ouetehuise gebruik word.

Die doelwitte van hierdie studie is om die BKEB te evalueer in gebruik by 18-jariges en ouer, en normatiewe waardes te bepaal vir gebruik in kliniese omgewings. Die toets is in 1997 en 2001 hersien. In 2002 is dit uitvoerig hersien, maar nooit ge-evalueer vir geldigheid nie. Bekende enkel-toetse is gebruik om die BKEB saam te stel. Dit is as geldig en betroubaar bewys, hoewel slegs onder buitelandse bevolkingsgroepe. Hierbenewens is sekere items herformuleer en ander bygewerk deur die navorsers. Normatiewe waardes sal ook handig wees in die afbakening van kognitief normaal-funksionerende en kognitief-ingekorte individue. Hierdie studie het daarin geslaag om 'n tabel van normatiewe waardes daar te stel.

Een-honderd-en-sestig Afrikaans- en Engels-sprekendes, en 14 Xhosa-sprekendes is tydens hierdie studie in hulle moedertaal ge-evalueer. Hierdie projek het dus ook 'n Xhosa-weergawe van die BKEB geskep. Die doel van die Xhosa-weergawe was om die gebrek aan 'n kultureel toepaslike kognitiewe instrument te beklemtoon. Resultate is ge-evalueer gedagtig aan veranderlikes soos taal, geslag, ouderdom en opleidingsvlak. Taal het die grootste invloed gehad op uitslae van Xhosa-deelnemers. Geslag het nie die uitslae so

dramaties beïnvloed soos ouderdom, en veral opleidingsvlak nie. Literatuur het meestal die groot uitwerking van hierdie veranderlikes bevestig. Die BKEB is dus relevant en handig in die naspeuring van ligte tot matige kognitiewe ingekortheid. Dit kan ook gebruik word om spesifieke kognitiewe ingekortheid te identifiseer. Die kan die omvang van ondersoek deur sielkundiges vernou, wat kan lei tot 'n groot besparing in tyd en geld. Hierbenewens kan mediese en nie-mediese personeel aangewend word in die gebruik van die BKEB.

Sekere tekortkominge is geïdentifiseer. Die steekproef mag egter die veralgemening van die uitslae beperk. Sekere toets-items mag ook hersiening vereis, tesame met verdere geldigheid-studies. Kliniese praktisyns word daarom aangeraai om die BKEB slegs in aanvulling tot omvattende kliniese ondersoeke te gebruik vir besluite m.b.t. 'n pasiënt se kognitiewe status. Die BKEB kom voor as 'n geldige instrument vir bedkant evaluering. Hierdie studie kon egter slegs die tafel dek vir verdere ondersoek, veral t.o.v. studies wat poog om normatiewe waardes daar te stel.

Dedication

To the late Leeroy Titus and others disabled by crime and illness.
May the expansion of science contribute to a better life.

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INTRODUCTION

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1.1 Historical perspective

1.1.1 Contributions to cognitive assessment

The term "neuropsychology" was introduced to the disciplines of psychology and neurology as early as 1913 and then used again in 1936 (Lezak, 1995). In the 1940's neuropsychology was established as a discipline. Its main principles were found in psychology, which featured as the dominant field of human behaviour. Psychologists realised the importance of assessing cognitive abilities in medical and psychiatric conditions.

The work of Luria contributed immensely to the social sciences and medicine. He introduced novel and theoretically sound approaches to neuropsychology that went beyond the 1920's and -30's scope of subjective psychology and oversimplified approaches to human behaviour (Christenson and Caetano, 1996). His work started before World War II, and developed into proper assessment procedures after the war. Luria has based his theories on inferences, made from work with frontal lobe patients. His theories and methodologies have laid a valuable and strong foundation for neuropsychology. This caused many clinicians to refer to Luria as the father of neuropsychology.

Luria formulated brain functioning as a co-ordinated working system, incorporating numerous functional areas. The specialisation of specific systems was sufficiently explained by him based on direct observational studies (Christenson and Caetano, 1996). From this, measurement procedures were developed to assess the cognitive functions related to the different brain areas. The procedures were incorporated into the Luria Neuropsychological Investigation (LNI). Functions in this battery include motor functions, accoustico-motor organisation, kinesthetic and higher cutaneous functions, speech, writing, reading, higher visual functions, arithmetic skills, mnestic, and intellectual processes (Lezak, 1995). Luria explained the different aspects of functioning as processes rather than functional classes (Christensen and Uzzell, 2000). While this does not always reflect specific impairments

related to brain functions, the results from the LNI significantly assist the neurological examination, neuro-imaging techniques and neuro-surgical techniques.

In 1944 the psychologist, Weschler, introduced a multi-faceted approach to cognitive assessment. These include the Weschler-Bellevue Intelligence Scales, the Weschler Intelligence Scales and the Weschler Memory Scales (Franzen and Iverson, 2000; Groth et al., 2000). Functions assessed are attention and concentration, language, constructional ability, concept formation, reasoning, and short- and longterm memory. These scales have been extensively revised and validated for use with different populations. Appropriateness of normative values for different populations have also been studied (Marcopulos et al., 1997).

In 1975, Folstein (Folstein et al., 1975) contributed significantly to bedside cognitive assessment by introducing the Mini-Mental Status Examination (MMSE). The MMSE measures the main cognitive functions such as attention, memory and language. It has set a standard for brief cognitive assessment. Other, longer test batteries and numerous individual item tests were also developed. Most, if not all, of these instruments have been reviewed by the neuropsychologist, Lezak (1995). She has greatly contributed to cognitive assessment by combining theoretical aspects with extensive descriptions of assessment tools. Her work has highlighted the worth of cognitive tests as part of the clinical workup.

1.1.2 Multi-disciplinary teamwork and the role of the clinician

Many interactions exist between neurologists and psychiatrists to investigate patient problems. Both groups benefit by using improved neuro-imaging techniques to better understand the pathological basis of brain diseases. Cognitive assessment procedures compliment this by providing information on functional localisation. Where more in-depth assessments of specific problems are required, neuropsychologists have to be involved. This interaction between neuropsychologists and other medical disciplines has lead to improvement in assessment options and ultimately, treatment.

Each psychiatric or medical disorder presents with different features. After localising problems in the brain, it is necessary to identify the associated impairments. Cognitive assessment can separate conditions according to their characteristic symptomology. When these features are reliably identified, a diagnosis can be made. For example, dementia globally impairs cognitive functioning. In the case of Alzheimer's disease, the patient initially presents with a dominant impairment of shortterm memory. As the illness progresses, language and executive functioning are impaired, and apraxia and agnosia develop.

Contrarily, dementia associated with Parkinson's disease primarily presents with motor disabilities. Psychomotor speed is slowed, executive function is impaired, apathy is present, and depression often co-exists.

1.2 Aim of this study

Proper neuropsychological assessment is very useful, but time-consuming. Alternatively, brief screening instruments only provide limited information on cognitive functioning. An intermediate level test will therefore be more ideal and effective in clinical practice. Tests falling into this category already exist. Most have proven validity and usefulness, but some limitations have also been identified. The Alzheimer's Disease Assessment Scale (Rosen et al., 1984), for example, provides limited information on cognitive functions such as executive functions. Other limitations also exist and will be discussed later.

Because of these drawbacks of time-consuming assessments on the one hand, and insufficient information on the other hand, the present study was undertaken to validate a novel bedside cognitive assessment battery that takes approximately 40 minutes to complete, providing comprehensive information on the different cognitive functions.

1.3 General aspects of bedside assessment

Every individual uses brain functions continually to sustain normal living in everyday life. This reliance on cognition involves the integration of information as a result of interaction with the environment (Lezak, 1995). Functions related to cognition, is referred to as cognitive functions and the assessment thereof, cognitive assessment.

The aim of a cognitive test is to measure cognitive status (Stuss et al., 1996). A healthy person's cognitive status is expected to lie within a normal range of functioning. "Normal" can be defined as functioning in an independent manner, in a community, with no active psychiatric or neurological disorder impacting on cognition (Ivnik et al., 1996). Where a change from normal to impaired functioning occurs, "normal" depicts the prior level of functioning (Crum et al.,1993). When cognitive impairment is suspected, cognitive assessment can assist clinicians in documenting changes. This process will form part of a clinical examination, often in consultation with other clinicians.

Bedside assessment literally means the assessment of cognitive functions at the bedside. However, this form of assessment does not strictly happen at the bedside. Assessments are most often performed in the clinician's office. The tests are practical and do not rely on specialised, medical or other equipment. Bedside tests are easily transferred from one location to another where assessment is needed. Locations can be at home, old age homes, a hospital or clinic.

Materials most often needed for bedside assessment are blank sheets of paper, a pencil and a stopwatch. In some instances a box of tools is provided to facilitate different test items. The Alzheimer's Disease Assessment Scale (ADAS) (Rosen et al., 1984; Doraiswamy et al., 1995) is a good example of a test using instruments, such as wordlists on cards in booklet form, and real objects for object recognition. Computers are also used more often for assessment of cognitive functions (Lezak, 1995). Computerised tests may be unpractical, as access to a computer or a portable computer is required.

Bedside assessment instruments can take on the form of short or longer tests. The shorter test usually screens for impairment, whereas one or more cognitive domains can be assessed more extensively with either test. An individual test assesses one domain of cognitive functioning. The Controlled Oral Word Association Test (COWAT) (Sumerall et al., 1997; Harvey and Siegert, 1999), for example, assesses word finding ability. Word finding is classified as a semantic function. When more than one domain is assessed, the instrument will include a selection of test items or a battery of tests.

The individual or shorter test is preferred when a general diagnosis needs to be made, whereas a longer test will highlight specific deficits (Stuss et al., 1996). A global estimate of dementia, for example, can be made with a short screening battery such as the Mini-Mental Status Examination (MMSE) (Dick et al., 1984; Ylikoski et al., 1992; Crum et al., 1993). The Mattis Dementia Rating Scale (MDRS) (Hofer et al., 1996; Lucas et al., 1998) is a longer battery that can be used to distinguish between different types of dementia such as Alzheimer's disease and vascular dementia. Also a long test, the Neurobehavioral Cognitive Status Evaluation (NCSE) (Kiernan et al., 1987) is used to distinguish between delirium and dementia. Yet, a bedside test is not as sensitive as neuropsychological tests (Kiernan et al., 1987) (see next section).

Another use of bedside batteries is to document changes in cognitive functioning over time. In clinical trials this type of test monitors the effect of new medication on cognition in Alzheimer's disease patients. The ADAS is such a test. The ADAS will only be performed

when a patient has received a diagnosis of Alzheimer's disease. The diagnosis is derived from other tests and clinical examinations.

Bedside tests can take on a different format; that of an interview schedule. The interview schedule is used to collect information from a patient or caregiver regarding behaviour in every day life. The caregiver usually is the most accurate source, since poor insight often characterises cognitive disorders. For instance, a more objective report can be obtained from a depressed patient's caregiver, since self-reported items can be unreliable (Roth et al., 1986). The Neuropsychiatric Inventory (NPI) and Activities of Daily Living (ADL) questionnaire are commonly used to illustrate cognitive deficits more tangibly.

Following are a discussion on another form of cognitive evaluation, neuropsychological assessment. This type of assessment is distinct from bedside assessment, yet overlaps in many ways.

1.4 General aspects of neuropsychological assessment

Practical, paper and pen assessment techniques were first described by psychologists and neurologists (Lezak, 1995). These clinicians sought to understand and document behavioural aspects related to psychiatric disorders, neurological disorders, and cognitive disorders due to medical conditions. Psychology is the study of human behaviour (Louw and Edwards, 1993). When a person behaves in a way which defies what is deemed normal, a psychologist will investigate this abnormal behaviour with psychological tests. A neurologist is interested in the pathology of the brain causing the abnormal behaviour. A neuropsychologist will be interested in how physical abnormalities or impairments of the brain impact on behaviour. These behavioural aspects are assessed by using a battery of selected tests (Hugo and Potocnik, 2002).

The neuropsychologist aims to thoroughly assess each aspect of cognitive functioning. Assessment can take place in a private practice, hospital or clinic. The purpose is to detect specific cognitive impairment in the main brain areas (see Chapter 2 for the different classes of cognition). When a patient is referred to a memory clinic, a clinician will perform a comprehensive clinical examination. If more extensive information on cognitive functioning is required, the patient is usually referred to a neuropsychologist. The neuropsychologist performs the cognitive assessments and report back to the clinician. This process assists in confirming a suspicion regarding diagnosis (Hugo and Potocnik, 2002), and devising treatments options (Royall et al., 1992).

A psychometrician is also eligible to perform cognitive tests, but in limited capacity. Psychometricians can assist psychologists in assessment procedures by administering a test under their guidance and supervision (Owen and Taljaard, 1989). Since neuropsychology is a specialised field, connecting medicine and psychology, advanced knowledge and training is required to administer tests. Interpretation of test results is however restricted to a neuropsychologist, psychiatrist or neurologist.

Another purpose of neuropsychological assessment is to differentiate between subtypes of a disorder after diagnosis (Kiernan et al., 1987; Stuss et al., 1996). Confusional states need to be differentiated from dementia, while identification of the different types of dementia will be useful (Kiernan et al., 1987). Dementia can include Alzheimer's disease, Lewy body disease, vascular dementia, substance-induced dementia and HIV-related dementia (Kaplan and Sadock, 1998). Each subtype has different causes and clinical and physiological presentations. A substance-induced dementia such as Korsakoff's syndrome is caused by chronic alcohol abuse (Gazzaniga et al., 1998). This amnestic disorder primarily affects memory processes.

Neuropsychological assessment is very useful as a diagnostic tool due to its sensitivity. The tests are sensitive to a broad range of cognitive functions, therefore able to detect specific impairments (Royall et al., 1992). As seen in the previous paragraph, Korsakoff's syndrome also impairs memory. In this instance, cognitive tests assist firstly in identifying the problem, and secondly, in highlighting specific problems related to shortterm memory. For the patient this means having problems in retrieving knowledge about the self and the world. Language impairment such as word finding difficulties (aphasia) and an inability to perform sequential commands (apraxia) very often feature in moderate to severe Alzheimer's disease. Neuropsychological tests can also distinguish between levels of impairment (Royall et al., 1992). Very early cognitive impairment can be detected due to the number of test items used. The longer the tests the more accurate the detection of decline in moderate and severe dementia (Stuss et al., 1996).

As with bedside instruments, numerous shorter and longer tests exist for neuropsychological assessment, complicating the decision that needs to be made regarding the test(s) required for assessment. Stuss et al. (1996) compared the MMSE, 6-item derivative of the Orientation-Memory-Concentration Test, the Dementia Rating Scale, short Mental Status Questionnaire and Ottawa Mental Status Questionnaire to see whether there are differences between short and long tests in terms of diagnostic capabilities. They found the tests to detect dementia similarly. To determine what test will therefore be most appropriate, will

depend on administration time and psychometric properties. Neuropsychological tests, however, can be very long to administer. It can require 3-8 hours (Kiernan et al., 1987). This may be particularly exhausting for the medically or mentally ill and elderly. Long assessment schedules such as the CAMDEX (O'Connor et al., 1989), although proven valid and useful, may produce unreliable scores for test-retest procedures in the elderly (Roth et al., 1986). Routine use will not be a good option.

Many neuropsychological instruments take on the form of simple pen and paper tests. The Trail Making Test (Ivnik et al., 1996) and Rey-Osterreich Complex Figure (Folbrecht et al., 1999) have standardised figures that are presented to the patient to be completed or copied and recalled. Other tests need specialised instruments. The Weschler Adult Intelligence Scale –R (WAIS-R) (Marcopulos et al., 1997) include a card sorting test and block design test, apart from tests assessing vocabulary, verbal fluency, memory and visuo-constructive ability. The Grooved Pegboard Test (Ruff and Parker, 1993) uses metal pegs that has to be inserted into holes on a metal surface mounted on a wooden box. The Finger Tapping Test, as described by Reitan (Morrison et al., 1979; Ruff and Parker, 1993), uses a device with a lever that a patient, when placed in his/her hand, must tap as quickly as possible with the index finger. A computer has also been used for this test. For this, an electronic tapping device is connected to a computer and the patient must tap a key with the index finger, successively as quick as possible (Shimoyama et al., 1990). In some instances a television and video apparatus are used. In the Face Recognition Task actual faces are shown on a television set to patients for recognition (Archer et al., 1994). Photographs are also used for this task (Hassing et al., 1998).

Neuropsychological assessment can detect specific impairment accurately. Yet, it can be very time-consuming, as noted above. It requires a clinical psychologist with expert training and regular clinical experience in cognitive disorders (Strub and Black, 1977). This impacts on patients' personal time, and is expensive for both patients and public hospital services (Lezak, 1995). Some of the tests, such as informant schedules, can be used over the telephone (O'Connor et al., 1989), but for a complete assessment it will be impractical due to the specialised equipment often involved.

Bedside assessment can be viewed as an intermediate step in the evaluation process. Neuropsychologists can benefit from bedside tests time wise. It can also narrow the scope of investigation, directing the focus on specific problems.

1.5 Development of a new bedside instrument

The motivation for developing a new bedside test will be to overcome the limitations of existing tests and to provide standardised norms for South African conditions. A test which do not require specialised instruments, be used at numerous locations, and be administered in less than one hour, picking up global and/or specific deficits reliably, is ideal. In addition, certain gaps need to be filled, for example, the lack of tests assessing executive functions. The short screening MMSE assesses the main cognitive functions in limited capacity, but lack items that evaluate executive functions (Royall, 1998). More extensive tests are needed to screen for cognitive impairment. The tests must however not be as extensive as neuropsychological tests. Screening tools are estimates of general cognitive functioning (Meiran et al., 1996). Tests assessing one cognitive domain may be more useful for detection of specific impairment.

In compiling a bedside test one must decide what the purpose of the test will be. Often this depends on the special interest of the clinician. Dementia affects most cognitive functions, for example attention and concentration, memory, motor functions, language and executive functions. Head injuries also can affect similar functions depending on the brain area(s) impaired. The different brain areas are interconnected, therefore more than one function will be affected (Gazzaniga et al., 1998). In disorders like schizophrenia, the location of lesions will predict expected, associated dysfunctions (Kaplan and Sadock, 1998). In the paranoid type, delusions or hallucinations will occur, while a catatonic will mainly present with motor impairments or peculiarities.

The focus of the bedside instrument is not only to assess functions limited to specific disorders. Sometimes a clinician will be interested in the extent of impairment in a particular cognitive domain. To focus on executive functioning, a test including items assessing all the main aspects of this domain, will be useful. Such a test should include items emphasising the integration of several environmental inputs, generation of different responses to stimuli, maintenance of complex goal-directed behaviour, ability to adapt to changing conditions, and awareness of self (Malloy and Richardson, 1994). In practical terms, this entails the measurement of motor functions, for example, performing specific hand movements (Christenson and Caetano, 1996). The generation of words also falls under executive functions. For the FAS test (Harvey and Siegert, 1999), a patient must name as many different words beginning with the letters F, A and S. The design fluency test (Jones-Gotman and Milner, 1977) involves the generation of non-specific figures and figures adhering to

specific guidelines. Thus, applicable literature is important in selecting test items and can also guide the clinician in what items need to be included.

Age will also be a decisive factor in terms of the test items developed or selected. The first obvious question will be whether children, adolescents or adults are of focus. Some disorders are only found in childhood, while others start in adolescence, going into adulthood. Since this thesis will focus on bedside techniques applicable for those 18 years and older, only examples related to disorders in adulthood will be mentioned.

Head injuries or traumatic brain injuries most commonly occur in young adults. However, it is also prevalent in old age homes due to falls (Lezak, 1995). Subsequent cognitive assessment is always useful as it helps to stimulate the recuperation of damaged brain areas. The decision regarding what tests to use under these circumstances usually depends on the level of impairment. The Glasgow Coma Scale assesses impairment severity in patients with altered states of consciousness after traumatic brain injury (Lezak, 1995). In general, older persons often suffer from mild brain injury, whereas the younger are affected more severely. The elderly also have more pronounced memory problems and slower processing than younger individuals after injury.

Dementia, such as Alzheimer's disease and vascular dementia is an illness associated with old age. Thus, one must be sensitive to differentiate between normal ageing and a memory illness (Kaplan and Sadock, 1998). Intuitively, the type of cognitive assessment used for dementia, must therefore differ from the assessment of younger brain injured patients. Yet, a much younger person may present with similar memory problems. Thus, tests used for dementia in the elderly can be useful to assess young people too, because of the same brain areas being involved in the pathology. Schwartz and McMillan (1989) have found no relationship between age at onset of impairment and the objective measure used to assess memory impairment, supporting the notion that similar tests be used for both younger and older groups of memory impaired individuals.

Standardised assessment techniques provide for the objective measurement of cognitive functions (Dooley, 1995). Tests are administered according to specific guidelines and a response is elicited from the patient. The score is, thus, not determined by a subjective interpretation of behaviour, but a specific answer (Royall et al., 1992). In addition, a test battery compiled by items elicited from literature would presume proven validity for the separate tests. However, this will only apply when the tests are used with populations similar to those documented in the literature. A pilot study will therefore be necessary to determine

whether a new test battery adheres to relevant validity criteria, producing reliable results. An appropriate patient or control group is selected for the pilot study. If problems are encountered with some items, it must be eliminated or changed to minimise uncertainties in assessment (Kiernan et al., 1987). After this process the researcher can proceed with the main study.

If the purpose of the study is to establish normative values or norms for a specific instrument, a control group is used. Norms can be defined as reference standards when placed in the context of a population (Crum et al., 1993). Norms can also be viewed as objective standards, assisting the clinician in making a diagnosis or assessing a patient (Harvey and Siegert, 1999). When norms are derived from a population it is called a normative comparison standard. When norms are derived from a patient's history or present traits it is called an individual comparative standard (Lezak, 1995).

The validity of norms very much depends on a person's demographic traits. Some variables are ethnicity, culture, social circumstances and educational background (Ivnik et al., 1996). Age, IQ, health status, and dependent versus independent living, can also affect test scores (Harvey and Siegert, 1999). Gender can also be a predictor of test results. Before sampling of a control group, the researcher must identify the variables that may impact on scores. During sampling the persons are grouped according to these variables and assessed. After assessment, the researcher estimates the degree of influence of the identified variables on test results. Variables such as anxiety, level of motivation and co-operation can also influence results (Kiernan et al., 1987). Often this affect is a function of normal processes. The clinician must therefore control for these factors in the test situation.

The validity of results will depend on sampling procedures and the inclusion of participants according to specified criteria. The more random the sample and representative of a given population, the more valid the results (Dooley, 1995). In the medical profession it is often practical to recruit patients or controls in a local hospital or clinic (Van Gorp et al., 1999). To avoid selection bias by site of diagnosis, one can recruit participants from two different sites, using research level diagnosis. This can include a structured neurological examination, neuro-imaging and blood tests, apart from cognitive assessments. Sometimes patients with different levels of impairment and different disorders, are grouped together (Van Gorp et al., 1999), for instance, mild and severe dementia, or vascular dementia and Alzheimer patients. This will limit the generalisability of results.

Another problem of validity is ceiling effects. When almost perfect scores are achieved by healthy subjects, the scores will be of no relevance when used in test-retest procedures (Kiernan et al., 1987). An example is the MMSE. The effect of improved educational environments must be kept in mind. Harvey and Siegert (1999) found that tests become less difficult over time, thus scores improve. The same has been found for the Graded Naming Test (Warrington, 1997) during which persons could name more objects than was previously the norm.

Normative values can be interpreted in terms of normal scores or with the Gaussian model (Crum et al., 1993). Normal scores are scores falling within a 95% interval of scores obtained by a given population. The 95% interval is also referred to as the fifth percentile. According to the Gaussian model a normative value will fall within the range of scores between two standard deviations of the mean. After an individual's scores have been placed in context of normative values, the possibility of errors in scores must be clinically judged (Crum et al., 1993). The clinician then needs to refer to other clinical information to possibly explain higher or lower scores than expected.

Test-retest and interrater reliability procedures are important measures of the validity of a bedside instrument. Test-retest reliability involves the assessment of the same participant, with the same test, two or more times (Dooley, 1995). Interrater reliability refers to the degree that scores are similar, when a person is assessed by two independent testers (Cole, 1990). The level of overall agreement is thus attained (Morris et al., 1997).

In summary, the development of a new bedside instrument will depend on the purpose of assessment. When a test has been compiled, it has to be standardised. This includes normative procedures and evaluation of the reliability and validity of the test. A pilot study is useful to ascertain how well the instrument assesses what it is suppose to assess. A well-defined research study can then set a table of norms, corrected for variables that may influence it significantly. Test results can then be compared to the norms to see whether a person falls in an impaired range or not.

CHAPTER 2

The physiology of cognition and approaches to cognitive assessment

2.1 Introduction

The brain's capacity to digest information and order action goes far beyond what is known and understood. The processes involved in cognition are complex and not easy to formulate. This chapter presents an overview of definitions, localisation and impairment related to the main classes of cognitive functioning. Physiological perspectives are then given to illustrate the order of assessment of functions. Some clinical perspectives on assessment and the construction of a cognitive test follow this subsection.

2.2 The six classes of cognitive functioning

Two main classification systems exist for the investigation of cognitive functions. This consists of an anatomical- and functional classification system. Neuro-anatomy focuses on the brain's cell units, and the associations between cell areas. The cell units or neurones are morphologically different, therefore making it possible to identify distinct physiological areas. This arrangement is called cytoarchitectonics. Distinct neuronal pathways connect the different areas, creating functional associations between the areas. Functional units form the basis of this arrangement, defining neurobehavioral aspects of the nervous system.

The functional units are classified as sensory, motor and association systems (Kaplan and Sadock, 1998). The sensory systems convert incoming stimuli into neuronal impulses, creating a representation of the world. The processing of information is dependent on the sensory modalities involved. For example, information received by the eyes is processed in the occipital areas. The motor systems reflect incorporated information through actions. These actions influence the environment and the behaviour of others (Kaplan and Sadock, 1998). However, ones actions are not purely reflexive. Actions are driven by motivation, goals and emotional reactions elicited by the information. The never-ending interaction with the world maintains associations between the numerous brain regions. Specific association systems therefore exist, which are activated, each by specific stimuli.

The outer layer of the brain, or cerebral cortex, is divided into four main areas, namely the frontal, parietal, temporal and occipital lobes (see Figure 2.1). Each area is specialised in the control of specific cognitive functions. No brain area is solely responsible for one function. Gazzaniga et al. (1998) has given a clear description of the different lobes and the

subcortical structures involved in functional processes (see Figure 2.2). The frontal lobe is divided into the motor cortex, frontal and prefrontal cortices. The parietal lobe includes the somatosensory cortices. The primary and secondary visual cortices are located in the occipital lobe. The primary auditory cortex and auditory association areas are located

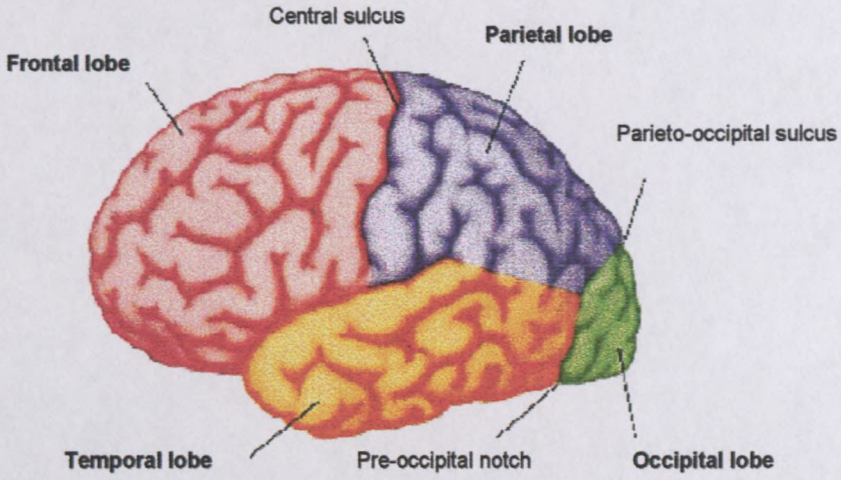

Figure 2.1 The four lobes of the cerebral cortex. The folds in the brain's surface, the central sulcus and parieto-occipital sulcus, separate the lobes. The pre-occipital notch is located in front of the occipital lobe.

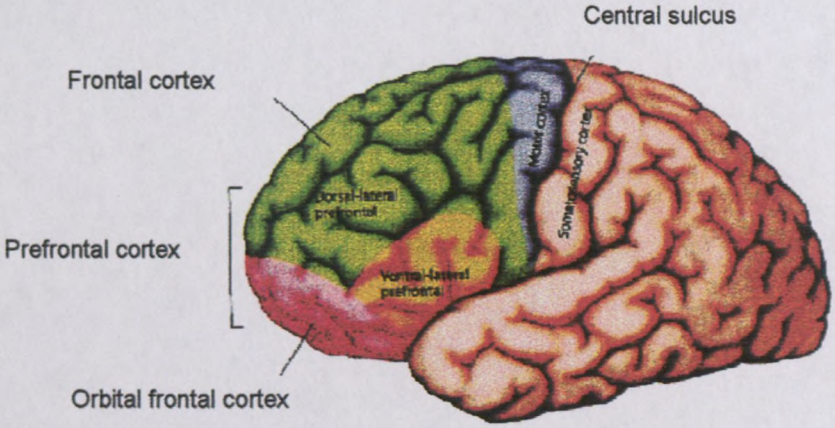

Figure 2.2 Divisions of the frontal cortex. The frontal cortex oversees functioning in numerous areas, for example the motor areas and somatosensory areas.

in the temporal lobe. All of these areas represent the main motor and sensory areas. The association cortex assists the main cortices in their functions. It is not exclusively motor or sensory. For example, visual information are processed in the occipital lobe, but also in the association areas located in the temporal and parietal lobes. The occipital- and temporal areas are interconnected by the "what" pathway, which aids the identification of objects.

The forebrain is located below the cerebral cortex (see Figure 2.3). The forebrain incorporates the limbic lobe and subcortical structures, forming the limbic system. The limbic lobe consists of the cingulate gyrus, parahippocampal gyrus, subcallosal gyrus, dentate gyrus and hippocampal formation. These structures are interconnected with each other and the main subcortical structures. The subcortical structures include the basal ganglia, hypothalamus and thalamus (diencephalon), and amygdala. The brainstem is located below the forebrain. It includes the midbrain, pons and medulla. The cerebellum is extended around the brainstem at the level of the pons and the spinal cord runs from the medulla to the caudal end of the body.

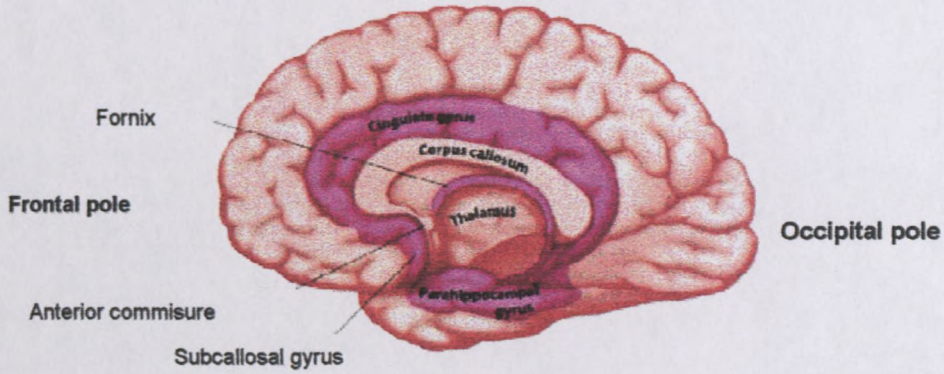

Figure 2.3 The limbic lobe. This figure indicates the structures of the limbic system.

By localising specific functions to above-mentioned brain areas, six classes of cognitive functions are derived. A description on the different classes and their associated brain areas follow. Impairments associated with each class are also mentioned.

2.2.1 Attention and Concentration

2.2.1.1 General aspects of attention and concentration

Attention and concentration act as the main controlling functions during conscious states. Efficient operation of most other brain functions depends on the intactness of these functions. When attentional processes are abnormal, problems to perform tasks are encountered due to altered consciousness (Mangun, 1997). For example, to perform a specific motor act on command, will be a problem. Attention is the ability to focus on a specific stimulus, and to maintain this focus, is concentration (Kaplan and Sadock, 1998). Attention refers to being aware of the environment and self. Awareness guides interaction with the world. The reaction elicited will depend on the level of awareness. When in a drowsy or tired state, one will not be so alert to the environment. Under normal circumstances one is

generally alert, whereas a state of hyper alertness will occur when in emergency situations (Gazzaniga et al., 1998). The different levels of attention and concentration contribute to establish a state of wakefulness.

The brain areas involved in attention are the superior colliculus in the midbrain, the pulvinar nucleus of the thalamus, and parietal cortex (Gazzaniga et al., 1998). The superior colliculus acts as a discriminator by directing the eyes towards specific stimuli. The pulvinar nucleus is visually responsive to colour, motion and orientation of stimuli. It also filters distracting information to allow a clear focus on relevant stimuli. What is relevant for the moment depends on current goals. The parietal cortex acts as an executive in discriminating and placing stimuli. Placing of a stimulus refers to its spatial position, or simply where it is located. Thus, selective attentional processes or spatial attention is at work (Gottlieb, 2002).

The thalamus is also important in concentration. An interaction exists between the thalamus and the anterior cingulate gyrus (Hugo and Potocnik, 2002). As seen above, the thalamus aids in the discrimination of an object, but a sustained focus is needed to identify and place it in context. The anterior cingulate gyrus plays a role in sustaining this focus (Malloy and Richardson, 1994). (See 2.1.5 for more information on context and interaction.)

2.2.1.2 Impairment in attention and concentration

Impairment in attention and concentration involves an inability to uphold a focus on specific stimuli. Impairments include distractibility, selective inattention, trance and hypervigilance (Kaplan and Sadock, 1998). Distractibility is experienced when there is an inability to focus, due to problems in filtering out irrelevant stimuli. When selectively inattentive, awareness of the self or environment is limited (Lezak, 1995). A trance refers to an altered state of consciousness. Attention is focused on things not immediately present as with hypnosis. In a state of hypervigilance there is an extensive focus on stimuli. Obsessive-compulsive disorder, for example, present with checking a door repeatedly to see whether it is locked.

2.2.2 Language

2.2.2.1 General aspects of language and language impairment

Language functions can not be examined in isolation. Although distinct brain areas have been identified, interaction exists between regions such as language, motor, memory and executive regions. The main language areas are Broca's area which is located in the inferior

frontal cortex and Wernike's area in the posterior-superior temporal cortex (Gazzaniga et al., 1998). These areas are interconnected. To understand the connections and localisation of language functions a comprehensive assessment is important (Malloy and Richardson, 1994). Language abilities include fluency, comprehension, repetition, naming and word finding, reading and writing.

Impairment in language function caused by brain damage is referred to as aphasia (Benson, 1973). Below normal blood flow to a specified brain region, or hypoperfusion, may also cause aphasia. Fridriksson et al. (2002) has found that reduced left cerebral hemisphere perfusion is related to aphasia severity. This suggests that hypoperfusion may contribute substantially to this disorder.

Many types of aphasia have been described (Benson 1973; Christensen and Caetano, 1996). Consensus in terms of characteristic features and diagnosis has been problematic (Malloy and Richardson, 1994; Gordon, 1998). Mixed aphasia has therefore been highlighted since most patients present with a combination of language deficits.

2.2.2.2 Spontaneous speech

The spontaneity of speech is a function of fluency. Fluency has been defined in various ways. Typical components have been identified according to the focus of research and the theoretical perspectives of clinicians (Gordon, 1998). These include articulation, expression, phrase length, paraphasia, syntax and word finding ability (Benson, 1973). Paraphasia occurs when a word sounding similar to the one required, is used, for example, "solly" for "sorry". Another example is when a different word is used out of the same category, for example donkey for horse. Expressive language incorporates all of these language functions.

Impairment in spontaneous or expressive speech is referred to as Broca's aphasia or motor aphasia (Kaplan and Sadock, 1998). It is also called expressive or non-fluent aphasia. Comprehension is intact, but the ability to speak is a problem. In fluent aphasia expressive language is intact, but incoherent. It contains jargon, empty speech and paraphasias (Gordon, 1998). Jargon refers to the rapid use of words that is unassociated and incomprehensible (Benson, 1973).

Perseveration often occurs when language production is impaired. Perseveration refers to the multiple repetition of words or actions. It is not restricted to language problems, but also features in, for example, disorders related to executive functioning.

2.2.2.3 Comprehension

Comprehension refers to the ability to understand speech. In a state of incomprehension sensible verbal interaction with the world is virtually impossible. Impairment in comprehension is referred to as sensory, fluent or receptive aphasia (Kaplan and Sadock, 1998). Since impairment is linked to damage in Wernike's area it is also referred to as Wernicke's aphasia. Symptoms are problems in understanding written and spoken language. More specifically, receptive difficulties are experienced by problems in differentiating between phonemes (Christensen and Caetano, 1996). A patient's speech, although fluent and spontaneous, is disordered and does not make sense.

2.2.2.4 Repetition

Sentence repetition represents a measure of speech fluency (Gordon, 1998). Patients can understand words, but have difficulty in producing coherent speech (Gazzaniga et al., 1998). Damage is caused by a disconnection of the neuronal pathways between Wernicke's and Broca's areas. The resulting impairment is called conduction aphasia. Similar symptoms have also been found with lesions in the insula and parts of the auditory cortex (superior temporal cortex) (Gazzaniga et al., 1998).

2.2.2.5 Naming and word finding

Naming and word finding can also be viewed as a measure of speech fluency. In addition, naming of objects also involve executive and perceptual functions. Words are retrieved when one is confronted with visual stimuli (Goodglass et al., 1968). The stimuli can include objects, parts of objects, colour and body parts. Verbal responses can also be elicited when one is required to audibly complete a sentence (Nathaniel-James et al., 1996).

Difficulty in naming and word finding is called anomia, or nominal aphasia (Hugo and Potocnik, 2002). Word finding problems are present in almost all patients with brain injury (Benson, 1973). Noteworthy is that normal individuals will also show much variation in naming ability. This will differ according to age, educational level, culture, and general knowledge. Impairment is characterised by pauses in speech where a specific word is needed to complete a sentence. Circumlocution can also be present. When a specific word can not be produced it is followed by a definition of the word.

2.2.2.6 Reading

The ability to read presupposes intact discrimination of letters into words and sentences, and comprehension of the written words. A verbal response to written words is reflected by articulatory motor processes (Collette et al., 2000). This include the following of words with the eyes and, when requested, audible reproduction of the words by speech. The left cerebral hemisphere is involved in reading ability. Impairment of reading is called dyslexia (Galaburda, 1994). Neuro-imaging has implicated the inferior occipital areas, temporal cortex and superior parietal areas in reading (Collette et al., 2000).

2.2.2.7 Writing

Combining letters into words and sentences according to grammatical and syntactic rules, underlie writing ability. Intact writing is reflected by sentences that is grammatically correct and makes syntactic sense to the reader. Impairment in writing, or agraphia, is associated with damage in the left cerebral hemisphere (Hugo and Potocnik, 2002). It is also referred to as afferent motor aphasia (Christensen and Caetano, 1996). Kinaesthetic processes or muscle movement sense may be impaired in this instance (Lezak, 1995).

2.2.3 Memory

2.2.3.1 General aspects of memory

Memory processes dictate most of our actions. Everything that we know has been and will be attained by learning processes. By learning, new information from the environment is encoded for possible storage in memory stores. First, the information has to be registered and if not filtered out, made stronger to enable storage. Consolidation refers to the strengthening of representations of information. On cellular level, this process refers to a strengthening of neuronal connections by increased activation. Rehearsal causes neurones to increase their firing rate, thus expanding its efficiency in making information readily accessible. Thus, maintenance of memories results from rehearsal.

2.2.3.2 Shortterm and working memory

The first type of memory formed after registration is shortterm memory. Shortterm memory takes on the forms of sensory memory, immediate or shortterm memory, and working memory. The types of memory are defined by how long information is retained during

processing. Sensory memory is involved in creating visual representations of external information. This process lasts milliseconds to seconds. Information is stored as sensory memory traces (Gazzaniga et al., 1998). These traces, which have a large capacity in contrast with shortterm memory, decay very quickly. They are not based on knowledge or meaning, but provide pictures in a visual icon format that is not consciously available.

Immediate or shortterm memory can hold information for seconds to minutes. It processes information based on knowledge. New information is filtered out or retained based on immediate needs and goals. This involves a continuous interaction with longterm memory stores, overseen by executive functions (Davis, 2001). The mechanism involved in the establishment of lasting memories has been a matter of debate. It has been suggested that information be consolidated stepwise, starting with the sensory memory system. Sensory traces are then held by shortterm memory, and transformed to longterm memory by repetition and rehearsal. Thus, the shortterm memory system is only viewed as a temporary holder of information (Gazzaniga et al., 1998). The idea of working memory has replaced this model. The shortterm working memory system involves active processing and not merely holding information.

Working memory is actively involved in shaping information (Mazoyer et al., 2000). These processes occur in the prefrontal cortex. The working memory system is limited in its capacity to store information. Sensory traces and/or information from longterm memory are retrieved and acted upon (Gerrig and McKoon, 2001). To demonstrate this, Baddeley developed a working memory model (Pukrop et al., 2003). The model consists of three interacting parts, namely, the executive control system, phonological loop and visuospatial sketchpad. The executive control unit acts as an attentional supervisory system. It oversees interactions between the phonological loop, visuospatial sketchpad and longterm memory. The phonological loop handles sound inputs and articulatory aspects of speech. The visuospatial sketchpad has to do with visual recollection.

2.2.3.3 Longterm memory

Longterm memory refers to information retained for days to weeks, or even years. Two main forms have been identified, namely explicit memory and implicit memory. Explicit or declarative memory refers to information that can be consciously accessed (Vakil et al., 1997). This includes episodic memory and semantic memory. The temporal cortex is involved in the storage of episodic and semantic information. Episodic memory formation is localised to the medial temporal lobe or hippocampal area, diencephalon and basal nuclei.

Personal aspects and history of the self is referred to as episodic memory. Knowledge about the world that does not directly relate to the self is called semantic memory. Semantic memories are mainly formed in the temporal neocortex.

Implicit or nondeclarative memory can not be brought into conscious thoughts (Davis, 2001). The association and sensory cortices, basal ganglia and possibly the cerebellum, are involved in implicit memory. Procedural memory is a form of implicit memory (Vakil et al., 1997). Skills and habits fall into this category, for example the knowledge to ride a bicycle. Knowledge about the bicycle is not needed after one has learned how to ride it. The basal ganglia are involved in procedural learning.

Priming, associative memory and non-associative learning are also classified under implicit memory (Keane et al., 1997). Priming involves the strengthening of links with specific stimuli, as a result of having been encountered before. It has been implicated in the neocortex. For example, a stranger will be recognised better when seen more often. Classical conditioning (Davis, 2001) is a form of associative memory. For example, a child learns to associate not obeying a command, with being punished. The amygdala and cerebellum has been implicated. Non-associative learning include habituation and sensitisation. Reflex pathways are involved. During habituation a person becomes used to the repeated occurrence of a stimulus or event. For example, one is not alarmed anymore by the petrol price rising every other week. Sensitisation causes one to be alert to certain stimuli. Previous experience of being burned by an iron will cause increased alertness when using it.

2.2.3.4 Impairment in memory processes

Impairment in memory is called amnesia. Amnesia results from brain injury, brain illnesses affecting the ability to recall past events (retrograde amnesia), or psychological trauma. A partial or total loss of the ability to recall things, is experienced (Keane et al., 1997; Vakil et al., 1997). In some cases, the patient will be unable to form new memories. The inability to form new memories is called anterograde amnesia. It mainly involves the medial temporal lobe (Elger et al., 1997). Retrograde amnesia refers to an inability to recall longterm memories. The hippocampus is the main structure affected. However, impairment is limited to weeks or a few years, for example three years before diagnosis. Conditions of temporary memory loss may also feature with retrograde amnesia. For example, transient global amnesia refers to a temporal inability to form new memories, and recall some information from the past. Shortterm memory remains intact. The suspected brain areas involved are the medial temporal lobe and diencephalon.

Dementia represents shortterm memory loss. Patients can recall longterm events about the self and the world, but have problems remembering recent events. For example, patients experience problems in locating objects (Kessels et al., 2002). Spatial memory or memory for the placement of objects is impaired. In addition, the person may get lost due to an inability to learn a new path. However, not only memory is affected. Dementia globally impairs cognitive functioning, but without clouding consciousness. This implies pathology in numerous brain areas.

2.2.4 Receptive and higher perceptual functions

2.2.4.1 Receptive functions

In order to understand how information reaches the different cognitive areas, aspects of the sensory system will be discussed briefly.

The four main modalities of the sensory system include vision, hearing, smell and taste. Somatosensory modalities include touch, pain, proprioception and temperature. Each of the main modalities has receptors respectively sensitive for visual stimuli, sounds, scents and tastes. The retina of the eyes encodes visual information and projects to the primary visual cortex of the occipital lobe. The hair cells of the cochlea are sensitive to sound and projections lead to the auditory cortex. Smells or olfactory stimuli are perceived by receptors in nose epithelium and received by the frontal lobe and limbic system. The brainstem evaluates information on taste projecting from receptors on the tongue (Kaplan and Sadock, 1998).

The visual system plays the most important role in perception. The auditory system may also be involved. After encoding, higher perceptual functions process visual information. This enables object recognition and examination of the environment to decide on appropriate action.

2.2.4.2 Higher perceptual functions

The higher perceptual system has the enormous capacity to discern and recognise objects in various orientations. Perception is constant, thus objects do not undergo a change in shape when the viewpoint changes. This refers to object constancy. To recognise objects, there is interplay between memory and perceptual systems (Murray and Richmond, 2001). Representations of objects and their characteristics are retrieved from memory stores to aid

recognition. When an object is novel a similar object is represented in the brain. For example, when a new species of flower is discovered, representations of similar looking flowers are elicited from memory stores.

Two main neural pathways have been identified in perceptual processes. The "what" or ventral pathway links the occipital and temporal lobes. This pathway is important in perception and recognition of an object. The "where" or dorsal pathway runs between the parietal and occipital lobes. The spatial position of an object, and its location in relation to other objects, is a function of this pathway. Thus, the information processed by each pathway is essentially different. The ventral premotor area has also been implicated in spatial localisation (Rizzolatti et al., 2002).

Objects and faces are recognised by its' characteristic features. Memories on previously seen objects assist in this process (Gerrig and McKoon, 2001). Cells representing each feature are simultaneously activated. For instance, for a train, cells representing a rectangular shape, great size, it running on a railroad and maybe the characteristic hooting, are activated. From last-mentioned it is clear that the auditory system can also assist recognition by perceiving sound and motion. The smell of the train's steam and railway tracks could also guide recognition. Thus, complex interactions exist between the occipital lobe and other brain areas to identify objects.

The perirhinal cortex has been implicated in object perception, recognition, discrimination and making associations between objects' features (Murray and Richmond, 2001). Features, such as the shape of a person's eyes, mouth and nose, specifically activate the inferior temporal gyrus and superior temporal sulcus (Gazzaniga et al., 1998). However, the perirhinal cortex also plays an essential role in viewing parts as a whole. Just by seeing a picture of a nose will not identify a face. Colour can also aid recognition. For example, a yellow, oblong shaped fruit, must be a banana.

2.2.4.3 Impairment in higher perceptual functioning

Impairment in the higher perceptual functions is called agnosia (Lindsay et al., 1997). In visual agnosia impairment are restricted to the visual domain. Vision itself is not affected and knowledge is intact, but there is an inability to process visual information. The object can be named when referring to other sensory domains such as the auditory or olfactory systems. Apperceptive agnosics experience problems in naming an object, because they cannot identify it. Thus, perceptual processing related to object constancy is impaired. In addition,

there is no loss of visual knowledge. Impairment is associated with lesions in the occipital lobe and bilateral temporal lobe (Paradiso, 2002). Lesions in the extrastriate cortex affects the perception of colour and motion (Paradiso, 2002).

Associative agnosia affects the ability to make a functional connection with objects (Gazzaniga et al., 1998). Access to the knowledge memory stores is problematic. Perceptual processing is normal in that representations are retrieved, but meaning can not be attached to an object. Left hemisphere lesions lead to impairment. For example, acquired alexia caused by infarcts is associated with problems in reading; a problem in recognising written words.

Prosopagnosia is indicative of an inability to recognise faces thus visual processing is affected. Recognition can, however, occur by hearing a person's voice. The auditory cortex therefore compensates for the loss. The occipital and temporal cortices are implicated in prosopagnosia. A very definite dissociation exists between object recognition and face recognition. For object and word recognition the focus is on analysis of parts, whereas for faces a holistic view is needed. Information is represented differently. In integrative agnosia separate parts forming an object can not be identified. With faces the separate parts can be recognised, but not integrated into a whole.

2.2.5 Motor functions

2.2.5.1 General aspects of motor functioning

Motor functions represent a physical manifestation of higher order cortical and subcortical processing. On subcortical level the basal ganglia and cerebellum control aggregate movements. The basal ganglia feature as a structural component in neuronal pathways (Alexander and Crutcher, 1990). It interacts with the subthalamic nucleus and substantia nigra, and is connected to the primary, premotor and supplementary motor cortices to assist planning and execution of movements. Walking is but one function controlled by these areas. These motor areas, for example, also control fine motor movements of the hands. In addition, connections are made with the prefrontal areas to assist in shortterm memory processes and executive functions. Executive control involves higher-order functions (see below). It has been implicated in the selection of movement as guided by perception (Gottlieb, 2002).

The cerebellum receives inputs from and project to the motor and sensory areas via the thalamus. This structure is not directly involved in the control of motor movements. It integrates information to maintain posture, and walking and co-ordinated movements. The major role is to maintain balance and flowing movements.

2.2.5.2 Impairment in motor functioning

Impairment in gross movements result in unco-ordinated movements and problems in tone or firmness of the body (Christensen and Caetano, 1996). On higher levels impairment in goal-directed movement results in apraxia. Ideomotoric apraxia refers to the inability to perform simple motor movements to command. Motor movements such as tone and power must be intact. Ideational apraxia is an inability to perform a sequence of acts to complete a task as a whole. Constructional apraxia refers to an inability to correctly copy figures, for example a cube (Lindsay et al., 1997).

2.2.6 Executive functions

2.2.6.1 General aspects of executive functioning

The dynamic executive system controls and directs attention, thoughts and behaviours in interaction with the memory system (Mazoyer et al., 2000). It is involved in planning and purposeful completion of a task. This system is also flexible in that it allows for behaviours to be adapted across varying situations. The prefrontal cortex is the locus of executive functions. Three main areas are included: the lateral prefrontal cortex, ventromedial cortex and anterior cingulate gyrus. Most areas of the brain are connected with the prefrontal lobe. The prefrontal cortex can be viewed as the single most important brain region influencing all brain functions either directly or indirectly.

The memory system is essential for the executive system to perform its functions. Representations of “how to”, “what”, or “where” of objects and procedures, guide action. The lateral prefrontal cortex provides a platform for the working memory system to perform mental operations. The working memory or executive attentional system controls the retrieval of information from the parietal lobe, temporal lobe and other areas fitting the current situation (see section 2.2.3.2). The anterior cingulate gyrus is also indicated in attentional processes (Gazzaniga et al., 1998).

The performance of routine acts is directed by familiar stimuli. For example, the road leading to the café has familiar landmarks telling one where to turn or go straight. The associations made thus underlie goal-directed behaviour, which are controlled by the hippocampus in interaction with the ventromedial and anterior cingulate cortices. Furthermore, in the social domain, one adheres to what is deemed appropriate. Thus, knowledge about social norms is retrieved from semantic memory stores to guide behaviour. Decisions regarding what course of action to follow is also controlled by the interaction of executive and memory functions. An analysis of costs and benefits, or problem solving, will direct choices to be made. In addition, emotional responses related to past subjective experience, are activated by situations (Borod, 1993). Thus, each option may evoke possible advantages and disadvantages, and an emotional connection guiding the final decision for action. Projections from the amygdala are involved in these processes.

The executive system also functions as a filtering mechanism. Fluent goal-directed behaviour follows when the focus is centred on relevant stimuli and distractions are filtered out. An alternative concept is that of an inhibitory system. The left inferior frontal gyrus has been implicated in response initiation, and the left prefrontal areas in inhibition of responses (Collette et al., 2000).

2.2.6.2 Impairment in executive functioning

Impairment in the filtering of information results in an inability to select task-relevant stimuli. The patient is bombarded with numerous cues, but unable to differentiate between them to select appropriate ones. On neural level, there is a problem in maintaining separate representations of stimuli in the lateral prefrontal cortex. Under normal circumstances there is a rapid decay of representations to distinctly identify relevant stimuli. With impairment the decay process is prolonged making it difficult to distinguish between stimuli.

Action in the social domain is also affected by executive dysfunction. The inability to perform goal-directed behaviour leads to problems in performing a plan of action. A patient may be able to carry out the initial steps, but then fails to follow it through. In addition, there is an inability to perceive the failure to accomplish the task. Reactions are impersonal and detached and flexibility as well as inhibitory control may be lost. Alternatives to problems can not be presented due to lesions in ventromedial areas and anterior cingulate. There is a lost sense for social norms and no feelings attached to doing something inappropriate. The person might swear or obliviously imitate inappropriate behaviour. These behaviours result from changes in personality.

2.3 The methodology of cognitive assessment

2.3.1 The hierarchy of cognitive assessment

Gross cognitive abilities have to be normal in order to allow for the assessment of higher cognitive abilities. A neurological examination (Lindsay et al., 1997) is therefore essential to guide further investigation. The neurological examination assesses higher cognitive functions related to the sensory and motor system (Hugo and Potocnik, 2002). Perception, eye movements, hearing, and reflexes, power, tonus and co-ordinated movements are but some of the functions. Primitive motor reflexes such as uncontrolled grab reflexes are indicative of pathology in young patients although it may be normal in the elderly. Thus, the neurological examination's results may be indicative of impairment, but requires confirmation from more in-depth cognitive assessment.

The hierarchy of cognitive assessment refers to the order in which cognitive abilities are assessed. The six classes of cognitive functioning represent distinct functional areas. However, these areas are not isolated from each other. Higher order executive functions such as goal-directed behaviour results from extensive and complex interaction between a number of brain areas. To reliably assess these functions, attention, concentration and language must be intact, including consciousness (Kiernan et al., 1987). In most instances, cognitive tests will start with items related to attention and concentration. It will then be followed by items assessing language, memory, perception and executive functions.

The sensitivity of an assessment tool is predicted by its ability to identify the level of impairment. Bedside tests are more sensitive than a neurological examination. Last-mentioned represents the one extreme to assessment and neuropsychological tests the other. Bedside assessment is placed in-between these two on a continuum. Bedside tests can globally assess mild to moderately impaired patients starting with easier items. Although easy test items such as pouring a cup of tea may be viewed as too easy, it has high specificity to detect impairment. When praxis is impaired, an inability to perform this task will confirm a suspicion of motor dysfunction. Impairment will also be apparent in other areas too, for example executive functioning.

The separate cognitive classes can also be assessed more extensively by a collection of items. The neurobehavioral cognitive status examination (NCSE) (Schwamm et al., 1987) arranges items in a so-called metric. Each domain consists of a series of graded questions, of which a screening item is followed by items graded according to level of difficulty. If a

screening item is completed without error, the specific metric is terminated. The NCSE has been developed to assess cognitive functions at the bedside. Thus, bedside instruments can, in some instances, detect severe impairment. Neuropsychological tests are sensitive to detect mild to moderate impairment due to extensive assessment procedures.

2.3.2 Defining the methods and structure of cognitive assessment

Cognitive assessment is defined in the light of theory- or method driven models. Theory most strongly delineated most approaches underlying assessment until a few years ago. The modern scientific era has, however, seen an inclination towards methods rather than theory (Blinkhorn, 1997). The main reason for this relatively recent change is inflexibility in going beyond the accepted. Scientists get used to certain paradigms within their discipline and it becomes ingrained as the way of thinking. This does not mean that the theories still apply as well as it might have earlier. Yet, the role that has been played by some, for instance Marie Curie, in laying a valuable basis for medicine cannot be omitted.

Psychologists make use of psychometric methods to test research hypothesis, whereas statisticians apply statistical methods to make theoretical models more manageable (Blinkhorn, 1997). Methods such as analysis of covariance can, for example, confirm the hypothesis that race significantly affects test results in schizophrenia (Buchanar and Heinrichs, 1988). This represents an analytic viewpoint. However, although useful, statistics places an obligation on theory to conform to specific techniques of evaluating information. In most instances, the acceptability of a result is measured in terms of its significance. If not found to significantly correlate with specified variables, the finding is, in strict terms, void. Should that result then not be placed in context of other approaches, an otherwise significant result is lost.

Neuro-anatomy has notably guided the assessment of cognitive dysfunction. Methods have been derived from theories regarding the anatomic organisation of functions. There has been a shift from isolated brain function models at one end, and mass action models on the other end, to cohesive brain behaviour models (Luria) (Christensen and Caetano, 1996). Mass action models implicate the entire brain in each behaviour. Cohesive models acknowledge the integration of functions between specific brain areas. In view of this a complete picture of impairment can be obtained (Roth et al., 1986).

According to Reckase (1996) the rationale of assessment is defined by a test's constructs. He/she postulates that the development of test items is based on construct validity. Thus,

test items are selected based on what the test aims to measure. To achieve this one has to understand the variables affecting test results. Gender, for example, affects mathematical ability in that men perform better than women. The items should also sufficiently measure the abilities within a domain. This will enable generalisation of results. Buchanar and Heinrichs (1988) have emphasised the need for exact and reproducible assessment methods. They have developed the neurological evaluation scale (NES) to supplement the neurological examination.

The dust bowl empiricist approach can also guide test construction. This approach suggests the selection of test items that produce different results in the cognitively impaired compared to normal controls (Reckase, 1996). Research is performed after test construction to demonstrate its efficiency. The item-response theory focuses on how test items influence the character of a test (Blinkhorn, 1997). This will predict the usefulness of the instrument for different disorders and levels of impairment.

CHAPTER 3
Existing batteries and individual tests

3.1 Introduction

The number of tests available for cognitive assessment has increased recently. Work is being done to validate existing tests, improve on test items and, develop new methods for assessment. It is difficult to describe every existing battery or individual test. Therefore, tests were selected to give a general idea of what is available for assessment of some or all of the six main cognitive domains. Most of the tests are frequently used, recognised and are well known.

The tests have been grouped according to its classification as a battery or individual test. Many tests used in South Africa (SA), are based on tests developed elsewhere. In some cases it has been adjusted to be culturally relevant. More often, SA clinicians still use tests based on standards set by England and the USA (Shuttleworth-Jordan, 1997). Much criticism has been raised concerning this issue, especially regarding the validity of tests not standardised for SA conditions. Where applicable the standardised SA version of a foreign test, or original SA test is described.

Psychological tests developed in SA, focus mostly on intelligence, aptitude, personality, and interest (Louw and Edwards, 1993). Students and employees in the public and private sector are often assessed by tests based on the latter two. Aptitude and intelligence tests are mainly used in schools. South Africa has developed a variety of intelligence tests for use with children and teenagers. The number of adult intelligence tests is very limited. The main test to assess intelligence is the SA version of the Wechsler Adult Intelligence Scale. It assesses the most prominent cognitive abilities.

3.2 Test batteries

3.2.1 Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) (Dick et al., 1984; Ylikoski et al., 1992; Crum et al., 1993) is arguably the most well-known and often referred to tool for cognitive assessment. The test evaluates orientation, attention, memory, language and comprehension. The goals of the MMSE are to grade the degree of cognitive impairment in the shortest time possible.

The MMSE takes 5-10 minutes to administer, and is easily administered at the bedside (Dick et al., 1984). It is a rough screening aid that is used to detect the presence of syndromes such as delirium and dementia (Nelson et al., 1986). Low scores, indicative of cognitive impairment, has been found for schizophrenia, mental retardation and depression (Crum et al., 1993). In addition, the MMSE is useful in grading brain-injured patients' cognitive status. This assists in devising treatment and rehabilitation options.

While the MMSE is useful to detect disorders, it is unable to localise impairment. The score obtained by the MMSE can therefore provide a starting point to guide further investigations. A score of 27 out of 30 may be indicative of a dementia in the light of shortterm memory complaints. However, almost perfect scores (29 out of 30) may also be found in the presence of impairment. In the early stages of vascular dementia, patients still present with good insight and awareness of date and time. In this instance, the medical history and information on the development of the disorder will be crucial for diagnosis. Different disorders portray physiologically different pictures. Alzheimer's dementia develops gradually whereas vascular dementia develops abruptly. A more extensive cognitive assessment will therefore be required due to the MMSE's inability to highlight the specific differences (Pasqualetti et al., 2002).

MMSE scores strongly correlate with age and educational level (Stuss et al., 1996; Marcopulos et al., 1997). The elderly achieve lower scores. The lower the educational level the lower the score. It is therefore important to consider a patient's age and educational level when interpreting an MMSE score. Consistency in findings suggests high validity of scores. Scores can be generalised, thus used as norms, when a population's characteristics are similar to the assessed group. The aim is to achieve a high rate of true positive diagnoses. The MMSE can assist in this process by laying a foundation for the clinical workup.

3.2.2 Short Portable Mental Status Questionnaire and Mental Status Questionnaire

The Short Portable Mental Status Questionnaire (SPMSQ) assesses orientation and memory (Zunzunegui et al., 2000). Another test, the Mental Status Questionnaire (MSQ) is identical to the SPMSQ apart from one item. The SPMSQ has an additional serial subtraction item (Nelson et al., 1986). Other items are questions regarding orientation to time and place, date of birth, age, past and current presidents. Both tests are good material for teaching due to its simplicity. The tests are useful in diagnosing dementia (Stuss et al., 1996) and delirium (Nelson et al., 1986). It can not, however, differentiate between the types of dementia.

Some studies, cited by Nelson et al. (1986), have demonstrated test scores to be influenced by race and educational level. The MSQ significantly correlates with age and education and is sensitive to gender differences (Stuss et al., 1996). However, a major limitation of the SPMSQ and MSQ is high false negative diagnoses. Scores must therefore be carefully adjusted to overcome this limitation (Nelson et al., 1986).

3.2.3 Executive Interview

The Executive Interview (EXIT25) (Royall et al., 1992) has been developed to assess executive functioning at the bedside. The purpose was to address the lack of test items sufficiently assessing this domain. The executive dimension is difficult to assess, since each individual functions uniquely. In this, a comprehensive assessment enables the identification of behaviours that goes beyond the expected norm.

The EXIT25 is useful in assessing conditions associated with executive dyscontrol. It is especially practical for use in the demented elderly (Royall et al., 1992). Dementia affects all aspects of executive functioning. These aspects are intrinsically related to personality features and resulting behaviour. A patient's demeanour most notably indicates impairment. For example, changes in a person from being spontaneous and outgoing to apathetic and uninvolved will alert a clinician.

The EXIT25 consists of 25 items. The items focus on the following executive functions; frontal release, cognitive perseveration, loss of spontaneity, disinhibition, verbal intrusions, utilisation behaviour, imitation behaviour, and environmental dependency (Malloy and Richardson, 1994). Purposeful behaviour is assessed by, for example, word and design fluency tasks. The patient must produce as many words or designs possible in a minute according to given instructions. Decision-making and automatic responses are also elicited by test items based on social situations (Royall, 1992).

The EXIT25 takes 10-15 minutes to complete. A score of 0-50 can be achieved. Each item is scored on a scale of 0-2, the criteria dependent on the specific item. The higher the score the greater the impairment. Where uncertainty exists regarding the actual presence of impairment, "cutoff" scores are helpful. However, these scores need to be determined carefully.

The EXIT25 has numerous advantages (Royall et al., 1992). It is simple to use by physicians from various disciplines and even non-medical staff can be named as raters. The EXIT25

also has sufficient face validity. Face validity means that the test is found to be appropriate, appealing and relevant (Tyler and Walsh, 1979). Scores highly correlate with the MMSE. Patients err on similar abilities, for example, performing a command. Thus, the level of impairment coincides with MMSE scores. The EXIT25 further enables the clinician to identify executive disability and localise the impairment. Executive dyscontrol can be identified in dementia, major depression, schizophrenia, diabetes mellitus, HIV and normal ageing (Royall, 1998). New ways to view problem behaviour is thus provided. This guides treatment options and impacts on the control of potentially problematic social cues.

3.2.4 Mattis Dementia Rating Scale

The Mattis Dementia Rating Scale (MDRS) (Schmidt et al., 1994) also referred to as the Dementia Rating Scale (DRS), evaluates general cognitive functioning in the demented. It is suitable for persons 50 years and older. It has sufficient reliability and validity for use as an initial screening instrument for dementia (Hofer et al, 1996). The MDRS can also differentiate between different types of dementia (Lucas et al., 1998). Numerous authors have demonstrated that the test distinctly discriminate Alzheimer's disease from dementia related to Huntington's disease, Parkinson's disease, Binswanger disease and progressive supranuclear palsy.

The MDRS is a compilation of well-known and frequently used cognitive test items. Since these items have proven to be valid and useful, the MDRS is favourably accepted (Hofer et al., 1996). Attention, initiation and perseveration, construction, conceptualisation and memory are assessed, and it takes 30-40 minutes to administer (Nelson et al., 1986). Items in the MDRS are hierarchically arranged to allow for discontinuation of the first item of a specific section when performance is adequate (Schmidt et al., 1994).

The range of possible scores is 0-144. Mattis has recommended a cutoff score of 137 and less as an indication of cognitive dysfunction (Schmidt et al., 1994), but extended normative studies found this to be too stringent (Lucas et al., 1998; Van Gorp et al., 1999). In addition, the need for age and education adjusted norms have been demonstrated as these have a profound effect on MDRS scores.

Nelson et al. (1986) pointed out specific advantages and limitations of the MDRS. The battery obtains information and interprets results in a standardised manner improving diagnostic accuracy. It is able to detect moderate to severe dementia and delirium. In addition, the MDRS have adequate test-retest reliability making it useful to monitor patients

over time. It is also useful as a teaching tool as it is simple and clear. However, the MDRS lacks test items for non-verbal functions. This restricts the detection of right hemisphere dysfunction. Another limitation is the high false negative rates found for mild cognitive dysfunction. To address some of these shortfalls, Schmidt et al. (1994) strongly suggest education-specific cutoff points within age groups, whereas Lucas et al. (1998) focus attention on the lack of norms for different ethnic and cultural groups. An adjustment towards higher cutoffs for highly educated persons and lower cutoffs for poorly educated populations has also been suggested (Lucas et al., 1998).

3.2.5 Kingston Standardised Cognitive Assessment-Revised

The Kingston Standardised Cognitive Assessment-Revised (KSCA-R) (Hopkins, 1993) focuses on global cognitive functioning in the elderly. This battery is a revision of the Kingston Geriatric Cognitive Battery. The main purpose of the KSCA-R is to detect cognitive impairment associated with progressive dementia. The KSCA-R, however, is not as sensitive as formal neuropsychological batteries. Thus, a rough estimate of a person's strengths and weaknesses are made. This can guide a multidisciplinary rehabilitation team's decisions regarding diagnosis and treatment (Hopkins, 1993).

Three major areas of cognitive functioning are assessed: (1) orientation, (2) spatial-motor ability, and (3) language (Hopkins et al., 1993). Most test items are original, thus developed by the authors. The KSCA-R is a pencil and paper test and no special training is required to administer it. It is a fairly quick measure that takes on average 30 minutes to complete. Results can be compared to available norms. The normative values compiled from patients and elderly controls have proved valid. Percentile scores on each item and a total score can therefore be compared to discern cognitive status.

The shorter version, the Brief KSCA-R, has been compiled to measure cognitive function over time. Administration time is 15 minutes. A great advantage of this faster test is that it can be reliably used at the bedside. It also provides more information on cognitive status than the MMSE (Hopkins, 1993).

3.2.6 Neurobehavioral Cognitive Status Evaluation

The Neurobehavioral Cognitive Status Evaluation (NCSE) (Kiernan et al., 1987; Schwamm et al., 1987) represents a global measure of cognitive function, with specific emphasis on the assessment of independent functional areas. Often screening instruments only focus on

global estimates of cognitive function. Extensive assessment of each main cognitive function may give more precise information regarding specific impairment. The main purpose of the NCSE is to distinguish confusional states from dementia and differentiate specific deficits of cognition (Kiernan et al., 1987).

The NCSE assesses three general cognitive factors and five major brain functions. The general factors include level of consciousness, attention and concentration. The major functions are language, constructions, memory, calculations and reasoning. The evaluation of attention and concentration is placed first since impairment in these areas will influence functioning in all other areas. Assessment can then be terminated early to avoid a distorted picture of functioning in other areas.

The NCSE is designed to shorten assessment time for persons with better cognitive functioning. Items are set in the form of what is called a metric. Each domain consists of a series of graded questions, of which a screening item is followed by items graded according to level of difficulty (Van Gorp et al., 1999). If a screening item is completed without error, the specific metric is terminated. Rapid cognitive assessment is achieved by screening normal individuals in less than 5 minutes, and assessing patients in 10-20 minutes time (Kiernan et al., 1987).

The authors of the NCSE have found the battery to be very sensitive in delineating specific deficits. However, further research by Van Gorp et al. (1999), in a comparison study with the MMSE and MDRS, has found low sensitivity of most items to separately detect dementia. Better results were found when decisions were based on one or more sub-tests. The NCSE could detect mild to moderate dementia with similar accuracy than the MMSE and MDRS, but did not appear to differentiate between Alzheimer's disease and vascular dementia.

The aim of the NCSE was to accomplish comprehensive, but quick assessment of each cognitive domain. However, all, but reading and writing skills were included in the language sub-test. One would be able to detect the major aphasic syndromes (Kiernan et al., 1987), but may need to further assess these to detect specific language impairment. In contrast, most users of the NCSE were found to refer back to a global estimate of cognitive function (Van Gorp et al., 1999), thus defying the main purpose of focusing on a differentiated profile.

3.2.7 Clinical Dementia Rating

The Washington University Clinical Dementia Rating (CDR) has been developed to follow the natural course of dementia of the Alzheimer's type (Burke et al., 1988). The battery measures current cognitive functioning, staging the level of impairment with high reliability (Morris et al., 1997). Multiple areas concerning activities of daily living are also included. The CDR is therefore much more comprehensive than the MMSE (Burke et al, 1988). It can be a useful accompaniment to the MMSE.

The CDR consists of six sub-tests: memory, orientation, judgement and problem solving, involvement in community affairs, involvement at home and in hobbies, and personal care. A score is obtained for each section and then an overall score is computed. Each sub-test score gives an indication of level of impairment, on a 5-point scale: 0=no impairment, 0.5=questionable, 1=mild, 2=moderate, and 3=severe impairment. The 'Personal Care' item has no 0.5 impairment level.

Substantial agreement (83%) on scores has been found between investigators from 30 different sites (Burke et al., 1988; Morris et al., 1997). Raters' perception of what the test measures appeared to be good (Franzen et al., 1989). In addition, the CDR's semi-structured format and definite criteria gives it good, reliable grounds to be used as a standardised, global scale within multi-center studies. Physicians and non-physicians with experience in working with Alzheimer's disease patients can use this test after training.

3.2.8 Cambridge Mental Disorders of the Elderly Examination

The CAMDEX or Cambridge Mental Disorders of the Elderly Examination (Roth et al., 1986; O'Connor et al., 1989) comprehensively assesses the main functional areas of cognition. The test has a multi-faceted approach. It aims to incorporate most factors that could influence decisions regarding a diagnosis of dementia, especially mild forms. The CAMDEX also differentiates dementia from non-dementing disorders such as delirium (Roth et al., 1986).

The CAMDEX consists of three main sections: (1) a structured, clinical interview with the patient to obtain information regarding present state, past history and family history; (2) a range of cognitive tests comprising a neuropsychological battery; and (3) a structured interview with an informant or relative about the patient's present state, past history and family history. Section 2, also referred to as the Cambridge Cognitive Examination (CAMCOG), includes the MMSE and additional items. Orientation, language, memory,

praxis, attention, abstract thinking, perception and calculation are assessed comprehensively. Section 1 and 2 also incorporate systematic assessment of language aspects. The patient sections take more or less 60 minutes to complete and the informant/relative section, 20 minutes.

The CAMDEX has high interrater reliability. It also has high sensitivity, and high specificity for dementia (Roth et al., 1986; O'Connor et al., 1989). Last-mentioned was especially true for those mildly demented. This confirms the aim of this test. Non-demented individuals are recognised by the instrument, even in situations of mild cognitive impairment.

O'Connor et al. (1989) has found informant histories, obtained from community studies, to correlate with elderly patients' scores on cognitive testing and observations made by psychiatrists. Social background had no effect on an informant's perception of a patient. In addition, no ceiling effects were demonstrated with the CAMDEX. Almost perfect scores with no specific value do not need to be clarified.

3.2.9 Cognitive Capacity Screening Examination

The Cognitive Capacity Screening Examination (CCSE) (Nelson et al., 1986) is a screening tool for general cognitive impairment. It consists of 30 items that include orientation, digit span, concentration, serial sevens, repetition, verbal concept formation, and shortterm verbal recall. Administration time is 5-15 minutes.

A score of less than 20 on the CCSE is indicative of cognitive impairment, but many validation studies have found high false negative rates (up to 51%) at this score (Nelson et al., 1986). Schwamm et al. (1987) has found a false negative rate of 57%. The cutoff value may need adjustment and hence, more studies are required.

The CCSE does not sufficiently assess non-verbal functions. Construction items are absent and the overall number of test items limited (Schwamm et al., 1987). The ability of test items to detect neurological syndromes, especially in the right brain hemisphere, has proven unreliable. A clinician will have to include other tests with the CCSE if comprehensive information on cognitive functions is needed.

3.2.10 Wolinsky Amnesia Information Test and the Galveston Orientation and Amnesia Test

The Wolinsky Amnesia Information Test (WAIT) (McDonald and Franzen, 1999) is essentially the same as the Galveston Orientation and Amnesia Test (GOAT) (Hilton et al., 1990). The WAIT contains all the GOAT items and some additional items. The GOAT is the most frequently used instrument for the assessment of cognitive status after closed head injury. It is a brief test and can be used in the emergency room, field, or at the bedside.

Although excellent validity and reliability results have been demonstrated with the GOAT, problems are encountered with scoring. A response is taken either as right or wrong, not allowing for an investigation of why an item is found difficult. The battery also lacks more in-depth items concerning personal or temporal information. Information regarding events that happened at a given time in a person's life is of temporal nature. Additional information could enhance the understanding of a patient's cognitive status, for example, when a patient's age is not given correctly, by asking the date of birth. Hence, the WAIT was developed.

The WAIT measures orientation to person, place and time; date of birth; memory for events that preceded and followed the injury; more details about the incident that caused the injury; and current and immediate past presidents of the United States of America. The item personal/temporal continuum memory and additional questions on events that may have occurred during a dazed state or changes in consciousness were added.

A score of 0-100 can be achieved on the WAIT. Each section is scored separately to allow for partial credit on items where difficulty is encountered. Deficits might therefore be more apparent. Examination for possible cutoff scores also proved useful. Patients can thus be grouped according to level of cognitive impairment, either as mildly injured or normal (>70), borderline (63-70) or defective (<63).

The WAIT has been found to adequately discriminate between the levels of impairment. In addition, the constructs used proved applicable and valid. The inclusion of the item personal/temporal continuum memory may be useful in guiding clinical decision-making.

3.2.11 Mental Deterioration Battery

The Mental Deterioration Battery (MDB) (Carlesimo et al., 1996), developed in Italy, aims at providing information on the functional status of various cognitive areas. Specifically, the

objective is to diagnose dementia and predict the type of dementia. The battery is practical for use wherever it is needed. Thus, no specialised equipment is required.

The MDB consists of seven tests with memory having two sub-tests, thus four verbal and four visuospatial tests. Verbal and visuospatial abilities are assessed in addition to memory, constructive praxis, language ability and conceptual reasoning. Memory is assessed by the two sub-tests, immediate and delayed recall of words. Well-known single tests have been included in the MDB. These include Rey's 15 words for recall, word fluency by Borkowsky, Benton and Spreen, and Raven's Progressive Coloured Matrices. It takes 45-75 minutes to administer.

Age and education significantly influence test scores (Carlesimo et al., 1996). Gender, however, did not effect results. When the separate tests were examined for validity, low diagnostic reliability was found. Yet, despite this finding, the battery as a whole produced very high specificity and especially, sensitivity to correctly discriminate between normal and demented individuals.

3.2.12 Alzheimer's Disease Assessment Scale

The Alzheimer's Disease Assessment Scale (ADAS) is a scale developed by Rosen et al. (1984). The purpose of the ADAS is to evaluate the severity of impairment in dementia of the Alzheimer's type. This presupposes a diagnosis of Alzheimer's disease. The scale is also used in clinical trials to monitor the course of the illness and effectiveness of medication (Doraiswamy et al., 1995).

The ADAS assesses cognitive and non-cognitive functions (Rosen et al., 1984). Originally the battery consisted of 40 items. 17 functions were cognitive and 23 non-cognitive functions. The more recent version includes 21 items that were selected on the basis of significant interrater and test-retest reliability. This makes the ADAS to be a reliable grader of impairment over time for independent raters. In some instances, only the cognitive version of the ADAS, the ADAS-Cog (Doraiswamy et al., 1995) is used. What has taken 45 minutes to administer is reduced to 20-35 minutes depending on impairment severity. The cognitive functions are memory, language and constructional praxis. The non-cognitive aspects include functions such as depression, concentration and distractibility, delusions, hallucinations, motor activity and appetite.

The ADAS has proven to be a reliable independent measure of cognitive and non-cognitive aspects of cognition (Rosen et al., 1984). The test could properly discriminate between normal controls and Alzheimer's patients. In test-retest procedures patients showed no improvement in scores, whereas controls improved. Thus, the inability of Alzheimer's patients to be influenced by potential learning effects is confirmed.

Results significantly correlate with level of education. Doraiswamy et al. (1995) has demonstrated a significant effect for baseline scores, and ADAS-Cog retest scores at 12 weeks for total score, and 10 of the 11 sub-test scores. The higher the educational level, the higher the scores, and vice versa. These scores were controlled for age, level of impairment and gender. This has definite implications for the interpretation of results.

3.2.13 Neurobehavioral Rating Scale

The Neurobehavioral Rating Scale (NRS) (Hilton et al., 1990) is a bedside battery briefly screening for cognitive dysfunction. It also includes a semi-structured interview to assess functional aspects of behaviour. The battery can be administered in 15-20 minutes. The NRS is implicated in closed traumatic brain injury (Vanier et al., 2000) and stroke. It has also been recommended for use in Alzheimer's disease, vascular dementia, alcohol dementia and HIV-related dementia (Sultzer et al., 1995).

The NRS assesses cognitive functions such as concentration, shortterm memory and distractibility. Secondly, behavioural aspects focus on apathy, irritability and social withdrawal. Thirdly, motor aspects including progressive problems with writing, balance and weakness in legs are evaluated. Vanier et al. (2000) has identified five factors through factor analysis of the NRS-revised. These include intentional behaviour, emotional state, survival-oriented behaviour, arousal status and language. The factors comprise 27 items arranged in a Likert-type scale. Behavioural changes are judged according to seven categories ranging from "not present" to "extremely severe".

The NRS and NRS-revised has significant interrater reliability (Hilton et al., 1990) and factorial and criterion validity (Vanier et al., 2000). It has been implicated as a reliable tool for the global assessment of dementia (Sultzer et al., 1995). The NSR is quick and easy to administer by nurses in place of routine cognitive assessment. This will assist in monitoring a patient's cognitive status, and planning for placement and care of HIV-demented patients.

3.2.14 The Wechsler Adult Intelligence Scale – Revised (WAIS-R) and South African Wechsler-Bellevue Adult Intelligence Scale

The South African Wechsler-Bellevue Adult Intelligence Scale (SAWAIS) is based on the WAIS-R, a revision of the intelligence scale developed by Wechsler (Franzen and Iverson, 2000). Intelligence refers to mental alertness, speed of intellectual function and comprehension. Psychologists aim at assessing general cognitive ability with the SAWAIS, whereas neuropsychologists focus on how brain damage affects different functions (Grieve and Van Eeden, 1997). Thus, a profile of cognitive functioning is acquired. Impairments assessed usually correlate with brain areas being tapped. However, the SAWAIS are not sensitive to detect frontal lobe impairment (Lezak, 1995).

The SAWAIS assesses the same abilities as the WAIS-R. It consists of seven verbal sub-tests and six practical sub-tests. The verbal items are information; comprehension; arithmetic; digits forward, backward and combined; and similarities. A vocabulary item is also included, but not counted when a final score is computed. The practical items include picture completion; object assembly; block design; digit symbol 90 seconds and digit symbol 120 seconds; and picture arrangement. After completion a verbal and practical IQ score is derived. The score is then categorised on different levels of intellect such as gifted, of normal intelligence or mentally retarded.

Different versions of the WAIS worldwide have demonstrated good validity. Unfortunately the same does not apply to SA. In the South African context, the need for culturally relevant instruments, are highly stressed. Socio-cultural factors such as language, education and different socio-economic environments significantly effect results (Grieve and Van Eeden, 1997). The lack of a standardised version of the SAWAIS, is a problem that has not received adequate attention (Pieters and Louw, 1987). Some items, for example, the question on the state president and literature referred to, are 20 years outdated. In addition, no information is available on the specific abilities assessed.

American descriptions of items are also generally used to interpret the SAWAIS. This definitely has a negative impact on the reliability and validity of the SA version (Pieters and Louw, 1987). Results have been used in forensic settings and for insurance and disability claims, with unknowing consequences. It has been suggested that other batteries, assessing similar abilities, may prove more useful to assess a range of cognitive abilities.

3.2.15 The Wechsler Memory Scale – Revised and Two-Sub-test Short Form

The Wechsler Memory Scale – Revised (WMS-R) developed by Wechsler (Van den Broek et al., 1998), is a comprehensive measure of memory. It takes 50 or more minutes to administer. The memory domains assessed are verbal, visual, general, figural and logical memory. Items include attention, concentration and orientation tasks; delayed recall tasks; digit and memory span; paired associates; and reproduction tasks. The WMS-R's length, and usefulness of such an extensive memory assessment, has received much criticism. Short forms have therefore been suggested (Van den Broek et al., 1998).

The Two Sub-test Short Form contains items derived from the WMS-R. The General Memory Index (GMI) includes items that contributed most significantly to the assessment of verbal and visual memory. A three-sub-test short form has also been suggested. In this form the GMI is predicted by items I of logical memory, visual reproduction and visual paired associates. The Delayed Recall Index is predicted by items II of last-mentioned items.

The short forms correlated well with scores from the WMS-R. The two-sub-test short form was, however, not as sensitive. Caution is needed in using it as an appraisal of memory functioning (Van den Broek et al., 1998). The three-test short form may be better to use when time is limited.

Age and education significantly affected numerous of the sub-tests of the WMS-R (Marcopulos et al., 1997). This has definite implications in the use of age and education adjusted norms for similar memory tests.

3.3 Individual tests

3.3.1 Controlled Oral Word Association Test

The Controlled Oral Word Association Test (COWAT) (Tröster et al., 1995; Harvey and Siegert, 1999) is a test of verbal fluency. It assesses the ability to generate words starting with a specific letter. One version of the COWAT uses the letters F, A, and S. A person must name as many words possible in a minute, for each letter. The COWAT represents a form of phonetic naming, whereas animal naming is a semantic version of naming. The letters C, F and L have also been used to limit word formation to specific phonemic classes (Sumerall et al., 1997).

According to standardised administration procedures a person may not use proper names. Perseveration, or giving a word more than once each time with a different ending, is also not allowed. Healthy individuals sometimes use words more than once. However, when a word is used five or more times in the above-mentioned manner, a clinician will suspect impairment in word retrieval (Sumerall et al., 1997).

Education significantly influences word naming (Ivnik et al., 1996; Harvey and Siegert, 1999). Persons with higher education generate more words. No significant effect for age and gender has been found. Depressed Parkinson's patients showed impairment in naming (Tröster et al., 1995). Harvey et al.(1999) and Sumerall et al. (1997) could, however, not demonstrate an effect for depressed patients.

3.3.2 Boston Naming Test

The Boston Naming Test (BNT) assesses word finding ability by confrontation naming (Saxton et al., 2000). Confrontation naming refers to the naming of objects on visual presentation. The inability to name objects is called nominal aphasia. It occurs in dementia such as Alzheimer's disease and many other conditions of brain injury.

The more recent version of the BNT consists of 60 items. The items are arranged in order of difficulty. Saxton et al. (2000) has also presented two equivalent 30-item short forms. These forms have been found reliable and to correlate well with the longer version. A person is given 20 seconds to name an object and when not named correctly or at all, this is followed by a stimulus cue, allowing another 20 seconds to respond correctly. If the person fails again, a phonemic clue is given and 20 seconds are allowed for the answer.

Age and education, but not gender, significantly influence test scores (Ivnik et al., 1996; Saxton et al., 2000). A study to establish aphasia severity demonstrated a significant correlation of BNT scores with the level of word finding ability in stroke patients (Holland et al., 2002). The lower the score, the more apparent the aphasia was. The BNT can also be useful in the evaluation of speech recovery or cognitive decline over time.

Reliable normative data are available for the BNT, which makes it useful for clinical practice. Yet, it has not been tested for validity. In addition it is lengthy and time-consuming.

3.3.3 Graded Naming Test

The Graded Naming Test (GNT) is a standardised tool for the assessment of word finding ability. It is useful in the detection of mild word finding difficulties and documenting changes in naming ability (Warrington, 1997). The test includes 30 line drawings, graded according to difficulty, in which a person must name what is in the picture (Harvey and Siegert, 1999).

The GNT can be used for those aged 18 and above. Scores very strongly correlate with general vocabulary level or verbal IQ, thus educational level (Harvey and Siegert, 1999). Last-mentioned is demonstrated by scores highly correlating with the National Adult Reading Test (Freeman and Godfrey, 2000). The higher the educational level the higher the scores obtained. Only a small correlation was found between age and GNT scores.

3.3.4 Clock Drawing Test

The Clock Drawing Test (CDT) is a quick and simple measure of frontal and tempero-parietal brain function (Brodaty and Moore, 1997), or more specifically, executive and visuoconstructive performance, and verbal and numerical memory (Kirby et al., 2001). The test is mainly used for the detection of mild to moderate Alzheimer's Disease.

There are different variations in measurement with the CDT. The most commonly used method requires the patient to draw a clock face with all the numbers, and the hands set at 10 past 11. Other methods include drawing a clock face with the time set at 10 past 11 where a pre-drawn circle is provided (Shulman method), drawing a clock with the arms set at 2:45 (Sunderland method), or merely drawing a clock on a pre-printed circle (Wolf-Klein method) (Brodaty and Moore, 1997). The Clock Completion Test (Watson et al., 1993) follows the same procedures as the Wolf-Klein method. Each of these methods has different criteria for scoring, which correlate fairly well with each other.

Although there is agreement in the ability of the CDT to accurately identify mild to moderate dementia (Watson et al., 1993; Gruber et al., 1997), results regarding the effect of age, education and depression have not been consistent. Age was found to influence performance on the CDT significantly (Marcopulos et al., 1999). One study suggested that increasing age might lower scores (Brodaty and Moore, 1997), whereas another found no effect for age. Education significantly influenced results in two studies (Gruber et al., 1997), but not in another study (Brodaty and Moore, 1997). Marcopulos et al. (1999) found a

sensitivity of CDT scores to depression, while Brodaty and Moore (1997) could demonstrate no effect. In most of these studies gender did not effect clock drawing ability.

3.3.5 Rey-Osterrieth Complex Figure

The Rey-Osterrieth Complex Figure (RCF) (Shannon and Tollman, 1994) assesses visuospatial ability and memory. It has been implicated in brain pathology and injury, for example dementia and multiple sclerosis. A standardised figure is presented to the patient and must be copied. Having the patient draw it without visual aid then assesses immediate recall. After 30 minutes, repeated copying assesses delayed recall.

The patient is closely observed for copying strategies. Coloured pens are provided in a specific order each time a section is completed, to document the order of and overall approach to copying (Lezak, 1995). Scoring then focuses on the accuracy of copying, placement and distortion of features. The Boston Qualitative Scoring System has proved most reliable in the light of other scoring systems (Folbrecht et al., 1999). It adds additional information on quantitative aspects. Objectivity is stressed to attain valid results.

3.3.6 Design Fluency Test

The Design Fluency Test (DFT) is a written test developed by Jones-Gotman and Milner (1977). The aim was to investigate the involvement of the right frontal hemisphere in the production of drawings. Similarly the COWAT (Tröster et al., 1995) assesses verbal fluency, but is dominated by the left hemisphere. In this instance, it is not important whether it is a written or verbal test, since lesions for language impairment are not strictly localised to the left frontal lobe (Jones-Gotman and Milner, 1977). The right hemisphere can also be implicated in limited capacity.

The DFT consist of a free drawing and fixed condition task (Carter et al., 1998). The free condition task lasts five minutes and the fixed four-line condition four minutes and the patient much adhere to specific guidelines. For both tasks the drawings must not be of actual objects or of parts of it, abstract drawings must not be identifiable, and scribbling is not allowed. The difference between the tasks is that only four lines are allowed for the second part. The emphasis is on the creation of as many and different drawings possible. Two examples are given of correct and incorrect responses respectively.

Royall et al. (1992) presented another version of the test, which assesses design fluency much quicker. Pre-drawn examples of designs are presented and the patient is required to draw as many different designs as possible. Each design may only have four lines and one minute is allowed. This version, thus, does not adhere to as many specifications as the original form.

Scoring based on the original version is more extensive than Royall's version. Results are derived from scoring the number of correct responses, wrong responses in terms of those named and drawn with the wrong amount of lines, and perseverative responses for each condition. For the short version every different design with four lines gets one point. The total score is thus derived.

The inability of patients to perform this task has pointed at poor output and high levels of perseveration (Jones-Gotman and Milner, 1977). Jones-Gotman and Milner (1977) explained these problems as difficulties in producing original responses, thus falling back on initial attempts. High perseveration could be due to an inability to monitor performance after correction.

The DFT is a valid measure of executive functioning. It has high overall and separate item interrater reliability (Carter et al., 1998). Scores for the novel drawings and perseverative errors highly correlate. The free drawing condition correlated better between raters than the fixed condition. Norms determined by Carter et al. (1998), in collaboration with Jones-Gotman, therefore have valid clinical application.

3.3.7 Judgement of Line Orientation Test

The Judgement of Line Orientation Test (JLO) has been developed by Benton and colleagues (Benton et al., 1978) as a simple measure of visuospatial judgement. No demand is made on motor skills and the test can be easily administered in the consulting room or at the bedside.

The purpose of the JLO is to assess perceptual ability by the discrimination of the direction of lines (Woodard et al., 1998). An array of 11 lines, separated by an angle of 18°, is presented for each of 30 items. Two forms, Form H and Form V, exist in which the items are presented in different order. A patient must match two lines of partial length with the array of lines as to identify each line's angle. If both lines are matched accurately, it is scored as correct. Scores between 15 and 18 is considered as indicative of mild to moderate impairment in visuospatial

judgement, whereas a score below 15 are considered as severely impaired. No time limit is imposed and administration time is 6-10 minutes.

The JLO, as a 30-item form, proved to be time-consuming, lengthy and frustrating to especially elderly patients (Woodard et al., 1998). Two short forms were therefore developed from the original Form V: the 15 odd-numbered items (Form O) and the 15 even-numbered items (Form E) set in slightly different order. In addition, more short forms, Form Q and Form S were constructed. The aim of these forms was to maintain the original order of ascending item difficulty (Gazzaniga et al., 1998).

The short forms are useful as screening instruments for visuospatial impairment and for repeated measurement in research (Woodard et al., 1998; Hugo and Potocnik, 2002). Almost similar mean scores were obtained for the full test and short forms, with generally high sensitivity, specificity, and predictive positive and negative value when a single cutoff score was used. However, impairment can not be categorised by the different short forms similarly to the longer version (Hugo and Potocnik, 2002). Consideration of the response time for each item, might lead to a more accurate diagnosis of brain disease by the longer form (Benton et al., 1978).

Results correlated significantly with gender and age (Benton et al., 1978). Men performed better than women. With no differences in age and gender of patient groups only right cerebral hemisphere groups showed significant impairment on the JLO. Level of performance also significantly correlates with educational level (Woodard et al., 1998). The younger the person and the higher the educational level, the higher the JLO performance.

3.3.8 Finger Perception

The localisation of fingers on touch or stimulation, is a function of tactile perception (Bakker and Van der Kleij, 1978). The left hemisphere mainly underlies this function. Verbal responses in naming the fingers touched are mediated by the temporal lobe. Information is given on the “where” of the finger(s).

Different techniques have been demonstrated for this task. Electronic stimulation devices, in addition to physical touch, are used (Bakker and Van der Kleij, 1978). In this instance, pairs of fingers on both hands are stimulated. Another way to assess finger perception is by touching two fingers on either hand while the person’s eyes are closed. A verbal response

must indicate how many fingers are in between those, that are touched (Hemp, Personal communication).

3.3.9 Face Recognition

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Face recognition (Archer et al., 1994) is assessed by having a person view familiar faces on a television screen and match unfamiliar faces to see which are of the same person. A range of photographs is also used (Hassing et al., 1998). The ability to analyse parts as a whole, thus higher perceptual functions, are evaluated. Memory also plays an important role in placing a face.

The Photo Recognition Task includes 40 black and white prints in booklet form. 20 prints are shown to the patient to memorise. On a consecutive trial these prints are then presented in addition to 20 unfamiliar cards. The cards have been randomly fixed. Indication of previously seen photos is required.

Face processing can indicate impairment in the perceptual domain. For example, schizophrenics have been found to significantly struggle with facial and expression recognition tasks (Archer et al., 1994). Age, education and gender did not influence face recognition in persons who are 80 years and older (Hassing et al., 1998). Performance in the very old may not be affected much by demographic variables due to a loss in general mental sharpness.

3.3.10 Finger Tapping

The most known measure of finger tapping is included in the Halstead-Reitan Neuropsychological Test Battery (Chavez et al., 1983). This item assesses motor speed. Functional processes can be localised in the contra-lateral prefrontal cortex (Morrison et al., 1979). Finger tapping can be used to distinguish cerebral, cerebellar and basal ganglia motor impairment from normal controls (Shimoyama et al., 1990).

Finger tapping speed is assessed with either electrical or mechanical devices. The patient must tap a lever as quickly as possible, in a given time, for a number of consecutive trials. The average number of taps is then calculated. Tapping on a table also assesses this motor function. In another version (Fisher, 1960), finger tapping is assessed simply by rapidly tapping the index finger to the thumb. For all of these versions both hands are used respectively.

Gender significantly correlates with finger tapping speed for both hands (Morrison et al., 1979; Chavez et al., 1983). Men tap much faster than women. Age also significantly affects results (Ruff and Parker, 1993). Interrater reliability has been problematic (Morrison et al., 1979). Differences were found between testers, but based on the amount of rest time allowed between trials. Testers should therefore strictly adhere to standardised procedures regarding the administration of the Finger Tapping Test.

3.3 A contribution to cognitive assessment in South Africa

The Bedside Cognitive Assessment Battery (BCAB), developed in South Africa, is mainly based on test items from abroad. Research done by countries experienced in the development of tests has set a strong foundation for the development of new tests. The focus of this thesis is the assessment of cognitive functions of persons' aged 18 and above. The theory and practical aspects attaining some of the tests described above has guided us in our exploration of test material suitable for the adult population.

Literature has demonstrated the limitations of test results that can not be reliably generalised. Procedures for norm setting to make the BCAB appropriate for the local population, thus, were the aim of this study. Furthermore, having the battery available to clinicians apart from psychologists is meaningful. It assists in streamlining the clinical examination of patients. The use of batteries similar to the BCAB has been successfully demonstrated by studies. This, however, holds that the administrator has training and experience deemed adequate to perform the test. An integral discussion on the BCAB follows in Chapter 4.

CHAPTER 4

A new bedside assessment battery

4.1 Development of the Bedside Cognitive Assessment Battery

South Africa still lacks authentic assessment tools for evaluating cognitive status in adults. The need for tests appropriate for South Africans is acknowledged, but few are willing to take on the great task of validating the foreign tests used. Foreign tests are readily available, with seemingly good validity, and has become established teaching tools. Clinicians feel most comfortable with the familiar, taught by training and practice. Yet, an increased awareness on the limitations and ethical aspects pertaining to currently used assessment tools has caused clinicians, such as psychiatrists and neurologists, to investigate additional psychometric means to assess their patients. In this, a need has arisen for cognitive tests of which those, which can be easily administered at the bedside, are most practical. The BCAB was therefore compiled to assess the main cognitive functions. The aim was to have a tool capable of obtaining a general, but comprehensive indication of a patient's cognitive status in reasonable time.

The main supervisor of this study compiled the BCAB in 1995 at the Neuropsychiatry and Neuropsychology Clinic (NNC) at Tygerberg Hospital (Cape Town). The battery was revised in 1997, and more extensively during 2001 and 2002 with the aid of the current researcher. Cognitive tests were selected, based on clinical experience, to have similar levels of sensitivity. Some items were adjusted and others substituted for items considered more appropriate. Initially, specific cut scores were selected from foreign publications. During the extensive revision phase a pilot study was conducted to obtain preliminary norms applicable to the local population.

For the pilot study, retrospective analysis of our patient database indicated an inter-quartile range for age of 25-52 years (mean = 37.21years) and for years of education of 6-12 years (mean = 9.95 years). A control group was selected to be similar for the variables of age and level of education. Sampling of participants occurred in Tygerberg Hospital. Hospital personnel and caregivers/family members of patients were approached for participation. 20 participants were selected. The participants had to be healthy, with intact cognitive functioning. Any person with a history of a head injury, alcohol abuse, drug abuse, or any psychiatric disorder was excluded. Assessment then occurred in a quiet room with no disturbance, after informed consent was obtained. A testing session lasted more or less 40 minutes.

Overall scores correlated significantly with age and level of education. Age correlated negatively with scores ($R=-0.59$, $p<0.01$) and education correlated positively with scores ($R=0.50$, $p<0.05$). The older the person, the lower the scores obtained, and the higher the educational level the higher the scores. The test items were then evaluated for its worth in producing reliable results. The items producing questionable results, giving a vague picture of cognitive functioning, were then replaced by other items. This laid the foundation for the current study.

Blacks are increasingly coming for treatment at local hospitals and clinics due to awareness campaigns on health issues and treatment options. A Xhosa-version of the BCAB has therefore been developed since the majority of blacks in the Western Cape are Xhosa-speaking. Thus, this version will be most appropriate for our local population. The BCAB-Xhosa battery is identical to the English and Afrikaans versions. Some items will however need to be adapted to be more suitable for the Xhosa culture. Twenty Xhosa participants are therefore included to set the grounds for further research.

4.2 How the BCAB assesses cognitive functioning

The BCAB has been largely based on bedside techniques described by Hodges (1994), and Strub and Black (1977). The six main cognitive domains are comprehensively assessed without requiring specialised equipment. Test items are presented to the patient verbally. Where applicable, figures are provided and blank A4 sheets as well as a pencil to perform certain tasks. The BCAB is a quantitative, and to some extent a qualitative measure. It is qualitative in the sense that, for example, the time to draw a figure can be compared between individuals to provide clues on response rate. The cognitive functions that are assessed include attention and concentration, speech, memory, gnosis, praxis, and executive ability. Administration time varies from 35-45 minutes, depending on the person's age, level of education, and level of impairment.

The BCAB consists of 24 items. The test items for the different domains have similar levels of difficulty, although some tasks may prove more challenging. The BCAB starts with items assessing immediate and working memory (Item 1 and 2). It is then followed by an attention and concentration item (Item 3). The shortterm memory items are placed first to provide for sufficient time to elapse before delayed recall. It also serves as an "ice breaker" to put the patient at ease and have optimal focus to assess attention and concentration. If gross impairment is demonstrated on attention and concentration, the assessment is terminated. Impairment in attentional ability interferes with other cognitive abilities in that a patient can

not adequately focus on the task at hand. Language function items follow the memory and attention items, and then the items for motor, perceptual and executive functions. The items are not strictly grouped together per functional domain.

The main consideration governing the placement of items was to avoid contamination of visual stimuli. Secondly, the hierarchy of assessment was of importance. The battery contains numerous items using figures or pictures. Items requiring a response by drawing are followed by items requiring a verbal response. Naming, for example, taps memory for objects by verbal response after the recall of figures by drawing. Hand movements, visually demonstrating motor control precedes animal naming. From this it is also apparent that the cognitive domains are not assessed as separate entities. Language skills, for example, are not assessed successively. The reason, apart from aiming to avoid contamination of stimuli, is to not exhaust the patient on language skills before assessment of other skills. Most language functions are assessed by Items 4-8. Animal naming is placed at position 15 and naming ability at position 19.

There is an overall, rough progression of items from easier to more advanced. However, the BCAB was not specifically structured to follow a pattern of increased difficulty. Executive functions are probably most challenging since it incorporates nearly all the cognitive abilities. In addition, the intactness of attentional, memory, perceptual, and motor functions will predict the successful completion of executive items.

The BCAB consist of an administration pad, figure sheet and scoring sheet. See the section on instrument in Chapter 5 for an outlay of each item and the Appendix for the complete assessment set. Items are administrated according to specific instructions. Direct instructions are provided for clinicians and adherence to this optimises the reliability of results. Most test items do not assess a single cognitive domain. For instance, animal naming assesses language and executive functioning, whereas digit repetition assesses attention and concentration, and working memory. Test scores of the different items are therefore summarised in the scoring sheet according to domain(s) involved. Instructions for scoring are included in the administration pad under each section. Scores are thus entered on the scoring sheet and measured against preliminary normative values. This establishes a total score or level of impairment for each domain.

4.3 Relevance of the BCAB for our local needs

Test batteries used in SA have relevance in as much as it considers local population variables. Age and education notably influence test results. Socio-cultural and race differences make this more complex. The urbanisation or acculturation process has largely impacted on the degree to which cognitive performance differs between groups (Shuttleworth-Jordan, 1996). Socio-cultural differences, and race to some degree, are well described and understood. Ultimately, the factors unique to cultural environments have the greatest influence on how a test is perceived and understood.

The level of urbanisation predicts cognitive performance. People are in various stages of being westernised as the modern world sets the norm for attainment of influence, and informed and advanced living. However, this more strongly applies to the younger generation. The older, formerly disadvantaged generation finds it harder to advance in modern society. Residing in a rural or urban area even causes qualitative differences between groups. In terms of education, for example, coloureds from rural areas often only completed Grade 6 (Standard 4). Whites on farms, in the second quarter of this century, left school after Grade 3 or 4 (Standard 1 or 2) due to, for example, the depression years that affected the home, and expectations of parents. These differences are reflected in the recruitment of participants. In contrast, urbanised middle and higher socio-economic class whites are expected to finish school. The largest discrepancy remains between those completely or semi-illiterate and highly educated (Grieve and Van Eeden, 1997). These must be kept in mind when results are interpreted.

Other socio-cultural factors include language differences and intelligence. The degree to which test items are comprehended is not necessarily a measure of intelligence. South Africa has 11 affirmed languages of which English is viewed as the national language. Yet, the vocabulary of the Westernised culture is not yet sufficiently familiar to the recently westernised Black culture. The assessment of a black person, thus, remains a daunting task for white clinicians without familiarising themselves with the culture and usage pattern of English. To illustrate, Xhosa people prefer to use English words in some instances due to it becoming a part of their dialect (Shuttleworth-Jordan, 1996). A task such as digit repetition is better understood when numbers are used in English. On the other hand, some words generally used by whites do not exist in the Xhosa language. Once again English words are used. The solution regarding valid cognitive assessment will therefore be to refer black people to a psychologist of the same cultural group. Assessment by uninformed clinicians

can seriously impact on individuals' lives when the presence or absence of pathology is judged wrongly.

Shuttleworth-Jordan (1996) has found test scores between different African student groups with or without English as their first language, and SA students with English as first language, to lie within one standard deviation from the mean. Results were compared with normative values set by Lezak (1995) for the same tests, language and age groups. Once again no differences greater than one deviation of the norm were found. Thus, differences are not so great as thought. However, it is imperative to carefully control for age and education.

In essence, differences are only skin deep in neurophysiological terms. The brain processes underlying functions are universal to the human race. But, cultures will consistently respond differently to so-called culturally loaded stimuli. Familiarity with certain tasks strongly depends on the home environment and the chance to learn the abilities. An adult, who only finished early years of primary school, will experience great difficulty with tasks assessing, for example, conceptual and mathematical abilities. Unfortunately the number of people having very little or no education is huge. Census 1996 reported that 90.1% of SA's population do not have a high school education (Nell, 1997). This implies that tests are only applicable for use with a small number of people. A clinician needs to be alert to this, because it may also be the cause of false positive diagnosis. Tests, if applicable, must not be used in isolation, but as part of a complete clinical examination.

According to figures up until mid-2002, approximately 200 to 300 patients, suffering from various neurological conditions, have been tested with the BCAB. The patients mainly represented coloureds and whites and were assessed in Afrikaans or English. Common neurological pathologies at our clinic include(d) head injuries, strokes, aneurysms, dementia and HIV-related brain diseases. The results were used to diagnose the presence of cognitive impairment, and to plan rehabilitation.

Limited training is required to perform the BCAB. Clinicians with applicable knowledge regarding the administration of tests and making judgements on functional status can be trained to use this battery. Nursing sisters, occupational therapists, psychologists, physiotherapists, speech therapists, general practitioners and specialists can use this battery. Other neuroscientists can also use the test. Normative values corrected for age and education will enormously aid the valid use of the BCAB for the local population.

CHAPTER 5
Methodology

5.1 Instrument

The BCAB evaluates cognitive functions for the six major domains of brain functioning. This includes attention and concentration, speech, memory, praxis, gnosis, and executive functions. A complete administration pad, figure and scoring sheet is included in the Appendix. Many of the items are scored as normal (2), borderline (1) or abnormal (0) according to clinical judgement. In other instances, score intervals are provided to convert raw scores to the afore-mentioned system. Guidelines regarding scoring are set out in the administration pad per item. Specific conversions are performed on the scoring sheet.

The test items are described below:

5.1.1 Test 1: Word Lists

The Word List task assesses immediate memory span. In addition, it provides an indication of learning strategies, and confabulation. The first Word List trial assesses verbal working memory and trials 2-4 verbal shortterm memory. Impairment in shortterm memory is referred to as dementia. Verbal working memory deficits can be traced to the prefrontal cortex.

Administration

For each of three trials, 10 words are read to the patient consecutively. The order of presentation varies in each trial. See below:

Trial 1:

CAR CARROT GREEN DONKEY CHURCH BOOK TABLE SHIRT SPEAR UMBRELLA

Trial 2:

DONKEY SPEAR UMBRELLA CAR CARROT SHIRT CHURCH GREEN BOOK TABLE

Trial 3:

SPEAR DONKEY BOOK CHURCH TABLE UMBRELLA CAR CARROT SHIRT GREEN

The patient is asked to recall as many of the words as possible. The words do not have to be given in the same order as presented.

Scoring

One point is awarded for each word correctly recalled and no clues are given. A delayed recall task (trial 4) follows after approximately 20 minutes' administration time, and the patient must again recall as many of the words as possible. On the scoring sheet trial 1 is scored separately and trials 2-4 together.

5.1.2 Test 2: Visual Design Reproduction

The reproduction of visual designs evaluates visual memory and constructional ability. More specifically, immediate working memory is assessed. Delayed recall of the figures follows this after approximately 20 minutes. The figures are similar to those of the Stanford-Binet Intelligence Scale (Terman and Merrill, 1948) and the Strub and Black bedside assessment battery. Impairment may involve various brain areas linked to the executive system. Pathology may include dementia and/or apraxia.

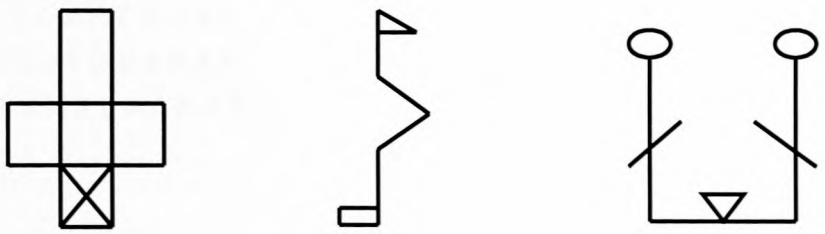

Figure 5.1 Three figures are presented for the immediate and delayed visual recall task. The figures are presented in the order as presented here, one at a time.

Administration

A stimulus card is presented for 10 seconds. After a 10 second delay the patient is instructed to recall the stimulus by drawing it. Three trials are performed.

Scoring

Table 1 describes the guidelines for scoring of the figures.

Table 5.1 Scoring guidelines for figures (Strub and Black, 1977).

Score	Classification	Description
0	Poor	Given for a failure to recall or reproduce a design
1	Fair	Given for recognisable but distorted, rotated, partially omitted, or confabulated features of a design
2	Good	Given for easily recognisable designs with minor errors of integration, omission, or addition
3	Excellent	Given for perfect (or near perfect) reproductions of the items with all the appropriate components, placements, and integration

The scoring guidelines are, as it says, guidelines. Clinical judgement ultimately predicts the score. Uncertainties in terms of a correct score may arise. Yet, scores between clinicians, generally agree.

5.1.3 Test 3: Vigilance Test

The Vigilance Test (Strub and Black, 1977) is a measure of attention and concentration. The brainstem, thalamus and cerebral cortex are involved. Impairment is implicated when a patient can not uphold his/her focus on specific stimuli.

Administration

A series of 60 random letters are read to the patient. The letter "A" appears randomly 18 times in this series (see below). The patient is required to listen carefully and tap the desk whenever the letter "A" is heard.

L T P E A O A I C T D A L A A
A N I A B F S A M R Z E O A D
P A K L A U C J T O E A B A A
Z Y F M U S A H E V A A R A T

Scoring

A perfect score is achieved when all "A" 's are identified correctly. The number of extra taps, if any are also scored as this may indicate perseveration.

5.1.4 Test 4: Spontaneous Speech

A complex picture is used to evaluate spontaneous speech. Broca's area in the inferior frontal cortex is involved in the production of speech. Goodglass and Kaplan (Gordon, 1998) has presented the well-known cookie jar picture to measure speech. Our aim was to devise a novel picture that would sufficiently stimulate speech production. The picture is presented in the Appendix (Figure 4 of the Figure Sheet). Speech fluency, articulation and word finding ability are measured by this item. Motivational systems may also be involved. A patient being apathetic, for example, may have limited or no motivation to use his/her creative abilities. Aphasia is implicated when speech production is impaired.

Administration

On presentation, a patient is requested to tell a story about what is happening in the picture.

Scoring

The tester must note if a spontaneous story is told, whether the patient describe the setting with at least two characters and an action, or whether he/she fails to tell a story. The item is scored as normal (2), borderline (1) or abnormal (0).

5.1.5 Test 5: Comprehension

The ability to comprehend spoken language is evaluated by staged commands. The left posterior-superior temporal area or Wernicke's area is involved. Impairment is thus implicated as Wernicke's aphasia.

Administration

On verbal command, the patient has to sequentially point to room objects and body parts. The commands are as follows:

1. "Point to the window."
2. "Point to your left elbow."
3. "Point to your chin."
4. "Point to your right cheek."
5. "Point to the ceiling and your forehead."
6. "Tap each shoulder twice with two fingers while your eyes are shut."

Scoring

This item is discontinued when a point of consistent failure is reached, that is, an inability to correctly execute the first two or three commands. A final score of normal (2), borderline (1) or abnormal (0) is given.

5.1.6 Test 6: Repetition

Sentence repetition represents a measure of speech fluency (Gordon, 1998). Wernicke's and Broca's areas are involved. Impairment is implicated as aphasia. The test includes three sentences. The first two sentences contain five words, and the last one ten words (see below). Although not strictly representing a progression, one can view this task as advancing from simpler to more difficult.

Administration

Three sentences are presented verbally, one at a time, and the patient is requested to repeat it. Additional sentences can be used according to clinical judgement if necessary. The sentence, "No ifs, ands, or buts" has been subtracted from the MMSE (Folstein et al., 1983).

Sam likes to play rugby.

No ifs, ands, or buts.

I go to the shopping centre to spend my money.

Scoring

The item is scored as normal (2), borderline (1) or abnormal (0).

5.1.7 Test 7: Reading

This task assesses reading ability and comprehension. The left cerebral hemisphere is involved in reading and impairment is implicated as dyslexia.

Administration

The patient is asked to read and respond to the command "close your eyes" (Folstein et al., 1983).

Scoring

The item is scored as normal (2), borderline (1) or abnormal (0).

5.1.8 Test 8: Writing

Writing is controlled by the left cerebral hemisphere. Impairment in writing ability is implicated as agraphia.

Administration

The patient is requested to write any short sentence (Crum et al., 1993). The sentence must make sense and be grammatically correct.

Scoring

The item is scored as normal (2), borderline (1) or abnormal (0).

5.1.9 Test 9: Digit Repetition

Digit repetition evaluates working memory for digits (Black and Strub, 1978). For this, the ability to remember information for seconds to a minute is tapped. Working memory is postulated to be part of the executive frontal lobe system. Memory and attentional processes, in addition to phonetic processes, are tapped. Impairment can be implicated as dementia or inattention.

Administration

A series of simple numbers, starting with two and ending with nine, is presented verbally and the patient has to repeat it. The series may be repeated once. Below is an illustration of the digit series in the order as it is presented.

3-7
5-4-9
8-2-5-7
5-9-6-8-3
5-7-1-9-4-6
8-2-9-3-6-5-1
3-9-8-2-5-1-4-7
7-2-8-5-4-6-7-3-9

Administration of this item is discontinued when a patient fails on two consecutive series.

Scoring

Each correct repetition is awarded 1 point. The score is then converted as indicated on the scoring sheet.

5.1.10 Test 10: Ideomotor Apraxia

Ideomotor apraxia is the ability to carry out learned voluntary acts. This item measures the capability to understand the elements and goals of an activity. Higher-level integration of (advanced) goal-directed movements is required (Chistensen and Caetano, 1996). The frontal cortex or executive system is thus involved. Impairment is implicated as apraxia.

Administration

The patient is requested to mime actions such as pour a cup of tea, add the sugar, and stir it, each hand separately.

Scoring

Task completion is scored as normal (2) or abnormal (0). No provision is made for a borderline rating since a midway action can not be identified distinctly. A patient can either perform these routine commands, or not.

5.1.11 Test 11: Successive Finger Taps

The successive tapping of fingers in an ordered way is a measure of praxis. It assesses motor integration and skilled co-ordination. The motor system is involved. Impairment is implicated as apraxia.

Administration

The patient has to touch each finger to the thumb starting with the index finger, forwards and backwards. Five of these cycles are to be completed.

Scoring

A cutoff time of 30 seconds is allowed for each hand for completion of five cycles. The rough score obtained is therefore subtracted from 30, for each hand. If the time exceeds 30 seconds, the score is 0.

5.1.12 Test 12: Finger Perception

Tactile or somatosensory perception is a measure of gnostic ability. Tactile perception refers to the ability to perceive touch. When one is touched, receptors or nerve endings under the skin are stimulated. The stimulation causes nerve cells to induce an electric impulse that is send to the central nervous system. The sensory cortex involved in tactile perception then interprets the signal, and a response is triggered by the interaction of the executive system and motor systems to cause a verbal response. Impairment is implicated as agnosia.

Administration

The patient is required to verbally indicate how many fingers is in-between those touched by the clinician. For a trial run, the clinician touches two fingers simultaneously to demonstrate the task. The patient keeps his eyes open and has to respond correctly before the test is continued. For six consecutive trials the patient must then answer the number of fingers with eyes closed.

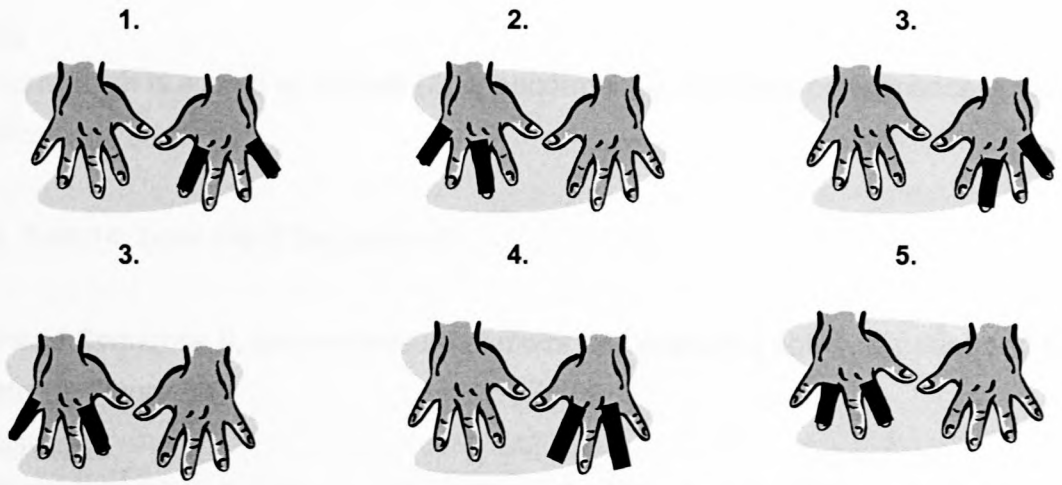

Figure 5.2 "How many fingers are in-between the fingers that I touch?"

Scoring

The task consists of three trials for each hand and each correct response is awarded 1 point. If a patient is incorrect in more than one instance for a particular hand, it may delineate sensory pathology to the contra-lateral hemisphere. Perceptual dysfunction on this test will suggest an agnosia.

5.1.13 Test 13: Luria Hand Sequence I

Luria Hand Sequence I and Luria Hand Sequence II are useful in the evaluation of basic motor functions (Luria in Hodges, 1994). Lower level integration and co-ordination, and maintenance of these movements is assessed (Christensen and Caetano, 1996). The left frontal lobe and motor areas are thus involved. Impairment is implicated as apraxia.

Administration

The patient is asked to perform three cycles of the task shown in Figure 5.3, after demonstration.

Figure 5.3 Luria Hand Sequence I

Scoring

Task completion is scored as normal (2) or abnormal (0). Faultless performance is regarded as normal.

5.1.14 Test 14: Luria Hand Sequence II

Luria Hand Sequence II, also a measure of motor and executive ability, is performed as illustrated in Figure 5.4.

Administration

The clinician performs the movement and the patient is asked to imitate it. As soon as the patient starts his own sequence the tester stops and assesses for completion of three cycles without error.

Figure 5.4 Luria Hand Sequence II

Scoring

Task completion is scored as normal (2) or abnormal (0). Faultless performance is regarded as normal.

5.1.15 Test 15: Animal naming

Animal naming is a measure of language and executive functioning. The frontal and temporal lobes co-ordinate the retrieval strategies of information. The task is commonly used as a measure of word finding ability. Concurrently, the flexibility to produce different responses belonging to a specified category is assessed. The Controlled Association Test by Terman and Merrill (1948) and Osterweil et al. (1994) represents a similar version to this task. Impairment in word finding ability is implicated as anomia.

Administration

The patient is required to name as many different animals with four legs in one minute.

Scoring

The score equals the number of animals correctly named. The use of similar responses, for example naming the same animal, is indicative of perseveration.

5.1.16 Test 16: Letter-Number Task

The Letter-Number Task is a measure of executive functioning. The ability to consecutively tap from brain areas involved in the processing of letters and numbers are assessed. This includes aspects of language and mental flexibility. Impairment may be traced to Wernicke's and Broca's areas, and the frontal lobe.

Administration

A simple series of letters and numbers are read to the patient with the request to give the next item (see below).

"A 1 B 2 C ?"

After providing the correct item, in this instance the digit "3", the patient is requested to perform the series until asked to stopped. The series is ended after digit "5".

Scoring

Ten letters and numbers must be provided. Each correct response is awarded 1 point.

5.1.17 Test 17: Recall of Wordlist after approximately 30 minutes

Delayed recall of words taps shortterm memory. Impairment is implicated in dementia.

Administration

Asking the patient to recall the words read in the beginning of the test session assesses delayed verbal memory. The words can be named in any order. Clues may not be given to guide recall.

Scoring

Each word correctly recalled is awarded 1 point.

5.1.18 Test 18: Delayed Recall of Figures after approximately 30 minutes

This task represents the delayed visual recall of the simple figures presented in the beginning of the test session. Visual memory is assessed and illnesses such as dementia may thus be implicated in light of impairment.

Administration

The patient is requested to draw the three figures presented approximately 20-30 minutes earlier. No cues are given.

Scoring

Scoring guidelines in Table 5.1 once again applies.

5.1.19 Test 19: Naming and Word Finding

Naming and Word Finding assesses word retrieval by means of visual stimuli (Goodglass et al., 1968), whereas Animal Naming assesses word finding by verbal response. Complex visuo-perceptual abilities are tapped. Impairment is implicated as agnosia.

Administration

The patient has to name the objects in Table 5.2. The first object is presented as a red piece of paper or other red object, and the second and third objects as indicated. The rest of the objects are presented as pictures (see Figure 5 in the Figure Sheet of the Appendix).

Table 5.2 The patient is requested to name the objects on visual presentation.

1 The colour red	9 Shark
2 Examiner's knuckles	10 Octopus
3 Ring finger of the patient's right hand	11 Telephone
4 Guitar	12 Scale
5 Dice	13 Trophy
6 Walking stick	14 Magnifying glass
7 Wheelbarrow	15 Stapler
8 Traffic light	

If a picture is not spontaneously named, the patient is asked to describe the function of the item to aid naming. When the patient can still not name it, pronouncing the first phoneme of the word provides a phonetic clue.

Scoring

A score of one point is awarded for each object identified correctly either spontaneously, through description or phonetic clue. Commonly used synonyms are accepted for spontaneous naming.

5.1.20 Test 20: Line Orientation

Line Orientation evaluates the ability to correctly perceive the orientation of lines. The lines are separated by a declination of 18° (Benton et al., 1978). The perceptual system is involved and the parietal and temporal lobe may thus be implicated in impairment or agnosia.

Administration

Four angled lines A, B, C and D have to be matched with the corresponding numbered line on an array of lines (see Figure 6 in the Figure Sheet in the Appendix).

Scoring

Each line matched correctly receives a score of 1 point.

5.1.21 Test 21: Design Distinction

The ability to distinctly discern objects, is a function of the perceptual and executive systems. Two frames of the same objects, with one oriented differently in each frame, are presented without covering either of the frames. Thus, the ability to filter out the distraction of one frame while focusing on the other is also tapped. Impairment is implicated as agnosia.

Administration

Firstly, an example is presented to explain the task to the patient. This is followed by two items, each with different objects (see below).

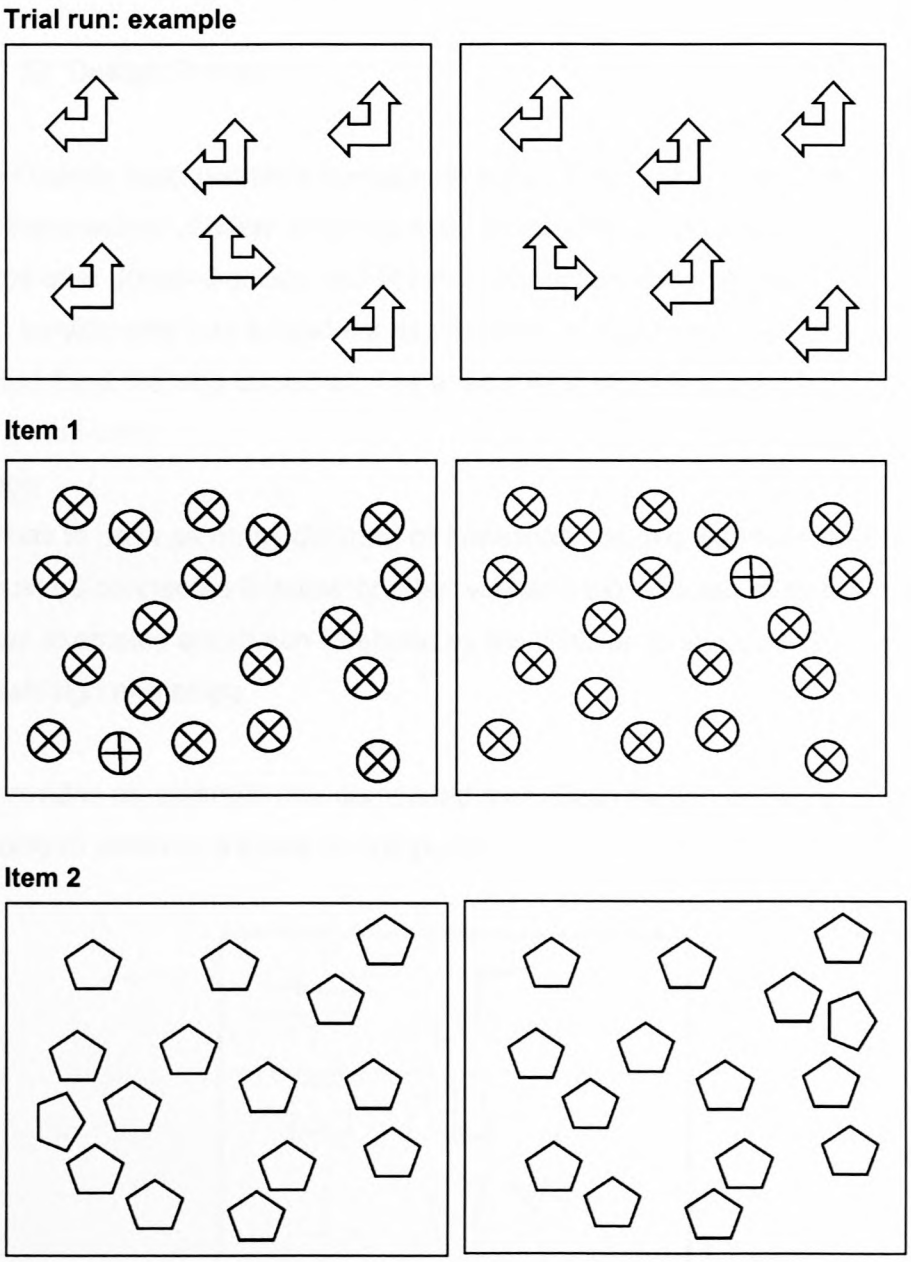

Figure 5.5 In the Design Distinction test the patient first has to complete a trial run and then pick out the one design in each frame for item 1 and item 2 that is differently orientated to the other designs.

Having the patient point out the one object orientated differently to the rest assesses object constancy. The patient is required to first point it out in the one frame and then the second frame as quickly as possible.

Scoring

The clinician must time the response to obtain a raw score. The raw score in seconds is then subtracted from 30 for the final score, since 30 seconds is the maximum time allowed. If the time exceeds 30 seconds, the score is 0.

5.1.22 Test 22: Design Fluency

The Design Fluency task assesses conceptual ability. Comprehension of the instructions followed by the creation of alternative drawings is required to correctly execute this task. This task is staged after Jones-Gotman and Milner's production of nonsense drawings (1977). The BCAB's version only has a fixed condition, whereas last-mentioned clinicians' version has a free and fixed drawing condition. The executive system is tapped and impairment may involve the frontal lobe.

Administration

The patient has to draw as many different or nonsense designs with four lines in one minute. The lines must be connected in some or other way and the clinician must be able to count the lines. Two examples are drawn freehand by the clinician to illustrate the task. These include a hash sign and steps.

Scoring

Figure 5.6 provides an example of a completed task. Each design adhering to above-mentioned criteria receives a score of one point.

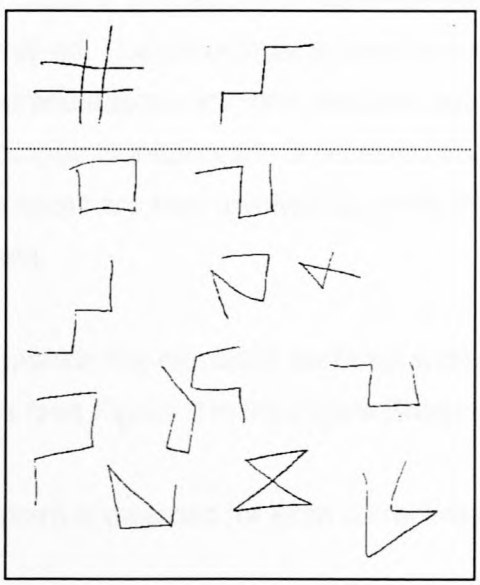

Figure 5.6 A completed example of the design fluency task. The two designs in the top area represent the examples given by the clinician. This individual has received a score of 11. Can you tell which design was incorrect?

5.1.23 Test 23: Reproduction Drawings

The copying of figures assesses visuo-graphic ability and visual attention. Impairment is implicated as apraxia and attentional deficits. Numerous tests incorporate figures to assess constructional ability (Rosen et al., 1984; Tariot et al., 1995). The cube seems to be the most popular choice during test construction, in addition to other shapes.

Administration

The patient is asked to copy a cross, arrow, and three-dimensional cube (see below).

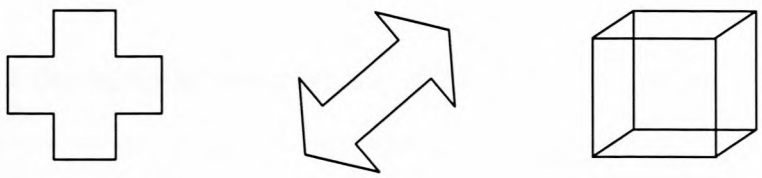

Figure 5.7 The cross, arrow and cube has to be copied to the best of the patient's ability.

Scoring

The drawings are scored as described in Table 5.1.

5.1.24 Test 24: Famous Faces

The recognition of familiar faces is a measure of higher perceptual functions. Memory functions are intricately involved. The perceptual system encodes external visual stimuli into representations. These representations are then matched against representations of previously seen faces. This type of information is retrieved from memory stores and guides recognition. The language areas are then involved to name the faces. Impairment is implicated as prosopagnosia.

Administration

The patient is required to provide the names of six famous people on presentation of a collection of picture-photos (see Figure 9 in the Figure Sheet of the Appendix).

Scoring

No clues are given and 1 point is awarded for each correct response. It is sufficient to only provide a surname.

5.2 Participants

The purpose of the BCAB is to aid the delineation of patients as cognitively intact, or impaired. The first and most important aim in the assessment of patients is to ascertain whether clinically significant problems are present. Healthy controls are therefore assessed to predict normal scores against which a patient's scores can be compared. The factors, age and education have shown to significantly influence cognitive functioning. Language and gender can also have a significant effect on performance. The control group is thus grouped according to these factors.

Table 5.3 Demographic characteristics of the Afrikaans, English and Xhosa participants.

	n	Mean	SD	Min	Max
Participants					
Afrikaans	127	-	-	-	-
English	33	-	-	-	-
Xhosa	14	-	-	-	-
Gender					
Male: Afr and Eng	43	-	-	-	-
Female: Afr and Eng	117	-	-	-	-
Male: Xhosa	4	-	-	-	-
Female: Xhosa	10	-	-	-	-
Age (years)					
Age overall: Afr and Eng	160	45.26	18.03	18	93
Age group 18-30: Afr and Eng	41	25.90	3.70	18	30
Xhosa	14	21.08	1.93	19	25
Age group 31-45: Afr and Eng	49	37.22	4.90	31	45
Age group 46-60: Afr and Eng	35	51.34	4.56	46	60
Age group >60: Afr and Eng	35	73.11	8.18	61	93
Education (years)					
Education overall: Afr and Eng	160	12.60	7.97	4	22
Education group 0-9: Afr and Eng	39	7.77	1.19	4	9
Education group 10-12.5: Afr and Eng	64	11.31	0.92	10	12.5
Education group 13+: Afr and Eng	56	15.84	2.72	13	22
Xhosa	14	14.53	1.45	13	17

n, number of participants; SD, standard deviation; min, lowest level; max, highest level; Afr, Afrikaans; Eng, English

A total of 174 subjects participated in this study. See Table 5.3 for the demographic characteristics. The language groups included Afrikaans (n=127), English (n=33) and Xhosa (n=14) speaking participants. The Afrikaans and English group consisted of 47 males and 127 females. The age of Afrikaans and English participants ranged from 18 to 93 years and

educational level from 4 to 22 years. The age and education groups of Afrikaans and English participants were then coded to give four age groups and three education groups. This prepared results for cross-validation by age and educational level. Age was coded as follows: Age group 1 = 18-30 years, Age group 2 = 31-45 years, Age group 3 = 46-60 years, and Age group 4 = >60 years. Education was coded as: Education group 1 = 4-9 years, Education group 2 = 10-12.5 years and Education group 3 = 13+ years of education.

Only a small number of Xhosa participants were approached for assessment with the BCAB Xhosa-version, as a preliminary project for further research. Owing to limited time and resources a decision was made to concentrate on just one of the age groups, being those aged 18 to 30. The focus therefore was to have one education group, namely those with an educational level of 13 or more years. Having one age and education group would ensure fair reliability of results when compared with Afrikaans and English participants of the same age and education group. The Xhosa group included 4 males and 10 females.

Sampling of Afrikaans and English participants occurred at Tygerberg Hospital, Panorama Medi-Clinic and old age homes and retirement villages in Bellville, Parow, Panorama and Goodwood (Western Cape). Sampling of Xhosa participants occurred at a local college in the Bellville area. Announcements were made, and lists for names provided to volunteer for the project. Flyers were also distributed and an advertisement placed in a local newspaper. Persons could react to last-mentioned by contacting the Mental Health Information Centre (MHIC) at the Faculty of Health Sciences, University of Stellenbosch Tygerberg Campus. The caller then had to answer questions regarding health status. These questions encapsulated the inclusion and exclusion criteria for this study.

Persons were included in the study if (1) aged 18 years or older, (2) having at least some years of education, and (3) not suffering from obvious medical or psychiatric disorders affecting cognition. Persons were excluded from the study if they (1) presented with a history of one or more head injuries or pathological brain lesions, (2) presented with a history or current problem of alcohol abuse, (3) presented with a history or current problem of drug abuse, and/or (4) suffered from any psychological or psychiatric condition.

5.3 Study procedures

All procedures necessary for completion of this study was approved by the Ethical Committee of the Faculty of Health Sciences, University of Stellenbosch. A consent document in Afrikaans and English was also approved. The document mainly explained the

objectives of the study, the procedures to be followed and the rights of the participant. See the Appendix for the English version of the consent document. Participants were informed that their results would be confidential and that they would have access to it. If a participant wanted to consult with a clinician regarding clinical issues, they were provided with the contact details of the Tygerberg and Panorama Memory Clinics. Participants were referred to the MHIC for general information on health issues, medical and psychiatric disorders, and support groups for families.

Participants were assessed at Tygerberg Hospital and the Panorama Medical Centre by the researcher. Xhosa participants were assessed at a college in the Bellville area. An occupational therapist (OT) also recruited and assessed some participants. A subject was only assessed once, except for those approached again for test-retest and interrater reliability (7 participants). On arrival, the researcher briefly became acquainted with the participant. A short, unstructured interview was conducted to determine whether inclusion and exclusion criteria were met. The informed consent document was then presented with an explanation of the project. After time was allowed to study and sign the document, and questions answered regarding the study, the test session started. Participants were assessed in a quiet room with no interruptions. A test session lasted on average 40 minutes.

The MMSE was administered first and then the BCAB. The MMSE is a brief standard against which the reliability of results can be tested. The test has proven validity and reliability. It is confidently used worldwide for the brief assessment of cognitive impairment. The researcher assessed Afrikaans and English participants in their mother tongue. A Xhosa clinical psychologist, also fluent in Afrikaans and English, assessed Xhosa participants with the Xhosa-version of the BCAB (See the Appendix for the Xhosa version). The psychologist received training in the administration of the BCAB at the Tygerberg Memory Clinic. In addition, changes in BCAB test items and administration procedures were discussed with the researcher. Possible differences between participants' responses due to culture were also discussed. The results regarding this are discussed in Chapter 7.

The OT assisted the researcher in test-retest and interrater procedures. The OT was also trained at the Tygerberg Memory Clinic and again in consultation with the researcher. Initially, the researcher would sit in with the OT and independently rate the participant's performance for interrater reliability. These participants were, thus, only assessed once. The researcher then used a video camera to record re-assessments. Participants recruited at the Panorama Medical Centre were randomly picked and approached again for assessment. After consent was given, participants were assessed with the MMSE and BCAB. Only the

performances on the BCAB were recorded. The video recordings on these participant's performance were then rated independently by the OT. Apart from drawings made by the participant, no results were provided to the OT. The procedures followed were identical to the initial assessment procedures, except for the use of the video camera.

5.4 Analyses of test scores

The data were analysed using standard statistical procedures. The statistical computer package, Statistica, was mainly employed. Results of Afrikaans and English subjects were evaluated against the variables: language, gender, age and education. Results for Xhosa participants were evaluated for the effect of language and gender. Xhosa participants represented one age and education group and could therefore not be compared with age and education groups other than those aged 18-30, with 13 or more years of education.

The effects of the variables were first examined separately and then jointly. Analysis of variance (F-tests) was used and the robustness of the F-tests in some cases was examined by performing logistic regression. Results were expected to be substantially the same for both procedures. However, logistic regression was the preferred procedure when scores were not normally distributed and binomial, thus a count out of a fixed total. MMSE scores and the results for the separate cognitive domains were also investigated for the effect of language, gender, age and education. The domains included attention and concentration, language, memory, praxis, gnosis and executive functions.

Test-retest reliability was evaluated by investigating scores for significant differences for 7 participants. The researcher performed the re-assessments. The Pearson product-moment analysis provided an estimated correlation between the first and second test occasion. The time intervals differed for two participants. The time interval was approximately 5.5 months for the 2 participants, whereas it came to approximately 9 months for the other 5 sets of data. Interrater reliability was also investigated by statistically correlating the results. The researcher and occupational therapist were involved in these procedures.

Chapter 6
Results

6.1 Overall effects for all participants

6.1.1 Overall performance on the BCAB and MMSE by Afrikaans and English participants

Overall performance on the BCAB was investigated by using factorial analysis of variance (f-ANOVA). The BCAB total score differed significantly according to age [$F(3, 148)=7.91$, $p<0.0001$] and education [$F(2, 148)=21.44$, $p<0.0001$]. Scores are presented in Table 6.1. The mean total BCAB score for all participants were 208.93. The trend for age was for lower mean scores for older participants. Age group 18-30 differed significantly from the older groups. The two middle age groups obtained similar scores. Age group >60 obtained the lowest mean score. See Figure 6.1 for the distribution of scores by age.

Table 6.1 Overall performance on the BCAB.

BCAB total score	n	Mean	SD
Overall	160	208.93	35.23
Age: 18-30 yrs	41	226.54	27.91
31-45 yrs	49	205.31	37.85
46-60 yrs	35	210.60	33.50
>60 yrs	35	191.71	32.27
Education: 4-9 yrs	39	183.00	25.56
10-12.5 yrs	64	206.48	31.60
13+ yrs	56	229.84	32.33

BCAB, Bedside Cognitive Assessment Battery; n, number of participants; SD, standard deviation; yrs, years

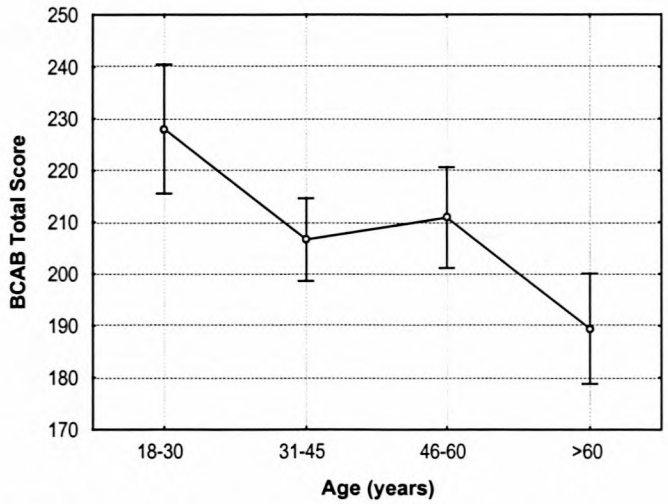

Figure 6.1 The distribution of the means of the BCAB total score according to age. The differences between the groups were significant [F(3, 148)=7.91, p<0.01]. Lower mean scores were demonstrated for older participants. The vertical bars denote 0.95 confidence intervals for the mean scores.

The three education groups also differed significantly from each other. The higher the level of education the higher the mean BCAB total score. Figure 6.2 represents the distribution of scores as influenced by education.

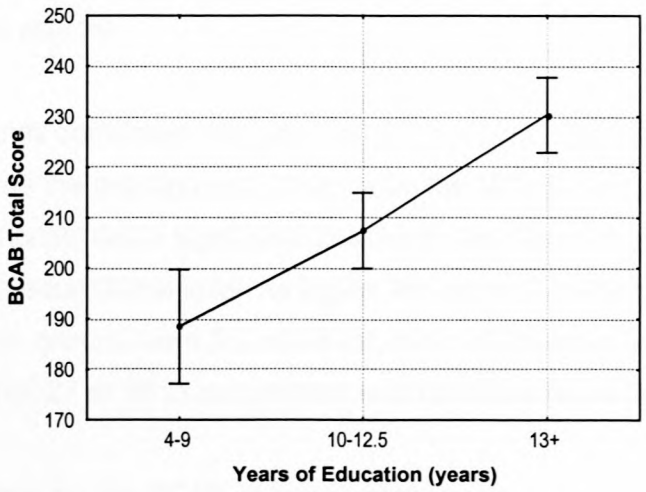

Figure 6.2 The association between BCAB total scores and education. The differences between the groups were significant [F(2, 148)=21.44, p<0.01]. The higher the educational level the higher the BCAB total score. The vertical bars denote 0.95 confidence intervals for the mean scores.

The association of MMSE and BCAB total scores was investigated by logistic regression. Scores demonstrated significance for the slope coefficient (t=6.66, p=0.001). Scores also demonstrated a significant correlation when compared with each other (r=0.94, p=0.001).

The maximum score than can be obtained on the MMSE is 30. The higher the MMSE score the better the performance on the BCAB. See Figure 6.3 for a scatterplot of scores.

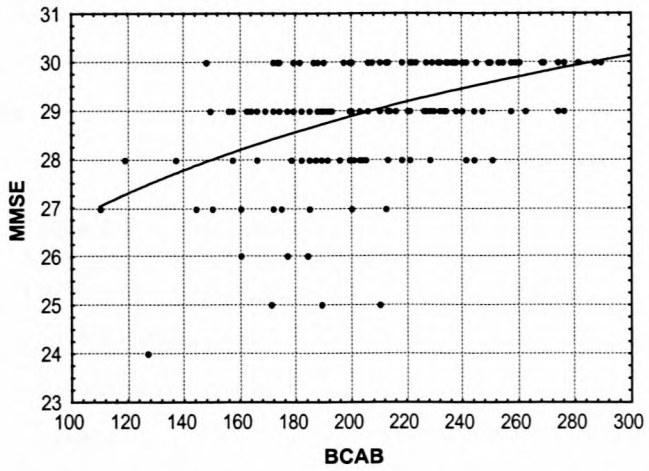

Figure 6.3 The joint distribution of MMSE scores and BCAB total scores. The MMSE and BCAB scores are positively correlated. The higher the MMSE score, the better the overall performance on the BCAB.

MMSE scores did not show significant differences according to language or gender. The mean score for Afrikaans and English participants was 29. Similarly the mean score for male and female participants was 29.

MMSE scores significantly correlated with age ($r=0.29$, $p<0.01$). Results demonstrated a negative correlation, thus the average performance on the MMSE decreased with older age. MMSE scores also demonstrated a significant positive correlation with education ($r=0.45$, $p<0.01$). The higher the educational level the higher the score. The fitted mean and median for all age and education groups were 29. However, more of the least educated participants obtained a score of either 27 or 28 in comparison with the other two education groups.

6.1.2 Overall performance on the BCAB of Xhosa participants

Xhosa participants were grouped according to age 18-30 and education >13 years. The BCAB total score for Xhosa participants were therefore compared to Afrikaans and English participants of the same age and education group. The scores for design distinction were not included in the BCAB total score. Administration of the item unintentionally differed between the researcher and Xhosa rater. Administration guidelines were carefully explained as part of training, but may need further clarification for optimal objectivity between raters.

One-way ANOVA revealed that mean BCAB total scores differed significantly between language groups [F(2,23)=4.06, p=0.031]. Further investigation, using the pooled within-group variance estimate of differences, demonstrated significant differences for Xhosa and Afrikaans participants [t(23)=2.21, p=0.036] and Xhosa and English participants [t(23)=2.36, p=0.014]. Results did not significantly differ between Afrikaans and English participants. See Table 6.2 for the scores.

Table 6.2 Overall performance on the BCAB for Afrikaans, English and Xhosa participants aged 18-30 and with an education of 13 or more years.

BCAB total score	n	Mean	SD
All language groups	26	196.96	17.22
Xhosa	14	189.14	14.02
Afrikaans	8	204.25	18.99
English	4	209.75	11.59

BCAB, Bedside Cognitive Assessment Battery; n, number of participants; SD, standard deviation

BCAB mean scores were higher for Afrikaans and English participants. The effect was most pronounced for English participants. See Figure 6.4 for the distribution of scores.

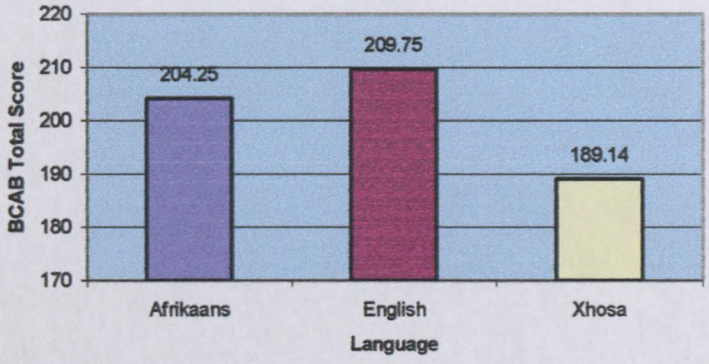

Figure 6.4 The distribution of the mean scores of the BCAB total score by the three language groups. The mean score is given above each column.

6.1.3 Performance on the six cognitive domains of functioning

6.1.3.1 Afrikaans and English participants

The six cognitive domains were investigated for overall performance per domain. The domains consisted of attention and concentration, speech, memory, motor functioning, perceptual functioning and executive functioning. The item *design distinction* (item 21) was not included under perceptual functioning. The results for the item were inconsistent and thus deemed invalid. Some participants would either obtain very high or low scores. Thus, the scores varied too greatly.

Specific items contributed to the total score for each functional domain. The categories follow below. (See the scoring sheet in the Appendix.)

1. Attention and concentration: *vigilance* (item 3) and *digit repetition* (item 9).
2. Speech: *spontaneous speech* (item 4), *comprehension* (item 5), *repetition* (item 6), *reading* (item 7), *writing* (item 8), *animal naming* (item 15), *naming and word finding* (item 19).
3. Memory: *word list trial 1* (item 1), *word list 2-4 total score*, *visual design reproduction* (item 2), *delayed recall of figures* (item 18), and *digit repetition* (item 9).
4. Motor functioning or praxis: *ideomotor apraxia* (item 10), *successive finger taps* (item 11), and *reproduction of drawings* (item 23).
5. Perceptual functioning or gnosis: *finger perception* (item 12), *naming and word finding* (item 19), *line orientation* (item 20), *reproduction of drawings* (item 23), and *famous faces* (item 24).
6. Executive functioning: *Luria hand sequence I* (item 13), *Luria hand sequence II* (item 14), *animal naming* (item 15), *letter-number task* (item 16), and *design fluency* (item 22).

Education significantly influenced the scores for all the cognitive domains: attention and concentration [$F(2, 148)=13.64$, $p<0.0001$], speech [$F(2, 148)=22.05$, $p<0.0001$], memory [$F(2, 148)=10.70$, $p<0.0001$], motor functioning [$F(2, 148)=5.32$, $p=0.0059$], perceptual functioning [$F(2, 148)=18.10$, $p<0.0001$] and executive functioning [$F(2, 148)=25.44$, $p<0.0001$]. The higher the educational level the higher the score. Age also significantly influenced the scores for the domains' memory [$F(3, 148)=7.91$, $p<0.0001$], motor functioning [$F(3, 148)=4.80$, $p=0.0032$] and perceptual functioning [$F(3, 148)=3.45$, $p=0.0183$]. The trend was for lower mean scores for older participants. One exception was perceptual functioning. The age group 31-45 performed worse than the other groups. See Table 6.3 below.

Table 6.3 Mean scores of Afrikaans and English participants by age and education for each cognitive domain.

	Age (years)					Education (years)			
n=160	**Mean 18-30**	**31-45**	**46-60**	**>60**	**p**	**Mean 4-9**	**10-12.5**	**13+**	**p**
Attention and Concentration	22.88	22.88	22.69	22.80	0.7809	21.87	22.75	23.55	<0.0001*
Speech	38.24	35.35	37.71	36.69	0.0630	33.05	36.14	40.46	<0.0001*
Memory	48.71	45.86	45.01	39.49	<0.0001*	40.23	44.80	48.63	<0.0001*
Motor functioning	50.37	44.02	45.03	40.29	0.0032*	39.82	45.14	48.59	0.0059*
Perceptual functioning	35.39	33.18	35.06	35.26	0.0183#	31.51	34.20	37.25	<0.0001*
Executive functioning	36.29	32.80	34.54	33.34	0.1191	28.23	33.55	39.09	<0.0001*

Results for all domains significantly differed for education, whereas only memory, motor- and perceptual functioning also differed significantly for age. Significant differences between groups are indicated by a p-value of $p<0.05^{\#}$ and $p<0.01^{*}$.
n, number of participants; p, significance level

The effect of education on scores was most pronounced. In addition, the effect of age was most pronounced for memory. Results for the memory domain were significantly influenced for all age and education groups. Scores of the youngest and oldest participants and the least and highest educated differed very significantly. See Figure 6.5 and 6.6 for the distribution of scores by age and education for memory.

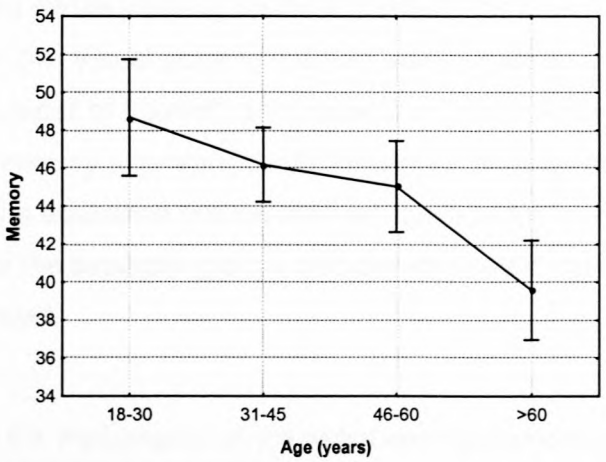

Figure 6.5 The distribution of scores for the memory domain according to age. The differences between the groups were very significant [F(3, 148)=7.91, p<0.01]. Lower mean scores were demonstrated by increasing age. The vertical bars denote 0.95 confidence intervals for the mean scores.

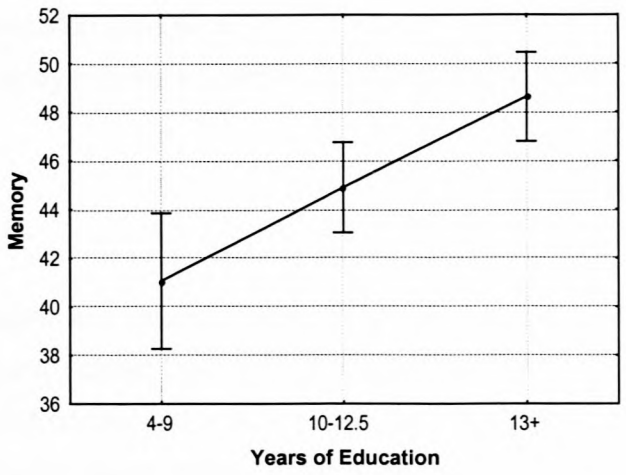

Figure 6.6 The distribution of scores for the memory domain according to educational level. The differences between the groups were very significant [F(2, 148)=10.70, p<0.01]. The higher the mean score the higher the educational level. The vertical bars denote 0.95 confidence intervals for the mean scores.

The memory divisions include verbal working memory and verbal shortterm memory, and visual working memory and visual shortterm memory. The total score of word list trial 1 and digit repetition determined verbal working memory. Verbal shortterm memory was assessed by the total of word trials 2-4. Visual working memory was assessed by visual design reproduction (immediate recall of figures), and visual shortterm memory by delayed recall of figures. Verbal working memory was significantly influenced by level of education [F(2, 148)=18.42, p=0.001]. The education groups differed significantly from each other. See Table 6.4. The scores for the separate groups also demonstrated more variance with an increase in educational level.

Table 6.4 Performance on the verbal working memory as it varies between the educational groups.

Verbal working memory: Word list trial 1 + Digit repetition	**n**	**Mean**	**SD**
Overall	160	10.18	2.40
Education: 4-9 yrs	39	8.61	1.53
10-12.5 yrs	65	10.08	2.03
13+ yrs	56	11.38	2.66

n, number of participants; SD, standard deviation, yrs, years

Word list trial 2-4 total and the immediate and delayed recall of figures differed significantly according to age and education (see section 6.2.1). Thus, an individual's age and educational level significantly influences verbal shortterm, visual working and visual shortterm memory.

6.1.3.2 Xhosa participants

Results for Xhosa, Afrikaans and English participants were investigated by one-way ANOVA. Xhosa participants generally scored lower than Afrikaans and English participants. Their scores were lower for most cognitive domains except for attention and concentration and perceptual functioning. Scores were similar for these domains, except for English participants who faired better with the attention and concentration items. See Table 6.5 for scores.

Table 6.5 Performance on the six cognitive domains by Xhosa, Afrikaans and English participants of age group 18-30 and education of 13 and more years.

Six cognitive domains	Xhosa (n=14)		Afrikaans (n=8)		English (n=4)			
	Mean	SD	Mean	SD	Mean	SD	F	p
Attention and Concentration	23.35	1.22	22.88	1.73	25.00	0.82	3.38	0.0516
Speech	36.86	2.41	43.88	4.85	41.00	2.45	11.53	0.0003*
Memory	48.07	5.30	50.25	7.32	56.75	7.37	2.99	0.0702
Motor functioning	47.64	7.29	54.88	3.76	53.75	3.50	4.27	0.0264#
Perceptual functioning	36.14	2.28	37.25	2.66	38.50	1.73	1.75	0.1967
Executive functioning	35.71	4.05	42.63	8.48	41.25	6.65	4.03	0.0315#

Significant differences between groups are indicated by a p-value of $p<0.05^{\#}$ and $p<0.01^{*}$.
n, number of participants; SD, standard deviations; F, F-statistic; p, significance level.

Results for the cognitive domains' speech, motor functioning and executive functioning differed significantly between the language groups. In speech Xhosa participants performed significantly lower than the other two language groups with Afrikaans participants performing the best. In motor- and in executive functioning Xhosa participants' scores were significantly lower than the scores of Afrikaans and English participants. The mean scores for last-mentioned two groups were similar for these domains.

Figure 6.7 represents the distribution of scores for each cognitive domain for Afrikaans, English and Xhosa participants. Scores generally co-varied per cognitive domain; the interval for which scores varied corresponded.

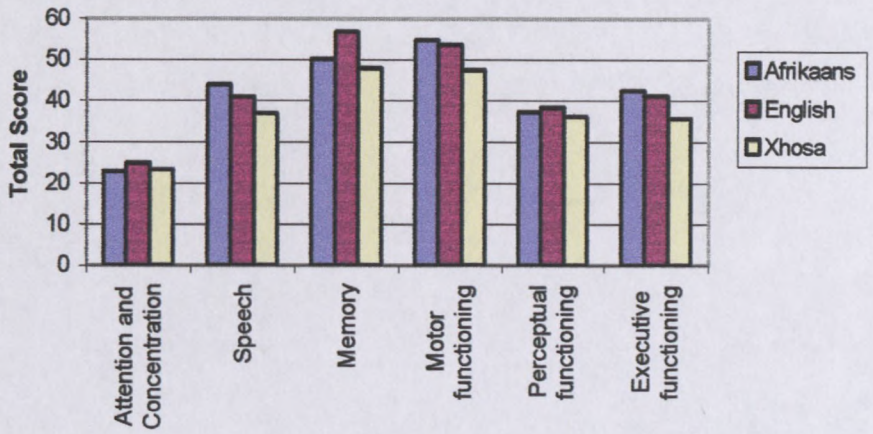

Figure 6.7 The distribution of scores between the language groups for each of the six cognitive domains.

6.2 The effects of language, gender, age and education on performance in the BCAB items

6.2.1 Afrikaans and English participants

Scores for the separate test items on the BCAB were analysed for the effects of the predictors' language, gender, age and education. Results were jointly investigated by an ordinary four-way ANOVA (for normal distributions) except in cases where the scores are counts out of some possible number of successes, in which case logistic regression was used. Interactions or combined effects for variables were also investigated. Significant results for the groups were documented, but in some instances, also the effects demonstrating notable, but not significant differences between groups. These results were interesting in that it could point out inert differences between language, gender, age and education groups for specific abilities. Note that the number of participants indicated in the tables varies from 158 to 160. This is explained by missing or unreliable data for some items for two participants. The data was unreliable when unforeseen disturbances occurred during assessment or items were misunderstood. Following are the results.

6.2.1.1 Word Lists

Word list trial 1

Word list trial 1 (total score=10) demonstrated significant differences according to age [$\chi^2(3)$= 9.98, p=0.0187] and education [$\chi^2(2)$=15.95, p=0.0003], but not language and gender. The

mean scores were lower for the older groups with Age group >60, on average, obtaining the lowest scores. The trend for education was for a higher average recall of words with higher educational levels. In addition, Education group 13+ demonstrated more variance in scores. See Table 6.6.

Table 6.6 Performance on word list trial 1 as it varies between the age and educational groups.

Word list trial 1	n	Mean	SD
Overall	158	5.33	1.43
Age: 18-30 yrs	40	5.60	1.53
31-45 yrs	49	5.57	1.34
46-60 yrs	35	5.23	1.59
>60 yrs	34	4.76	1.10
Education: 4-9 yrs	38	4.66	1.16
10-12.5 yrs	65	5.26	1.23
13+ yrs	55	5.87	1.61

n, number of participants; SD, standard deviation, yrs, years

Word list trial 2

Performance on word list trial 2 (total score=10) also demonstrated significant differences according to age [$\chi^2(3)=12.36$, $p=0.0063$] and years of education [$\chi^2(2)=10.71$, $p=0.0047$], but not language and gender. The trend for age was for lower mean scores for older participants. The trend for education was for higher mean scores for the higher educated. The higher the educational level the more words is recalled. See Table 6.7 for scores.

Table 6.7 Performance on word list trial 2 as it varies between the age and educational groups.

Word list trial 2	N	Mean	SD
Overall	160	7.44	1.30
Age: 18-30 yrs	41	7.83	1.30
31-45 yrs	49	7.63	1.25
46-60 yrs	35	7.25	1.40
>60 yrs	35	6.89	1.05
Education: 4-9 yrs	39	7.03	1.18
10-12.5 yrs	65	7.34	1.16
13+ yrs	56	7.84	1.42

n, number of participants; SD, standard deviation, yrs, years

Word list trial 3

Performance on word list trial 3 (total score=10) differed significantly according to gender [$\chi^2(1)=6.27$, $p=0.0123$] and age [$\chi^2(3)=13.81$, $p=0.0032$], but not language and education. Women on average recalled 1 word more than men. The trend for age was for lower mean scores for the older participants. The older the person the less words were recalled. See Table 6.8 for the scores.

Table 6.8 Performance on word list trial 3 by gender and education.

Word list trial 3	n	Mean	SD
Overall	160	8.36	1.14
Gender: Male	43	7.98	1.30
Female	117	8.50	1.04
Age: 18-30 yrs	41	8.68	0.96
31-45 yrs	49	8.55	1.00
46-60 yrs	35	8.29	1.25
>60 yrs	35	7.80	1.21

n, number of participants; SD, standard deviation, yrs, years

Word list trial 4

Performance on delayed word recall - trial 4 (total score=10) demonstrated significant differences according to gender [$\chi^2(1)=10.33$, $p=0.0013$], age [$\chi^2(3)=44.81$, $p<0.0001$] and years of education [$\chi^2(2)=27.54$, $p<0.0001$]. Women on average recalled 7 words and men 8 words, thus women performed better than men. The trend for age was for lower mean scores for older participants. Notably, age group >60 performed much lower in comparison with the other three age groups. The trend for education was for higher mean scores for the higher educated. The higher the educational level the more words was recalled. Scores were notably lower for the least educated group in comparison with the other two education groups. See Table 6.9 for the scores.

Performance on word list trial 4 were also significant for the interactive effect of gender and age [$\chi^2(3)=11.75$, $p=0083$]. This implies that age effects were not consistent for men and women. Mean scores did not consistently increase or decrease by age.

Table 6.9 Performance on word list trial 4 as it varies by gender, age and education.

Word list trial 4	n	Mean	SD
Overall	160	6.61	2.06
Gender: Male	43	6.02	1.99
Female	117	6.82	2.05
Age: 18-30 yrs	41	7.46	1.30
31-45 yrs	49	6.80	1.25
46-60 yrs	35	6.69	1.40
>60 yrs	35	5.26	1.05
Education: 4-9 yrs	39	5.72	1.18
10-12.5 yrs	65	6.65	1.16
13+ yrs	56	7.18	1.42

n, number of participants; SD, standard deviation, yrs, years

Word lists 2-4

The total for trials 2-4 (total score=30) differed significantly according to gender [χ^2 (1)=11.45, p=0.0007], age [χ^2 (3)=45.79, p<0.0001] and education [χ^2(2)=37.11, p<0.0001], but not language. This confirmed the above-mentioned separate effects of gender and age for word lists 2, 3 and 4. Last-mentioned word lists thus accounted for the significant effect for total word recall. Women on average recalled more words than men. See Table 6.10.

Table 6.10 The total of word list trial 2 to 4 by gender, age and education.

Word list trial 2-4	n	Mean	SD
Overall	160	22.41	3.91
Gender: Male	43	21.21	4.03
Female	117	22.85	3.78
Age: 18-30 yrs	41	23.98	3.17
31-45 yrs	49	22.98	3.56
46-60 yrs	35	22.23	4.08
>60 yrs	35	19.94	3.92
Education: 4-9 yrs	39	20.79	3.53
10-12.5 yrs	65	22.40	3.58
13+ yrs	56	23.54	4.17

n, number of participants; SD, standard deviation, yrs, years

The trend for age was for lower mean scores for older participants. Age group >60 notably performed the worst. The trend for education was for higher mean scores for the higher educated. The higher the educational level the more words was recalled. The least educated obtained particularly lower scores.

6.2.1.2 Visual design reproduction

Performance on the immediate recall of figures (total score=9) demonstrated significant differences according to age [$\chi^2(3)=8.13$, $p=0.0433$) and education [$\chi^2(2)=19.51$, $p<0.0001$]. The mean scores generally decreased by age group from youngest to oldest. Age group 46-60, however, obtained slightly better scores than age group 31-45. The trend for education was for higher mean scores for the higher educated. See Table 6.11 for scores.

Table 6.11 Performance on visual design reproduction as it varies by age and education.

Visual design reproduction	N	Mean	SD
Overall	159	6.58	1.64
Age: 18-30 yrs	41	7.27	1.52
31-45 yrs	49	6.49	1.56
46-60 yrs	35	6.66	1.39
>60 yrs	34	5.82	1.82
Education: 4-9 yrs	39	5.85	1.55
10-12.5 yrs	64	6.56	1.60
13+ yrs	56	7.13	1.55

n, number of participants; SD, standard deviation, yrs, years

The combined effect or interaction of the factors gender and age for visual design reproduction was also significant [$\chi^2(3)=8.83$, $p=0.0317$]. Differences in mean scores by age differed between men and women. Scores, thus, did not consistently increase or decrease by age for gender.

6.2.1.3 Digit repetition

Performance on digit repetition (total score=8) demonstrated significant differences according to education [$\chi^2(2)=29.11$, $p<0.0001$], but not language, gender or age. The higher the educational level the longer the digit series that could correctly be repeated. The three education groups differed significantly from each other. See Table 6.12 for scores.

Table 6.12 Performance on digit repetition as it varies by education.

Digit repetition	n	Mean	SD
Overall	160	4.91	1.32
Education: 4-9 yrs	39	4.08	0.88
10-12.5 yrs	65	4.82	1.20
13+ yrs	56	5.61	1.37

n, number of participants; SD, standard deviation, yrs, years

The combined or interactive effect of language and age for digit repetition was also significant [$\chi^2(3)=8.62$, $p=0.0348$]. The mean scores thus differed by age group between Afrikaans and English participants. Scores, thus, did not demonstrate consistent trends of an increase or decrease by age.

6.2.1.4 Finger tapping

Performance on finger tapping for the *right hand* demonstrated significant differences according to age [$F(3, 147)=5.21$, $p=0.0019$] and education [$F(2, 147)$, $p=0.0084$]. The trend for age was for lower mean scores for the older participants. Age group 18-30 and age group >60 especially differed from the middle two age groups and each other. The oldest group performs finger tapping at a notable slower pace. The trend for education was for higher mean scores for the higher educated. The higher the educational level the quicker finger tapping was performed. Scores were especially lower for the least educated group. See Table 6.13 for scores.

Table 6.13 Performance on finger tapping of the right hand as it varies by age and education.

Finger tapping right hand	N	Mean	SD
Overall	159	16.82	4.92
Age: 18-30 yrs	41	19.17	2.76
31-45 yrs	49	16.51	5.28
46-60 yrs	35	16.89	3.74
>60 yrs	34	14.38	6.20
Education: 4-9 yrs	39	14.62	5.78
10-12.5 yrs	64	17.02	4.62
13+ yrs	56	18.14	4.08

n, number of participants; SD, standard deviation, yrs, years

Performance on finger tapping for the *left hand* demonstrated significant differences only according to age [F(3, 147)=3.89, p=0.0103]. Age group 18-30 once again differed significantly from Age group >60, whereas the middle two age groups obtained similar scores. The results thus indicated similar trends for the age groups in finger tapping for both the right and left hand. See Table 6.14 for scores.

Table 6.14 Performance on finger tapping for the left hand as it varies by age.

Finger tapping left hand	n	Mean	SD
Overall	159	17.04	4.91
Age: 18-30 yrs	41	19.37	2.55
31-45 yrs	49	16.59	5.42
46-60 yrs	35	16.71	4.21
>60 yrs	34	15.24	6.02

n, number of participants; SD, standard deviation, yrs, years

6.2.1.5 Finger perception

Performance on finger perception for the *left hand* (total score=3) demonstrated significant differences only according to education [F(2, 148)=4.12, p=0.0181]. The higher the level of education, the better the fingers touched were recognised. Education group 4-9 significantly differed from Education group 13+. Education group 10-12.5 obtained similar scores to Education group 13+. Education group 4-9 on average scored 2 and Education group 13+ scored 3. Interestingly, no significant differences were demonstrated for the right hand. Participants for all education groups scored 3. No significant differences according to age were demonstrated for either the right or left hand.

6.2.1.6 Animal naming

Performance on animal naming did not differ significantly according to gender, language or age. However, men could on average name 2 more animals than women. Men named 15 animals per minute and women named 13 animals.

Significant differences were demonstrated according to education [F(2, 148)=18.07, p<0.0001]. Highly significant differences between the education groups were demonstrated. The higher the educational level, the more animals were named in a minute. See Table 6.15 for scores.

Table 6.15 Performance on animal naming as it varies for education.

Animal naming	n	Mean	SD
Overall	160	13.48	4.50
Education: 4-9 yrs	39	10.49	2.92
10-12.5 yrs	65	12.98	3.67
13+ yrs	56	16.13	4.81

n, number of participants; SD, standard deviation, yrs, years

6.2.1.7 Letter-number task

Performance on the letter-number task (total score=10) demonstrated significant differences according to language [$\chi^2(1)=6.58$, $p=0.0103$] and education [$\chi^2(2)=57.05$, $p<0.0001$], but not gender and age. Afrikaans participants on average dropped 1 point whereas English participants more often obtained perfect scores. Education group 4-9 significantly differed from the higher education groups. Persons with less than ten years of schooling, on average, scored less than the higher educated groups, whereas last-mentioned obtained similar scores. See Table 6.16 for the scores.

Table 6.16 Performance on the letter-number task by language and education.

Letter-number task	n	Mean	SD
Overall	160	9.56	1.16
Language: Afrikaans	127	9.46	1.28
English	33	9.94	0.24
Education: 4-9 yrs	39	8.69	1.76
10-12.5 yrs	65	9.86	0.50
13+ yrs	56	9.82	0.88

n, number of participants; SD, standard deviation, yrs, years

6.2.1.8 Delayed recall of figures

Performance on delayed recall of figures (total score=9) demonstrated significant differences according to age [$\chi^2(3)=45.25$, $p<0.0001$) and education [$\chi^2(2)=19.29$, $p<0.0001$], but not language and gender. The trend for age was for smaller mean values at the higher age groups. The younger the person the more accurately the figures were recalled. For

education higher average scores were obtained by the higher educated. The higher the level of education the more accurately the figures were recalled. See Table 6.17 for the scores.

Table 6.17 Performance on the delayed recall of figures as it varies by age and education.

Delayed recall of figures	n	Mean	SD
Overall	159	5.94	2.17
Age: 18-30 yrs	41	7.07	1.78
31-45 yrs	49	5.82	2.01
46-60 yrs	35	6.11	1.97
>60 yrs	34	4.56	2.27
Education: 4-9 yrs	39	4.97	2.07
10-12.5 yrs	64	5.95	2.22
13+ yrs	56	6.59	1.94

n, number of participants; SD, standard deviation, yrs, years

The main effect of age and education was significant, but also the combined effect of age and education [$\chi^2(6)=20.53$, $p=0.0022$]. Although scores decreased with age and increased with education the significant combined effect reflected inconsistent patterns within the age groups, which were not totally in agreement with the overall main effect. Scores, thus, do not increase or decrease consistently across all age and education groups. The combined effect of language and age was also significant [$\chi^2(3)=17.77$, $p=0.0005$]. Scores did not demonstrate a consistent pattern for age between the language groups.

6.2.1.9 Object naming

Performance on spontaneous object naming (total score=15) demonstrated significant differences according to education [$\chi^2(2)=34.31$, $p<0.0001$], but not language, gender and age. Participants with less than 13 years of education significantly scored less. The higher the educational level the more objects could be named. See Table 6.18 for the scores.

The combined effects of age with education [$\chi^2(6)=19.14$, $p=0.0039$], age with language [$\chi^2(3)=9.17$, $p=0.272$] and age with gender [$\chi^2(3)=10.83$, $p=0.0127$] were also significant. The mean scores did not demonstrate consistent patterns across all age groups for education, language or gender.

Table 6.18 Performance on the spontaneous naming of objects as it varies for education.

Spontaneous object naming	n	Mean	SD
Overall	160	13.46	1.59
Education: 4-9 yrs	39	12.72	1.64
10-12.5 yrs	65	13.15	1.61
13+ yrs	56	14.34	1.00

n, number of participants; SD, standard deviation, yrs, years

6.2.1.10 Design fluency

Performance on design fluency did not demonstrate significant differences according to language, gender or age. However, Afrikaans participants produced 1 design less than English participants. Afrikaans participants on average scored 5 (SD=3.34), and English participants 6 (SD=3.38). Women produced 1 design less than men. Women on average scored 5 (SD=3.19) and men 6 (SD=3.71).

Performance demonstrated significant differences according to education [$F(2, 146)=13.83$, $p<0.0001$]. The higher the educational level the more designs were produced. It was evident from the results that Education group 13+ outperformed education group 4-9 dramatically. See Table 6.19 for the scores.

Table 6.19 Performance on design fluency as it varies for education.

Design fluency	n	Mean	SD
Overall	158	5.37	3.34
Education: 4-9 yrs	39	3.23	2.26
10-12.5 yrs	63	5.06	2.84
13+ yrs	56	7.19	3.53

n, number of participants; SD, standard deviation, yrs, years

6.2.1.11 Reproduction of drawings

Performance on reproduction of drawings (total score=9) differed significantly according to gender [$\chi^2(1)=7.96$, $p=0.0048$) and education [$\chi^2(2)=46.86$, $p<0.0001$], but not language and age. Men could reproduce figures more accurately than women. The trend for education was for higher mean scores at the higher educational levels. See Table 6.20 for the scores.

Table 6.20 Performance on the reproduction of figures by gender and education.

Reproduction of figures	n	Mean	SD
Overall	159	7.44	1.57
Gender: Male	43	7.98	1.50
Female	116	7.24	1.55
Education: 4-9 yrs	39	6.21	1.69
10-12.5 yrs	64	7.42	1.35
13+ yrs	56	8.32	1.00

n, number of participants; SD, standard deviation, yrs, years

The main effect of education was significant. However, there was a significant interaction effect for age and education [$\chi^2(6)=20.22$, $p=0.0025$]. Again this reflected inconsistent patterns within the age groups, which stands in contrast to the overall effect of age. Scores, thus, do not increase or decrease consistently across all age and education groups.

6.2.1.12 Famous faces

Performance in the naming of faces (total score=6) demonstrated significant differences according to education [$\chi^2(2)=14.45$, $p=0.0007$], but not language, gender and age. The trend for education was for a slight increase in mean scores for the higher educated. Yet, the scores came to 5 for each education group after rounding of the mean. Thus, the significance of scores was attributed to differences in the variance of scores between the different education groups. See Table 6.21 for the scores.

Table 6.21 Performance on the naming of faces as it varies by education.

Famous faces	n	Mean	SD
Overall	160	4.88	1.01
Education: 4-9 yrs	39	4.54	0.94
10-12.5 yrs	65	4.83	1.08
13+ yrs	56	5.18	0.90

n, number of participants; SD, standard deviation, yrs, years

Performance also differed significantly according to the combined effect of language and gender [$\chi^2(1)=7.38$, $p=0.0066$). Afrikaans men and English women did better than Afrikaans women and English men. The latter two demonstrated more variance in scores. They could

on average name 5 faces correctly with a range in scores of 4-6. The first two groups could on average also name 5 faces, but with a range in scores of 5-6.

In addition, performance on the naming of faces differed significantly for the combined effect of gender and education [$\chi^2(2)=9.28$, $p=0.0096$]. The average scores, thus, did not demonstrate consistent patterns in mean scores by education for men and women.

Summary of main findings for Afrikaans and English participants:

- Performance on *word list trial 1* (item 1) was significant for the effects of age and education.
- Performance on *word list trial 2* (item 1) was significant for the effects of age and education.
- Performance on *word list trial 3* (item 1) was significant for the effects of gender and age.
- Performance on *delayed recall of words* (item 17) or word list trial 4, was significant for the effects of gender, age and education.
- The total for *word lists trial 2-4* was significant for the effects of gender, age and education.
- Performance on *visual design reproduction* (item 2) was significant for the effects of age and education.
- Performance on *digit repetition* (item 9) was significant for the effect of education.
- Performance on *finger tapping* for the right hand (item 11) was significant for the effects of age and education.
- Performance on *finger tapping* for the left hand (item 11) was significant for the effect of age.
- Performance on *finger perception* for the left hand (item 12) was significant for the effect of education.
- Performance on *animal naming* (item 15) was significant for the effect of education.
- Performance on *letter-number task* (item 16) was significant for the effect of education.
- Performance on *object naming* (item 19) was significant for the effect of education.
- Performance on *design fluency* (item 22) was significant for the effect of education.
- Performance on *reproduction drawings* (item23) was significant for the effects of gender and education.
- Performance on *famous faces* (item 23) was significant for the effect of education.

6.2.2 Xhosa participants

Scores for the separate test items were analysed for significant differences according to language and gender. No significant differences were demonstrated for gender. However, some items' scores significantly differed between Xhosa, Afrikaans and English participants, for age group 18-30 and education of 13 and more years. Following are the results.

6.2.2.1 Digit repetition

Performance on digit repetition (total score=8) demonstrated a significant difference [F(2, 23)=2.02, p=0.0492] according to language. Xhosa and Afrikaans participants performed similarly, whereas English participants achieved the highest scores. See Table 6.22 for the scores.

Table 6.22 Performance on digit repetition for Xhosa, Afrikaans and English participants of age group 18-30 with education of 13 or more years.

Digit repetition	n	Mean	SD
Overall	26	5.54	1.45
Xhosa	14	5.50	1.16
Afrikaans	8	4.88	1.73
English	4	7.00	0.82

n, number of participants; SD, standard deviation, yrs, years

6.2.2.2 Finger tapping

Performance on finger tapping for the *right hand* demonstrated a significant difference [F(2, 23)=3.63, p=0.0426] according to language. Xhosa participants took a bit longer than English

Table 6.23 Performance on finger tapping of the right hand for Xhosa, Afrikaans and English participants of age group 18-30 with education of 13 or more years.

Finger tapping right hand	n	Mean	SD
Overall	26	18.42	4.97
Xhosa	14	16.21	5.84
Afrikaans	8	20.88	1.46
English	4	21.25	1.89

n, number of participants; SD, standard deviation, yrs, years

and Afrikaans participants to perform this task. See Table 6.23 for the scores.

6.2.2.3 Animal naming

Performance on animal naming differed significantly according to language [F(2, 23)=12.42, p=0.0002]. The groups differed significantly in terms of the number of animals named. In addition, Afrikaans participants outperformed Xhosa and English participants, whereas Xhosa participants named the least animals. See Table 6.24 for the scores.

Table 6.24 Performance on animal naming for Xhosa, Afrikaans and English participants of age group 18-30 with education of 13 or more years.

Animal naming	n	Mean	SD
Overall	26	15.65	3.91
Xhosa	14	13.29	2.13
Afrikaans	8	19.50	4.00
English	4	16.25	2.06

n, number of participants; SD, standard deviation, yrs, years

6.2.2.4 Line orientation

Performance on line orientation (total score=4) differed significantly according to language [F(2, 23)=5.50, p=0.0111]. Xhosa and English participants on average identified all lines correctly, whereas Afrikaans participants scored 3. See Table 6.25 for the scores.

Table 6.25 Performance on line orientation for Xhosa, Afrikaans and English participants of age group 18-30 with education of 13 or more years.

Line orientation	n	Mean	SD
Overall	26	3.69	0.68
Xhosa	14	3.93	0.27
Afrikaans	8	3.13	0.99
English	4	4.00	0.00

n, number of participants; SD, standard deviation, yrs, years

6.3 Test-retest and interrater reliability

The Pearson correlation coefficient (r) was used to estimate the test-retest and interrater reliability of the BCAB. Excellent results were obtained for both validity measures. The results were measured against the generally accepted level of 0.70 (Cole, 1990). A total of 7 participants were included for each validity procedure. The test-retest reliability was 0.90, thus indicating a 90% level of agreement between scores. This overall result only differed by 1 percentage point when the 9 months group was separately investigated for test-retest reliability. The interrater reliability for two independent raters was 0.93, thus indicating a 93% level of agreement between raters in scores.

6.4 A table of normative values

Results demonstrated significant differences between the separate age and education groups for overall performance on the BCAB and numerous test items (see section 6.1.1 and 6.2). Consequently cutoff scores, representing normative values, were calculated for each age and education group. However, the middle age groups, age group 31-45 and age group 46-60, generally obtained similar scores. The expected trend was for age group 46-60 to obtain significantly lower scores than age group 31-45, thus an overall trend of lower mean scores for older participants. The cutoff scores for the two middle age groups were therefore combined to obtain an average score. Thus, normative values are presented for the age groups 18-30, 31-60 and >60 years, and for the education groups 4-9, 10-12.5 and 13+.

The normative values represent a lower 10% cutoff score, thus excluding the lower 10% of scores. These values are the lowest expected scores, by the current sample, for cognitively intact individuals. Confidence intervals are provided for the BCAB total score. This was possible due to the results demonstrating a normal distribution. The other item scores did not demonstrate a normal distribution. See Table 6.26 for the normative values as distributed seperately by age and education, and Table 6.27 for the combined effect of age and education.Table 6.27 will be most practical for use by clinicians.

Table 6.26 Normative values by the separate effects of age and education for the Bedside Cognitive Assessment Battery (BCAB).

TEST ITEMS	Age (years)			Education (years)		
	18-30	31-60	>60	4-9	10-12.5	>12.5
	n=41	n=84	n=35	n=39	n=64	n=56
BCAB Total Score	186	161	150	149	172	196
Confidence Intervals	190.82 - 262.26	162.29 - 253.62	150.40 - 233.02	150.28 - 215.72	166.03 - 246.93	188.46 - 271.22
Cognitive Domains						
1. Attention and Concentration	21	21	22	21	21	22
2. Speech	31	30	31	28	30	35
3. Memory	39	35	32	32	36	37
Verbal Working Memory (Word List Trial 1 + Digit Repetition)	7	7	8	7	7	7
4. Motor Functioning	43	32	16	18	31	38
5. Perceptual Functioning	30	28	31	25	28	34
6. Executive Functioning	28	25	25	20	27	31
Individual Tests						
Test 1: Words Trial 1	4	4	4	3	4	4
Test 1: Words Trial 2	6	6	6	6	6	6
Test 1: Words Trial 3	7	7	7	7	7	7
Words Total Trials 2-4	20	19	15	16	17	18
Test 2: Visual Design Reproduction	5	5	4	4	4	5
Test 3: Vigilance Test	18	18	18	17	18	18
Test 4: Spontaneous Speech	2	2	2	2	2	2
Test 5: Comprehension	2	2	2	2	2	2
Test 6: Repetition	2	2	2	2	2	2
Test 7: Reading	2	2	2	2	2	2
Test 8: Writing	2	2	2	2	2	2
Test 9: Digit Repetition	3	3	4	3	4	4
Test 10: Ideomotor Apraxia	2	2	2	2	2	2
Test 11: Finger Tapping: Right Hand	16	11	4	4	11	13
Test 11: Finger Tapping: Left Hand	16	9	4	5	11	14

Table 6.26 (continued) Normative values by the separate effects of age and education for the Bedside Cognitive Assessment Battery (BCAB).

TEST ITEMS	Age (years)			Education (years)		
	18-30	31-60	>60	4-9	10-12.5	>12.5
	n=41	n=84	n=35	n=39	n=64	n=56
Test 12: Finger Perception: Right Hand	2	2	2	1	2	2
Test 12: Finger Perception: Left Hand	2	2	2	1	2	2
Test 13: Luria Hand Sequence I	2	2	2	2	2	2
Test 14: Luria Hand Sequence II: Right Hand	2	2	2	2	2	2
Test 14: Luria Hand Sequence II: Left Hand	2	2	2	1	2	2
Test 15: Animal Naming	9	8	8	6	8	11
Test 16: Letter-Number Task	8	8	8	6	10	10
Test 17: Words Trial 4 (Delayed Word Recall)	6	4	2	3	3	4
Test 18: Delayed Recall of Figures	4	4	2	2	3	4
Test 19: Spontaneous Object Naming	12	11	12	10	11	13
Test 20: Line Orientation	2	2	3	2	3	3
Test 22: Design Fluency	3	2	3	1	2	4
Test 23: Reproduction of Drawings	6	5	6	4	6	7
Test 24: Face Recognition	4	4	4	3	4	4

Table 6.27 Normative values by the combined effect of age and education for the Bedside Cognitive Assessment Battery (BCAB).

ITEMS	Age (years)	Education (years)		
		4-9	10-12.5	>12.5
BCAB Total Score (without the item 'Design Destinction')	**18-30**	167	179	191
	31-60	155	166	178
	>60	149	161	173
COGNITIVE DOMAINS				
1. Attention and Concentration	**18-30**	21	21	21
	31-60	21	21	21
	>60	21	21	22
2. Speech	**18-30**	29	30	33
	31-60	29	30	32
	>60	29	30	33
3. Memory	**18-30**	35	37	38
	31-60	33	35	36
	>60	32	34	34
Verbal Working Memory (Words 1 + Digit Rep)	**18-30**	7	7	7
	31-60	7	7	7
	>60	7	7	7
4. Motor Functioning	**18-30**	30	37	40
	31-60	25	31	35
	>60	17	23	27
5. Perceptual Functioning	**18-30**	27	29	32
	31-60	26	28	31
	>60	28	29	32
6. Executive Functioning	**18-30**	24	27	29
	31-60	22	26	28
	>60	22	26	28
INDIVIDUAL TEST ITEMS				
Test 1: Words Trial 1	**18-30**	3	4	4
	31-60	3	4	4
	>60	3	4	4
Test 1: Words Trial 2	**18-30**	6	6	6
	31-60	6	6	6
	>60	6	6	6
Test 1: Words Trial 3	**18-30**	7	7	7
	31-60	7	7	7
	>60	7	7	7
Words Total Trials 2-4	**18-30**	18	18	19
	31-60	17	18	18
	>60	15	16	16
Test 2: Visual Design Reproduction	**18-30**	4	4	5
	31-60	4	4	5
	>60	4	4	4
Test 3: Vigilance Test	**18-30**	17	18	18
	31-60	17	18	18
	>60	17	18	18
Test 4: Spontaneous Speech	**18-30**	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 5: Comprehension	**18-30**	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 6: Repetition	**18-30**	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 7: Reading	**18-30**	2	2	2
	31-60	2	2	2
	>60	2	2	2

Table 6.27 (continued) Normative values by the combined effect of age and education for the Bedside Cognitive Assessment Battery (BCAB).

ITEMS	Age (years)	Education (years)		
		4-9	10-12.5	>12.5
Test 8: Writing	18-30	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 9: Digit Repetition	18-30	3	3	3
	31-60	3	3	3
	>60	3	4	4
Test 10: Ideomotor Apraxia	18-30	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 11: Finger Tapping: Right Hand	18-30	10	13	14
	31-60	7	11	12
	>60	4	7	8
Test 11: Finger Tapping: Left Hand	18-30	10	13	15
	31-60	7	10	11
	>60	4	7	9
Test 12: Finger Perception: Right Hand	18-30	1	2	2
	31-60	1	2	2
	>60	1	2	2
Test 12: Finger Perception: Left Hand	18-30	1	2	2
	31-60	1	2	2
	>60	1	2	2
Test 13: Luria Hand Sequence I	18-30	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 14: Luria Hand Sequence II: Right Hand	18-30	2	2	2
	31-60	2	2	2
	>60	2	2	2
Test 14: Luria Hand Sequence II: Left Hand	18-30	1	2	2
	31-60	1	2	2
	>60	1	2	2
Test 15: Animal Naming	18-30	7	8	10
	31-60	7	8	9
	>60	7	8	9
Test 16: Letter-Number Task	18-30	7	9	9
	31-60	7	9	9
	>60	7	9	9
Test 17: Words Trial 4 (Delayed Word Recall)	18-30	4	4	5
	31-60	3	3	4
	>60	2	2	3
Test 18: Delayed Recall of Figures	18-30	3	3	4
	31-60	3	3	4
	>60	2	2	3
Test 19: Spontaneous Object Naming	18-30	11	11	12
	31-60	10	11	12
	>60	11	11	12
Test 20: Line Orientation	18-30	2	2	2
	31-60	2	2	2
	>60	2	3	3
Test 22: Design Fluency	18-30	2	2	3
	31-60	1	2	3
	>60	2	2	3
Test 23: Reproduction of Drawings	18-30	5	6	6
	31-60	4	5	6
	>60	5	6	6
Test 24: Face Recognition	18-30	3	4	4
	31-60	3	4	4
	>60	3	4	4

Chapter 7
Discussion and Conclusion

7.1 Development of a new bedside assessment battery

The purpose of this project was to validate a new bedside cognitive instrument, namely the Bedside Cognitive Assessment Battery (BCAB). The main aim was to set normative values against which an individual's performance can be compared. In order to do this the test was evaluated for the effects of demographic variables. These included language, gender, age, and level of education. Overall performance, performance on the six main cognitive domains of functioning and separate test items of the BCAB could therefore be investigated for the coherence of results, including the novel items. Comparisons of BCAB tests can thus be made with similar, existing test results. In addition, the Mini-Mental Status Evaluation (MMSE) was used as a golden standard to investigate the compatibility of the BCAB with accepted cognitive assessment scales, to predict global cognitive performance.

7.2 The effect of age, education, language and gender on the BCAB

7.2.1 Overall performance on the BCAB

Overall performance on the BCAB demonstrated a highly significant influence of age and educational level for Afrikaans and English participants. The Xhosa group only represented one age and education group, thus limiting the interpretation of these variables. Test results differed between Xhosa, Afrikaans and English participants (see below). The significant findings confirm the effect of age and education on the results for similar, global estimates of cognitive functioning. Scales such as the Mattis Dementia Rating Scale (Scmidt et al., 1994); Clinical Dementia Rating (Roth et al., 1986); Wechsler Adult Intelligence Scale - Revised (Franzen and Iverson, 2000); and Wechsler Memory Scale (Van den Broek et al., 1998) are significantly influenced by age and education.

Age effects were more pronounced for youngest and oldest persons, although a general decline in performance is demonstrated with increasing age. A global deterioration in cognitive performance, especially towards old age is expected in normally functioning individuals (Rabbitt and Lowe, 2000). The degree of deterioration will however predict the presence or absence of neuro-pathology. The two middle age groups (31-45 years and 46-60 years) performed similarly. Those aged 46-60 even performed slightly better than the younger group. Bee (2000) points out that this group is able to focus more efficiently on the

task at hand due to a decrease in occupational and family demands at this stage of life. Individuals are approaching retirement, generally having achieved their goals and children being in high school or already out of the house.

Education demonstrated a greater influence than age on test scores. Results differed significantly between those with less than 10 years of education, 10-12.5 years of education and 13 or more years of education. The greatest difference was found between least and highest educated individuals. The global deteriorating effect of age impacts on cognition regardless of educational level. Yet, the age-related decline is more profound in the less educated (Chey et al., 1999). Scores for the lower educated group also demonstrated more variation. This is in agreement with a study of Crum et al. (1993). They postulated that a greater prevalence of developmental and disease conditions exist under the least educated, and that tests are not taken well, causing lower performance. The lack of or limited education deprives children of intellectual stimulation, influencing cognitive development negatively (Chey et al., 1999). In addition, this can predict future cognitive impairment such as dementia (Marcupolos et al., 1999). In contrast, the highly educated demonstrate the least variance in scores. Consistently high performance on tests may reflect better accessibility to financial, medical and educational resources in the middle- and higher socio-economic status groups.

Language did not influence overall performance for Afrikaans and English participants significantly. However, English participants in general performed better than Afrikaans participants. English participants obtained scores above the general mean total score, whereas Afrikaans participants' scores were similar to the mean. Cultural differences in terms of home environment may influence cognitive development. The value of verbal communication within a family, for example, may predict the richness of a person's learning experiences. Some cultures emphasise the active sharing of one's ideas and perceptions, whereas other cultures only communicate when necessary to accomplish a goal (Walsh, 1993).

In addition, Afrikaans children are more often expected to conform to traditional norms and values, whereas more individual freedom and actualisation of the self is emphasised for English children (Louw, 1994). The common saying within Afrikaans circles, "children are to be seen, but not heard", meant as a sign of respect towards older people/adults, represents an illustration of this. Last-mentioned tradition may have led to a lesser degree of being able to participate in possible learning occasions, insinuating a richer learning experience for English children and consequently English adults.

Overall cognitive performance on the BCAB differed significantly for language for Xhosa participants in comparison with Afrikaans and English participants, but not highly so. Xhosa participants only represented the age group 18-30 and educational level of 13 or more years. Sample selection focused on one age and education group to ensure reliable results. Therefore, Afrikaans and English groups having the same characteristics were compared to this Xhosa group. Xhosa participants obtained lower scores than Afrikaans and English participants. Once again, English participants performed the best, although only slightly better than Afrikaans participants. Results for the Xhosa group fell below the general BCAB mean for this group, whereas the other two language groups scored above the mean.

Xhosa participants' lower performance may be explained in terms of the context of the African- or Black culture. Walsh (1993) highlights the great impact of prejudice and discrimination on blacks' lives and consequent cognitive performance. The effects include less access to housing, educational opportunities, medical services, and employment; a general sense of powerlessness; and very few support systems in society. Black families face the daily challenge of overcoming these disadvantages in the post-apartheid mainstream. Yet, the Xhosa group for this study was highly educated. It seems that fewer opportunities in general, may be implicated in this instance. The new generation of young Blacks may also be distinctly different from older Blacks due to all the political changes.

7.2.2 Performance on the six cognitive domains

All the cognitive domains assessed by the BCAB were significantly influenced by education. The significance level was very high for all domains ($p<0.01$). The BCAB is thus capable of reliably delineating the cognitively intact from impaired individuals per domain by education. Age significantly influenced the memory, motor and executive systems, thus not all domains. The significance levels were not as high as for education. This confirms the superior effect of education.

The effect of age was most pronounced for memory. Results for the memory domain were significantly influenced for all age and education groups. Significance levels were high ($p<0.01$). The oldest participants obtained the lowest scores. The global deterioration effect of age on memory is a well-established biological fact affecting all normally functioning individuals. The degree to which they are affected will, however, predict whether a memory illness is present or not. The BCAB therefore seems to be a good predictor of normal ageing, thus, a good detector of memory impairment. This is also confirmed for executive ability

(Rabbitt et al., 2000; Wecker et al., 2000). In addition, the executive system incorporates aspects of motor ability. The effect of age is thus explained.

The results for the cognitive domains, speech, motor functioning and executive functioning differed significantly between Xhosa, Afrikaans and English participants. Xhosa participants generally obtained lower scores. The effect for motor- and executive functioning was rather small, but highly significant for speech. This finding for speech supports the notion that there are actual differences between language groups or cultures in the taking of cognitive tests. The BCAB being developed out of the dominant, Western perspective on assessment is, thus, not fully appropriate yet for use with Xhosa people. In addition, scores notably co-varied per cognitive domain. This implies fair reliability of results per cognitive domain. However, the samples were very small. One must therefore take caution when drawing conclusions from these results.

7.2.3 Performance on the separate test items

Significant age and education effects were demonstrated for the separate items of the BCAB. In addition, Afrikaans, English and Xhosa participants' scores were influenced by language. Gender only significantly influenced results for Afrikaans and English participants. Following is a discussion on the separate test items.

7.2.3.1 Immediate and delayed recall of words

The immediate recall of words on the second and third trial and delayed recall of words were significantly influenced by age. For all trials, individuals demonstrated a lower level of recall by age for those above 45 years. The scores were, however, the same for the age group 46-60 and >60. Strub and Black (1977) have demonstrated an age-related decline for the delayed recall of words for those aged above 60. Only 4 unrelated words were used for recall after a delay of 30 minutes. The BCAB uses 10 unrelated words for recall. The effect of age is confirmed by the total of trials 2-4 demonstrating significant differences between the age groups. The results show a gradual decrease in scores, with those aged >60 demonstrating significantly lower recall rates.

Education significantly affected the immediate recall of words on the first and second trial, and the delayed recall of words. The highest education group consistently recalled the most words. Hassing et al. (1998) explains the significant effect of education on the delayed recall of words, in terms of the strategic demand of this task. Higher educational level is associated

with greater verbal ability and retrieval-strategies. The total scores for trials 2-4 were also significant. Again individuals with the most education performed the best.

Significant gender differences were encountered for word list trial 3, the delayed recall of words and the total for trials 2-4 for Afrikaans and English participants. The significance was however small. Women could recall more words than men. A possible reason for this may be that women pay more attention to verbal tasks, whereas men are more practically oriented.

7.2.3.2 Visual design reproduction

Age and education significantly influenced visual design reproduction or the immediate recall of figures. Participants aged >60 and those with an educational level of 4-9 years obtained the lowest scores. Individuals scored 6 out of a possible 9. The figures used were similar to those presented by Strub and Black (1977). The exact same scoring system was used to rate the figures (see Table 5.1 in Chapter 5). A score of 2-3 per figure is suggested, coming to a total of 6-9 for three figures. The total scores found for visual design reproduction thus corresponded. However, scores per figure were generally lower (score=1).

7.2.3.3 Digit repetition

Age and education influences performance on digit span forward significantly (Hodges, 1994). This project demonstrates a highly significant effect ($p<0.01$) for education for Afrikaans and English participants, but not age. Hodges (1994) suggests a general score range of 6±1, with a score of 5 being either normal or marginal dependent on educational level. In addition, a young and intelligent person is expected to at least score 6. For our sample, the lowest education group scored 4, those with education of 10-12.5 scored 5, and those with 13 or more years of education scored 6. The score for the highest education group is in line with Hodges's suggestion regarding intelligent individuals. IQ or general intellectual ability is very closely related to the level of education attained (Harvey and Siegert, 1999). The higher the educational level the higher the IQ level. These suggestions can however not be generalised to the lower educated groups. The South African sample may be essentially different from the British sample from which scores were derived. The lower educated sample has been more disadvantaged in terms of educational backgrounds than the British, who experience the benefits of a first world environment. In addition, scores are generalised from a sample representing highly educated, young individuals.

Language influenced performance on digit repetition for Xhosa participants only slightly. Xhosa participants obtained slightly higher scores (5.5) than Afrikaans participants (5). Xhosa participants' scores therefore did not differ from the general norm. English participants significantly outperformed the latter two. They have scored 7, which is deemed above average. This may reflect this sample's having a higher level of education. English participants had a mean educational level of 13.53 years (Education group 13+) as opposed to Afrikaans participants with 11.67 years (Education group 10-12.5).

7.2.3.4 Finger tapping

Finger tapping for the right and left hand was significantly influenced by age. The older the person the slower the tapping rate. Studies demonstrated significant effects for finger tapping for both hands due to age (Ruff and Parker, 1993), but not gender as found by Chavez et al. (1983).

Finger tapping for the right hand was also significantly affected by educational level. Differences were most pronounced for the lowest education group. Correct execution of this task often proved difficult for this group. Completing the finger tapping cycles, beginning and ending with the index finger were in itself not problematic. The finer rules, for example, not tapping any finger twice or stopping between cycles, caused problems. These rules were not performed consistently, or not adhered to although explained more than once. Limited education negatively affects the development of conceptual abilities, which in turn affects the comprehension of tasks (Marcopulos et al., 1997; Chey et al., 1999). The finer details in performing this task may, thus, have proved too advanced for the least educated group. In addition, the completion of five tapping cycles was timed. The researcher sometimes having to correct the participant could have halted progress during assessment.

Language had a slight significant influence on finger tapping of the right hand for Xhosa participants. They took longer than Afrikaans and English participants to complete the task. These differences may be attributed to less-developed fine motor skills in general functioning. This points at possible differences in learning experiences between Afrikaans, English and Xhosa participants.

7.2.3.5 Finger perception

Educational level had a significant effect on the perception of the left hand's fingers in Afrikaans and English participants. The effect was most pronounced for the lowest education

group. No effects for Xhosa participants for either hand were demonstrated. The right hand perceive touch consistently better than the left hand regardless of whether a verbal or non-verbal response is required (Bakker and Van der Kleij, 1978). Left-hemisphere dominance for the right hand is suggested, pointing at functional asymmetry of the brain. The Xhosa group may have been too small to demonstrate the same effect.

7.2.3.6 Animal naming

Results on the naming of animals demonstrated a highly significant influence of educational level for Afrikaans and English participants, but not age, language or gender. This is similar to tests assessing word finding ability (Ivnik et al., 1996). It was, however, interesting that men could name two more animals than women. This may reflect different interest levels of men in comparison with women.

For the BCAB this item requires the naming of the most animals possible, with four legs, in one minute. Animal naming tests in general do not categorise naming. Therefore results can not be superimposed on the BCAB for this item. Scores are also significantly higher than for the BCAB. The BCAB version may be more time constraining due to a greater demand on mental flexibility. Persons must be able to subcategorise the different animal classes before responding. Thus, fewer animals were named per minute. In addition, raters were not allowed to give cues during administration, for this can cause improvement in scores (Bruno and Zimmerman, 2000), giving invalid results if not used consistently and in a standardised manner.

Language very significantly affected animal naming for Xhosa, Afrikaans and English participants aged 18-30, with 13 or more years of education. Afrikaans participants outperformed Xhosa and English participants. Xhosa participants named the least animals. It may be that the Xhosa language includes fewer words for animals in comparison with Afrikaans and English. In addition, Xhosa participants would more often have to use phrases and not single words to name an object. Logically this will prolong the naming of animals.

7.2.3.7 Letter-number task

The sequencing of letters and numbers was significantly influenced by education for Afrikaans and English participants. The lowest education group dropped one point on this task, whereas those with more education obtained perfect scores. This task requires higher order executive functions; mental flexibility and the ability to shift course are necessary for

successful completion of executive tasks (Wecker et al., 2000). Participants must be able to flexibly shift between letters and numbers, keeping with the pattern involved. Lower performance, thus, highlights the effect of limited education on cognitive development.

Language also influenced scores significantly. English participants performed better than Afrikaans participants. This may be explained in the light of the significant effect of education. The English group generally had a higher level of education than the Afrikaans group.

7.2.3.8 Delayed recall of figures

Afrikaans and English participants' performance on the recall of figures after a delay of approximately 20 minutes demonstrated a highly significant effect by age. Performance steadily decreases with an increase in age. This decrease in scores is consistent with findings for similar tests (Hodges, 1994). Education significantly influenced performance in that the lowest education group achieved the lowest scores. The effect of low education remains consistent over a wide spectrum of test items.

The combined effect of age and education also affected performance significantly. Interestingly scores decrease with an increase of age regardless of educational level. The delayed recall of figures mainly taps visual shortterm memory, but also executive ability. For accurate recall, it is necessary to maintain and separate the essential features of each figure. Memory and executive functions both determine global cognitive efficiency (Rabbitt and Lowe, 2000). Memory functions, however, are more localised, forming a distinct cognitive subsystem. In addition, it has been demonstrated that normal age-related decline in cognitive performance occurs regardless of the level of frontal functionality or level of intelligence (Rabbitt and Lowe, 2000). As mentioned earlier, the level of intelligence is related to a person's educational level. Thus, the isolated effect of age is confirmed. Participants aged 18-30 performed the best in the delayed recall of figures. This also confirms the influence of age; younger participants perform the best, whereas older participants perform worse.

7.2.3.9 Object naming

Object naming was significantly influenced by education. This finding corresponds with similar tests of naming (Harvey and Siegert, 1999; Saxton et al., 2000). The highest educated participants performed the best. These studies also demonstrated a significant effect for age. Our study did not demonstrate an age effect.

Afrikaans and English participants more often failed on the naming of the third or ring finger of the right hand, and a picture of a stapler. Participants' response, after assessment, regarding the incorrect naming of the two objects, pointed at specific possibilities. The second or fourth finger on the left hand is generally named the ring finger due to it carrying the wedding band, whereas the right hand's third finger is non-specific. A ring is either worn on it or not. For the stapler, a line drawing is extended by a shadow and the lines do not fully connect to form a closed figure. The characteristics of the drawing itself seemed to confuse the way the object was perceived.

Most Xhosa participants demonstrated an inability to name the picture of an octopus. The Xhosa rater's response to this was that it is not culture friendly, thus not generally known to their culture. The picture therefore needs to be exchanged with another, fairly difficult object that is culturally relevant, or removed with concurrent adjustment of the score for the BCAB Xhosa-version. Errors were also encountered in the naming of the examiner's knuckles. According to the Xhosa rater a Xhosa word for knuckles does not exist. Xhosa people do not often refer to the English word for it. The Xhosa dictionary has a descriptive phrase for it, but is not generally known. The rater also predicted naming difficulties for low educated individuals for the picture of the stapler. Walsh (1993) point at a linguistic alienation or verbal division between cultures. Language patterns or the use of words differs for each language and are shaped by the local environment.

One participant was assessed in Afrikaans, because of being totally fluent in the language. Yet, afterwards the person mentioned that Xhosa was also spoken in her home, although less than Afrikaans. Interestingly, she erred in the naming of knuckles, an octopus, and magnifying glass. The inability to name the first two objects confirms the above-mentioned effects for Xhosa participants.

7.2.3.10 Line orientation

Language significantly influenced line orientation for Xhosa, Afrikaans and English participants aged 18-30 with an education of 13 or more years. Xhosa and English participants generally obtained perfect scores, whereas Afrikaans participants dropped one point on this task. The sample size was very small for these groups. The sample included 14 Xhosa, 8 Afrikaans and 4 English participants. Afrikaans participants' lower performance may therefore be attributed to last-mentioned.

Education significantly influences performance on the Benton's judgement of line orientation test (Woodard et al., 1998). The higher the educational level and the younger the person, the higher the score. This is in contrast with our findings for Afrikaans and English participants. Our version of this test uses the same array of numbered lines, but the lines to be matched, is of similar length, thus not half the length as in Benton's version (Benton et al., 1978). In addition, only four lines of different angles are to be matched, separately. The test thus, presents a novel version of the judgement of line orientation test. It is not clear from this study how the different test conditions and considerably shorter version influence results.

7.2.3.11 Design fluency

The production of four-line designs was significantly influenced by education. The effect was highly significant with the highest education group, which performed the best. Previous studies have not specifically stated the effect of education on scores (Jones-Gotman and Milner, 1977; Royall et al., 1992; Carter et al., 1998). Tyler and Walsh (1979) have found a high correlation between scores and the MMSE. MMSE scores significantly correlate with education as demonstrated in Chapter 1 and 3. The higher the MMSE score, the more designs are produced. In addition, our scores for design fluency correlated very highly with MMSE scores (r=0.92). This implies a significant relationship between educational level and the production of designs. Our result is thus supportive. In addition, the free-drawing condition for design fluency which is almost identical to the BCAB's version, correlated highly, and better between raters than the fixed drawing condition (Carter et al., 1998). The results are therefore valid as normative values.

Language did not significantly affect results. The finding that Afrikaans participants produced one design less than English participants, was however interesting. English participants were generally higher educated than Afrikaans participants. Thus, the sample not being fully representative of all education groups for both language groups could be implicated. In addition, women produced one design less than men. Once again a far greater number of women participated in the study than men. Results may therefore not be an accurate representation of the general population.

7.2.3.12 Reproduction of drawings

Education demonstrated a very significant effect on the reproduction of drawings. Education, but not age affects the copying of simple two- or three-dimensional figures (Lezak, 1995). The effect of education and no effect for age are thus in accordance with these findings. The combined effect of age and education were also significant, but not as pronounced as for education. Scores increased with an increase in educational level for all age groups except those aged 18-30. The age group 18-30 may, thus, copy drawings similarly regardless of educational level.

7.2.3.13 Famous faces

Education significantly influenced the recognition of familiar faces in spite of the differences in scores being small. Scores demonstrated a clear increase with education although only by decimal point. This follows the general, global pattern shown for education. After rounding of the mean, the mean scores for all groups were the same in that it did not differ according to age or education. The significance may therefore be attributed to the variation in scores within education groups respectively.

Interestingly, Afrikaans and English participants most often failed in naming the face of Muhammed Ali. This may reflect the level of general knowledge of participants. All Xhosa participants, except for two, could not name the face of Adolf Hitler. According to Xhosa people, the history concerning Hitler and the Second World War were not taught in their schools in contrast with Afrikaans and English medium schools. This explains the inability in most instances to name the face.

7.3 The MMSE and BCAB

MMSE scores were significantly influenced by education. Overall, the score for Afrikaans and English participants were similar. The score obtained was 29. The only differences in score were for Afrikaans speaking participants and the participants with less than 10 years of schooling. They obtained a score of 28. Lower scores on the MMSE, especially for the least educated, have been demonstrated (Chey et al., 1999; Marcopulos et al., 1999). In addition, Crum et al.(1993) has found a score of 29 for individuals with at least ten years of education. The sample for last-mentioned study included 18 056 participants. The highly educated also demonstrated little variance in MMSE scores, whereas the low educated group's scores varied more. Lower variability in scores implies lower sensitivity of tests or ceiling effects

(Crum et al., 1993). This affects the detection of cognitive impairment; the cognitively impaired are not always detected by the MMSE. Thus, the MMSE should always be accompanied by tests that screen for cognitive impairment more extensively. Otherwise, normal functioning individuals can not be reliable separated from the impaired.

Significant effects for age have been demonstrated for the elderly (Osterweil et al., 1994). The scores tend to be lower, especially for the very old. Our study did not demonstrate an effect for age. The distribution of participants by age may have concealed possible significant effects. Participants aged 61-94 was, for example, grouped together. Ideally, elderly participants aged 61-79 should be separated from those aged 80 and older, since last-mentioned group achieves the lowest MMSE scores.

7.4 Implications of results for the validity of the BCAB

7.4.1 Test-retest and interrater reliability

The BCAB has demonstrated excellent test-retest reliability for normally functioning individuals. Results did improve slightly on the second test occasion, but the effect was not significant. Improvement in scores is expected for the cognitively intact, but not for impaired individuals, except where treatment improves general cognitive functioning. In addition, a test is found to be reliable when it ranks the same individual similarly when re-assessed (Rabbitt and Lowe, 2000). Thus the BCAB may be a consistent measure of cognition in the cognitively impaired.

In the demented, measures that can reliably document changes in cognitive performance are essential for studies (Cole, 1990). A reliable, global measure should therefore be able to demonstrate the temporary improvement in cognitive performance, for example, Alzheimer's patients who are newly started on medication, as well as the deterioration that follows after some time. The BCAB remains to be studied for its ability to grade changes in brain diseases or brain injury.

The BCAB has also demonstrated very high agreement between raters on overall scores. High interrater reliability suggests consistency of a measure (Cole, 1990). The co-rater for this study was an occupational therapist. Morris et al. (1997) has found high interrater agreement between physicians and non-physicians to rate cognitive performance, suggesting that both groups are equally adept at using tests. The physicians included psychiatrists and neurologists, and the non-physicians, nurses, social workers,

psychometrists, research assistants, and doctorate fellows. No real difference was found between the two groups by profession. Medical doctors demonstrated an interrater agreement of 82%, and non-medical raters 85%, with an overall level of agreement of 83%. An occupational therapist, in addition to above-mentioned professionals, is therefore equally, if not, more competent to perform bedside cognitive assessment batteries after sufficient training.

Training before and during use of a test is essential to optimise the agreement of results (Cole, 1990). Interrater reliability is problematic when not adhering to standardised procedures (Morrison et al., 1979). Raters also need to be experienced in working with patients such as the demented (Franzen et al. 1989). Nurses, for example, can use tests to assist in monitoring the cognitive status of patients suffering from closed traumatic brain injuries, stroke, dementia, and HIV-dementia (Sultzer et al., 1995). This may decrease the pressure on overworked physicians.

7.4.2 General validity of the BCAB

7.4.2.1 Construction of the BCAB and reliability of items

The purpose of creating a new bedside cognitive assessment battery, was to have an intermediate level test that overcomes overly time-consuming assessments, and assessments providing insufficient information on all domains of cognitive functioning. The BCAB would therefore provide comprehensive information on the different cognitive functions, and means to differentiate between cognitively intact and impaired individuals. Items were selected to extensively but quickly, assess each of the six cognitive domains, which include attention and concentration, language, memory, motor functions, perceptual functions and executive functions. Items then needed to have clear and exact administration and scoring guidelines. A semi-structured format and definite criteria of test items provide for the reliable use of a battery as a standardised, global scale (Franzen et al., 1989).

The BCAB was extensively revised to optimise standardised use. However, some items caused uncertainty regarding administration and scoring procedures. These items include spontaneous speech, successive finger taps, naming and word finding, and design distinction. (See the BCAB's administration pad in the Appendix.) Vague scale items needs to be clarified to provide optimum validity of a test (Cole, 1990). Also, subjectivity in rating is minimised by improving the descriptive criteria of test items (Morris et al., 1997). In addition,

increased diagnostic accuracy follows when results are obtained and interpreted in a standardised manner (Nelson et al., 1986).

There were no uncertainties regarding what the item 'spontaneous speech' measures. Criteria were provided to guide the rating of spontaneous speech and queries focused on scoring. When would the degree of impairment be rated as borderline? A description on each guideline for scoring will also be helpful, for example, providing a definition next to 'paraphasias'.

The item 'successive finger taps' explains clearly what the task entails. For standardisation purposes it will be helpful to state when the rater must correct the patient when performing the task. The time is measured to complete five cycles per hand and correcting the person on mistakes during performance, interferes with the task. A formal trial run, to demonstrate whether a person understands the task, is recommended. If the person persists in incorrectly performing the task, then times should not be documented and performance marked as abnormal. Additional scoring criteria should therefore be considered.

The 'naming and word finding' task provides three columns for the scoring of naming ability. The first criteria provide for the rating of spontaneous naming of objects, the second for correct description of objects, and the third for naming after provision of a phonic clue. The criteria are not accompanied by exact guidelines regarding the placement of responses. However, the first criterion was fairly clear and therefore used in the analysis of the data. The Alzheimer's disease assessment scale provides a clear example of how this item can be improved and thus, standardised. Examples for each object, regarding the second and third criteria, needs to be included. Yet, the third criterion is not included in the ADAS. The ADAS has proved to be a very reliable scale in multi-centered studies. Removal of the requirement for a phonic clue is therefore recommended.

The 'design distinction' item has proved difficult for raters and participants. Administration procedures were often questioned and some participants seemed to misunderstand the task. Consequently results were inconsistent, invalid and could not be used to provide normative values. The scoring system did not allow for responses taking longer than 30 seconds and scores subsequently varied greatly between total failure and very good performance. The test is viewed as an accurate measure of perceptual ability, but procedural difficulties limits the interpretation of results. A suggestion therefore is to lengthen the time for completion of this task. Administration guidelines may also need revision.

The item 'design fluency' reliably assessed executive functioning. The test requires the provision of examples to illustrate the task to the person assessed. In all cases, examples of steps and a hash sign were hand-drawn by the rater. However, the validity of this item will be optimised if pre-printed examples are provided for design fluency (Royall et al., 1992).

7.4.2.2 Global estimates of cognitive functioning versus the localisation of specific cognitive functions

The BCAB generally proved to be a reliable global estimate of cognitive functioning. Although some test items could not be compared to literature, because of the creation of novel forms of existing items and new items, results could mostly be predicted by clinical experience. Yet, at least half of the test items were almost similar or exactly the same than published test items, for example, most of the language tasks, the vigilance test, visual design reproduction, digit repetition, animal naming, Luria's hand sequences, design fluency, and the reproduction of drawings. The use of well-known, valid and frequently used individual tests, leads to high sensitivity of items within a battery to correctly discriminate between normal functioning individuals and the demented (Nelson et al., 1986; Carlesimo et al., 1996).

Obtaining a global estimate of cognitive functioning is useful to predict the presence or absence of cognitive impairment. However, the question regarding the domain(s) affected by disease or injury, remains. If a patient's diagnosis is already known, a clinician will be able to predict the loci of impairment and the associated dysfunction. The test is used to confirm the impairment, document changes or detect additional problems. Otherwise, the cognitive test may be used to guide a clinical investigation regarding diagnosis. In this sense, it is essential to consider a profile of cognitive impairment rather than solely a global estimate (Hodges, 1994). A test capable of validly delineating impairment, insinuates a sensitivity for changes in some cognitive domains, but not others (Rabbitt and Lowe, 2000).

Hodges (1994) has provided a checklist of non-localised and localised cognitive functions for the complete assessment of cognitive ability. The BCAB include assessments of all functions except orientation (non-localised) and calculation (localised). The MMSE, which usually accompanies the BCAB, covers these functions. The BCAB may, thus, represent a good detector of mild to moderate impairment. As is, the BCAB technically fulfils that role. Yet, as described above, some items need validation anew and the tightening of administration and scoring guidelines to optimise standardisation and overall validity.

7.5 Normative values for the BCAB

7.5.1 Separate effects of demographic variables

Normative values adjusted for the significant effect of demographic variables are the most valid and relevant. The investigation of results for overall and separate effects is essential to guide decisions regarding diagnosis and treatment. Age and education most strongly influenced scores on the BCAB. Language and gender's influence was limited to a few items for Afrikaans and English participants. Language differences were also prominent for a few items for Xhosa participants, in comparison with Afrikaans and English participants. Last-mentioned participants were of age group 18-30 with an educational level of 13 or more years.

Age and education also influenced the BCAB's memory items significantly. The immediate and delayed recall of words and figures, were significantly influenced by age and education and digit repetition by education. Age and education adjusted norms are most useful in clinical practice for most measures of memory due to its significant effects (Marcopulos et al., 1997). This has definite implications for similar memory tests, implying strength for the BCAB's memory section to assess for memory impairment.

All executive items, except for the Luria hand sequences, were significantly influenced by education. These include animal naming, the letter-number task and design fluency. Two of the three motor items were significant for both age and education. The two motor items are successive finger taps and the reproduction of drawings. Normative values for the BCAB will, thus, be most useful when grouped firstly according to age, secondly to education and thirdly to the combined effect of age and education. This will allow for the comparison of scores for the same item for each demographic factor and overcome the effect of small sample size when age and education is combined. A clinician will then be able to discern the degree of similarity between scores. Should scores also correlate with tests with proven validity for the same results, cross-validation of scores can occur (Rabbitt and Lowe, 2000).

The use of standardised tests using culturally relevant norms is also stressed (Pieters and Louw, 1987). Scores obtained for Xhosa participants demonstrated significant differences due to language and possibly socio-economic circumstances. Our Xhosa sample generally achieved lower scores than Afrikaans and English participants. Major high false negative rates have been demonstrated for race groups when briefly screened for cognitive status (Stuss et al., 1996). Cutoff scores would therefore need careful examination in the setting of

norms. Lower cutoffs are imperative. Although normative values can not be provided here for Xhosa controls, this study aimed at establishing a starting point for norm setting procedures. Some differences in test taking were highlighted and tentative scores presented. Ways to improve and standardise the BCAB Xhosa-version is therefore provided. This version will accordingly be modified.

7.5.2 Combined effects of demographic variables

Several combinations of the demographic variables gender, language, age and education influenced results significantly. The combinations, for example, included the interaction of age and education, gender and age, and language and education. See Chapter 6. These effects are not as simple to interpret as the separate effects explained in the previous section. To accordingly calculate valid normative values, the significant interactive effects per test item have to be incorporated in an appropriate statistical model.

Normative values for scores representing a normal distribution are relatively simple to calculate. On the other hand, more advanced statistical calculations are required for scores having, for example, a binomial or Poisson distribution. In several cases, the BCAB test items represented last-mentioned distributions. This implies that more in-depth investigations are needed to create valid tables of normative values. Scores presented here can act as preliminary guides for the effects of age and education, if used with caution because of small sample sizes. Suggestions are therefore made to aid further norm setting. An example of the calculation of a cutoff score for a normal distribution of scores follows in the next section.

7.5.3 The presentation and calculation of normative values

Normative values can be presented as percentiles and total scores (Hopkins et al., 1993; Prigatano et al., 1994), and also as medians and mean scores. The percentiles represent the percentage of normal controls that achieved a specific total score on a test, for instance overall and per cognitive domain. In addition, lower cutoff scores will be most useful to distinguish between the cognitively intact and impaired. Scores can differ greatly due to the effect of demographic variables (Hodges, 1994). Higher cutoff scores for highly educated and lower cutoffs for the low educated is therefore recommended within age groups (Schmidt et al., 1994). Otherwise, high rates of false negative diagnosis may follow for mildly impaired individuals. For the BCAB lower cutoff scores will be most useful. The BCAB total score, for example, demonstrated a normal distribution of scores. See below for an example of the calculation of a cutoff score for such a distribution.

Age and education, separately and jointly, most notably influenced overall performance on the BCAB. The starting point therefore is to calculate mean values firstly for the separate and the combined effect of age and education with big enough samples. The mean scores then need to be fitted, thus the score that will best predict performance per group, have to be calculated with an appropriate statistical procedure. A decision regarding the percentage of scores to be cut off, are made before this procedure, for example to exclude the lowest 10% of scores. A fitted mean score, for instance for those aged 18-30 with an educational level of 4-9 years, is then used as part of a regression equation to calculate a cutoff score for the specific group. The regression equation, y = a - c*s, is used with *y* representing the cutoff score. *a* represents the fitted mean score, *c* the 10% percentile for a normal distribution, * the multiplication sign and *s* the standard deviation.

7.6 Conclusion

The BCAB is an objective measure assessing specific classes of cognitive functioning in a standardised manner. The brain processes or classes of functioning are viewed as an integrated working system. Functions are not limited to specific brain areas, but co-operate with each other. Yet, a clinician will be able to identify specific areas of functioning when, for example, a brain tumour effects functional behaviour. The BCAB will therefore be able to assess for global impairment and specific impairment. Dementia globally impairs functioning, whereas closed head injuries can affect functioning globally or specifically, dependent on the brain area(s) involved. This also has implications for rehabilitation. Clinicians will have an idea of what areas of behaviour to focus on to improve functioning. In addition, the BCAB may be useful to assess executive dyscontrol related to schizophrenia, major depression, HIV and normal ageing (Royall, 1998). The executive system is linked to almost all brain areas, acting as an overseer of functioning.

The BCAB is useful, relevant and appropriate. The BCAB overcomes time-constraints by assessing individuals in less than one hour dependent on age, educational level and level of impairment. This provides for minimal frustration during assessment. The diversity and interactive nature of items also provide for enjoyment. The BCAB can also be administered at the bedside at numerous locations. Clinicians are therefore not constrained by specialised equipment, and disabled or elderly individuals can easily be assessed in caring facilities or old age homes. If a physician is not available, non-physicians can administer the BCAB when sufficiently trained. The BCAB is therefore also a useful teaching tool.

The BCAB also have limitations. Some items need updating and re-evaluation for validity. Administration and scoring procedures have to be tightened. Current validity of overall scores may therefore be in question. Caution should be used in the interpretation of scores and the BCAB must be accompanied by a complete clinical examination. The BCAB is also not recommended for medico-legal purposes. The BCAB is a rough screen for mild to moderate impairment. It guides decisions regarding possible impairment, thus mediates the course to be taken for further investigation.

Sampling of participants may also limit the generalisability of results. English participants generally had a higher level of education than Afrikaans. This implies a confounding effect for education. In addition, the Afrikaans sample included a large number of coloureds whereas the English sample, but for two participants, only included whites. Cultural aspects in terms of different home environments, and socio-economic status may also affect the interpretation of results, especially for Xhosa participants.

Age and education most notably influenced results. The aim therefore was to present normative values for the separate and combined effect of age and education. However, the sample sizes when grouped for the combined effect, were quite small. This study was able to fulfil this aim, but caution should govern the use of these normative values.

The interactive effects of language and gender with each other and last-mentioned variables also played a significant role in some cases. This warrants further investigation concerning the impact on normative values. A proper study using a much greater number of normal controls, thus needs to follow. Take note that the test items not discussed either in the results or discussion section, were valid as part of the BCAB. Participants obtained near perfect or perfect scores, thus, such performance is the expected norm. Also take note that the suggested normative values in the scoring sheet were based on the initial pilot study, thus not representing a spectrum of age and education groups.

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Appendix

1. Bedside Cognitive Assessment Battery (BCAB)
   English version - Administration Pad

2. Bedside Cognitive Assesment Battery (BCAB)
   Figure Sheet

3. Bedside Cognitive Assesment Battery (BCAB)
   Scoring Pad

4. Bedkant Kognitiewe Evaluerings Battery (BKEB)
   Afrikaanse weergawe - Administrasie Blad

5. Bedside Cognitive Assesment Battery (BCAB)
   Xhosa version - Administration Pad

6. Informed Consent Document

Important Warning

This test battery can only be used by persons with adequate training.
Normative values are not yet available and this test cannot be used for medico-legal work. The battery has many limitations and you are encouraged to contact the authors for discussion of this.

UNIVERSITY OF STELLENBOSCH
TYGERBERG MEMORY CLINIC

&

PANORAMA MEMORY CLINIC

BEDSIDE COGNITIVE ASSESSMENT BATTERY (BCAB)

ADMINISTRATION PAD

Frans J. Hugo , Annerine Roos, Sandra Brink, Frances Hemp, Dorothy Calata and Robin Emsley

Developed and compiled in 1995
Revised in 1997
Revised in 2001
This version revised 2002

NAME: _____

DATE OF BIRTH: _____ **GENDER:** _____

HOSPITAL NO: _____ **DATE:** _____

YEARS OF EDUC: _____ **MOTHER TONG:** _____

ASSESSED BY: _____

MATERIALS REQUIRED FOR TEST ADMINISTRATION: Pencil, stopwatch and 4 blank A4 pages (no lines)

INSTRUCTIONS: Carefully study each item for correct administration procedures before utilizing the BCAB as an assessment tool of cognitive functions. Present the BCAB test items in the order that it is set out in the following section.

Aknowledgements for Test Items:
Visual Design Reproduction; Vigilance Test; Digit Repetition; Line Orientation: Strub, R.L., & Black, F. W. (1977). *The mental status examination in neurology*. Philadelphia: FA Davis Company.
Spontaneous Speech; Comprehension; Repetition; Reading; Writing; Ideomotor Apraxia: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Luria Hand Sequence I; Luria Hand Sequence II: Luria in: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Line Orientation: Benton, A.L., Varney, N.R., & Hamsher, K.de S. (1978). Visuospatial judgement: a clinical test. *Archives of neurology 35*(6): 364-367.
Succesive Finger Taps; Finger Perception: Frances Hemp
Design Fluency: Royall, D.R., Mahurin, R.K., & Gray, K.F. Bedside assessment of executive cognitive impairment: the executive interview. *Journal of the American Geriatric Society*. 1992; 40(12): 1221-6
Animal Naming: Goodglass, H., Barton, M.I., & Kaplan, E.F. (1968). Sensory modality and object-naming in aphasia. *Journal of Speech and Hearing Research 11*(3): 488-496.

COGNITIVE ASSESSMENT:

1. WORD LISTS:

Give the patient the following instructions:

"I am now going to read a list of words to you. Listen carefully so that you will be able to remember the words. I will ask you to say the words back to me after reading it to you. You will have three chances now to memorize the words and I will ask you again later to recall it."

Read the words at a rate of one word per second. The patient must not be guided in recalling the words and may not be corrected. The words left out may also not be given to the patient. Score 1 for each word correctly given.

Trial 1:

CAR CARROT GREEN DONKEY CHURCH BOOK TABLE SHIRT SPEAR UMBRELLA

Trial 2:

"I will now read the same words in a different order. You must again say all the words back to me that you can remember."

DONKEY SPEAR UMBRELLA CAR CARROT SHIRT CHURCH GREEN BOOK TABLE

Trial 3:

"I will now read the same words in a different order. You must again say all the words back to me that you can remember."

SPEAR DONKEY BOOK CHURCH TABLE UMBRELLA CAR CARROT SHIRT GREEN

TRIAL	SCORE
1	
2	
3	

2. VISUAL DESIGN REPRODUCTION:

See stimulus cards, Figures 1-3. The patient is required to reproduce each of the three designs on a piece of white paper after a 10 second presentation and 10 second delay. Multiple attempts are not encouraged, but if the patient wants to redraw a design then a second attempt is allowed. The following instructions are given:

FIGURE	SCORE
1	
2	
3	
TOTAL	

"I am now going to show you some simple designs. I want you to carefully look at each design for 10 seconds, so that you can draw what you have seen from memory. Do not draw the design until I have told you to begin, as we will wait 10 seconds. Remember the designs, because later I will ask you to draw it again."

Score the designs as described in Appendix I.

3. VIGILANCE TEST:

Tell the patient:

"I am going to read you a long series of letters. Whenever you hear the letter A, indicate by tapping the desk."

Read the following letter list in a normal tone at a rate of one letter per second. Count the number of As that were correctly indicated by a tap from the patient (maximum score = 18). Also, count the number of extra taps (perseverations).

L T P E A O A I C T D A L A A
A N I A B F S A M R Z E O A D
P A K L A U C J T O E A B A A
Z Y F M U S A H E V A A R A T

Number of As correct:	
Number of extra taps:	

4. SPONTANEOUS SPEECH:

Refer to Figure 4 and ask the patient to

"Tell me a story about what is happening in the picture."

	Yes	No
Tells a story spontaneously that describes the setting, names at least 2 characters and describes an action		
Fluent speech		
Normal articulation		
Paraphasias		
SCORE (SEE GUIDELINES)		

Abnormal spontaneous speech is shown by impaired fluency, articulation and the presence of paraphasias. Note if the patient tells a spontaneous story which describe the setting, names at least 2 characters and describes an action. Note if the patient tells a story with prompting, or fails to tell a story. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

5. COMPREHENSION:

Patient's response to pointing commands:
Ask the patient to point to the following objects and body parts. Record the adequacy of performance. Score on the patient's first try. Do not give visual cues.

Final score: Score as normal (2) when all the commands are executed correctly, borderline (1) when 5 commands are correct, and abnormal (0) when less than 5 commands are correct.

COMMAND	MARK IF CORRECT
1. "Point to the window"	
2. "Point to your left elbow"	
3. "Point to your chin"	
4. "Point to your right cheek"	
5. "Point to the ceiling and your forehead"	
6. "Tap each shoulder twice with two fingers while your eyes are shut"	
TOTAL CORRECT (MAX = 6)	
FINAL SCORE (SEE GUIDELINES)	

6. REPETITION:

Score	

Tell the patient to repeat the sentences. If necessary use additional words or sentences. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

Sam likes to play rugby.

No ifs, ands, or buts.

I go to the shopping centre to spend my money.

7. READING:

Ask the patient to read and respond to the sentence CLOSE YOUR EYES. See figure sheet. If necessary use additional sentences. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

Score	

8. WRITING:

Ask the patient to write a short meaningful sentence on a blank piece of paper. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

Score	

9. DIGIT REPETITION:

Tell the patient:

"I am going to say some simple numbers. Listen carefully and when I am finished, say the numbers after me."

Present the digits in a normal tone of voice at a rate of one digit per second. Take care not to group digits either in pairs or in sequences that could serve as an aid to repetition. If the patient makes a mistake then inform him so and repeat the same series. If the patient is incorrect again then score as incorrect. Carry on to the next series. Stop if the patient is incorrect on two consecutive series. The score equals the number of sequences correctly recalled.

ITEM	1st Attempt	2nd Attempt	Score 1 for correct and 0 for incorrect after two attempts.
3-7			
5-4-9			
8-2-5-7			
5-9-6-8-3			
5-7-1-9-4-6			
8-2-9-3-6-5-1			
3-9-8-2-5-1-4-7			
7-2-8-5-4-6-7-3-9			
TOTAL (MAX = 8)			

10. IDEOMOTOR APRAXIA:

This item describes the adequacy of the patient's performance in carrying out motor acts to command. Note if imitation or use of a real object was necessary to facilitate performance. Test both right and left handed function. Final score: Score as normal (2) when every step is performed correctly and abnormal (0) when any step is performed incorrectly.

ITEM **"Show me how you would:"**	RIGHT HAND: MARK IF CORRECT	LEFT HAND: MARK IF CORRECT
1. Pour a cup of tea		
2. Add the sugar		
3. Stir it		
TOTAL CORRECT		
FINAL SCORE (SEE GUIDELINES)		

11. SUCCESSIVE FINGER TAPS:

Ask the patient to put both hands in the air with the elbows resting on the table. He/she has to touch each finger to the thumb in turn starting with the index finger, forwards and backwards. Measure the time for each hand to complete five cycles, preferably with a stopwatch, and in seconds. Start measuring when the index finger touches the thumb. If the patient taps a finger twice (e.g. index/pinkie), inform the person that it is incorrect and that each finger should be tapped only once. Observe for movement in the hand that is not involved in the task. Stop the task if the patient takes longer than 30 seconds.

Successive finger taps:		
HAND	Time (seconds)	Final Score = 30 – Time
RIGHT		
LEFT		

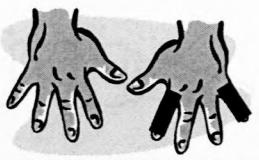
12. FINGER PERCEPTION:

Ask the patient to place his hands on the table in front of you.

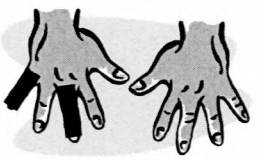
"I am now going to touch two of you fingers and you must tell me how many of your fingers are in between."

Touch the fingers indicated in black below. The patient should answer one.

1. "Now close your eyes while I continue this test. How many fingers are in between the fingers that I touch?" A correct answer scores one point.



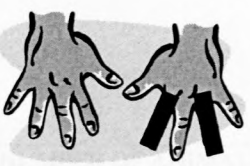
2. "And now?"



3. "And now?"

4. "And now?"

5. "And now?"



6. "And now?"

PICTURE	SCORE RIGHT	PICTURE	SCORE LEFT
2.		1.	
4.		3.	
6.		5.	
TOTAL (3)		TOTAL (3)	

13. LURIA HAND SEQUENCE I

SCORE	

Ask the patient to perform the task shown below. Faultless performance is normal. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

14. LURIA HAND SEQUENCE II

Start the alternating hand sequence and ask the patient to imitate you. After the patient starts his own sequence, stop yours and score 3 cycles. Successful completion of this task is 3 cycles without error.
Test both left and right hands. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

	SCORE
Left hand	
Right hand	

15. ANIMAL NAMING:

Ask the patient to name as many different animals with four legs as possible in one minute.

NUMBER OF ANIMALS	

16. LETTER – NUMBER TASK

"I will now read you a sequence of letters and numbers and you must listen carefully so that you can complete it."

Read the following slowly without grouping in pairs.

"A 1 B 2 C ? Good. "

LETTER – NUMBER	MARK IF CORRECT	LETTER – NUMBER	MARK IF CORRECT
A		3	
1		D	
B		4	
2		E	
C		5	
		TOTAL (MAX = 10)	

Provide the correct answer if the patient cannot and again repeat the instructions. If the patient still cannot provide the correct answer, then score 0.

"Now you start with A and perform the sequence until I ask you to stop."

17. RECALL OF WORDLIST AFTER APPROX. 30 MINUTES:

Prompt by asking patient to recall the 10 words read previously on 3 occasions.

SCORE	

SPEAR DONKEY BOOK CHURCH TABLE UMBRELLA CAR CARROT SHIRT GREEN

18. RECALL OF FIGURES AFTER APPROX. 30 MINUTES:

Ask the patient to again recall and draw Figures 1-3. Score according to guidelines in Appendix I.

FIGURE	SCORE
1	
2	
3	
TOTAL (MAX = 9)	

19. NAMING AND WORD FINDING:

Show the patient a red coloured object, the body parts indicated in the table, and the pictures in Figure 5. Ask him/her to name this. If the patient cannot name an object, ask him/her to describe it. Note whether this will lead to identification. Lastly, provide a phonic clue by pronouncing the first sound (phoneme) of the word.

Objects	**Spontaneous Naming**	**Correct Description**	**Naming on Phonic clue**
The colour red			
Examiner's knuckles			
Ring finger of the patient's right hand			
Guitar			
Dice			
Walking stick			
Wheelbarrow			
Traffic light			
Shark			
Octopus			
Telephone			
Scale			
Trophy			
Magnifying glass			
Stapler			
TOTAL (MAX = 15)			

20. LINE ORIENTATION

Ask the patient to match the target lines with the display of 9 numbered lines as indicated in Figure 6. The patient must answer by providing a number. Score 1 for each named correctly.

LINE ORIENTATION	SCORE
1. A (No 7)	
2. B (No 6)	
3. C (No 2)	
4. D (No 4)	
TOTAL SCORE (MAX = 4)	

21. DESIGN DISTINCTION:

Tell the patient:

"I am now going to show you a page with designs. Pick out the design in each frame that stands out as different to the rest. I am going to measure how long you take to do this, so try to be as quick as possible. The first picture will only be an example."

Show the first picture (example) while giving the instructions, and allow the patient to perform the task (see Figure 7). If he/she struggles then help him. Make sure he understands how to complete the test before continuing.

DESIGN DESTINCTION:				
	Both standout designs correctly identified		Time to respond (seconds)	Final Score = 30 – Time
	Yes	No		
Fig 1 Circles				
Fig 2 Diamonds				
			TOTAL	

"The test will now begin. As quickly as possible identify the design that stands out or is different from the rest. Remember that I will take your time."

Stop the test if the patient cannot complete the task after 30 seconds.

22. DESIGN FLUENCY:

Tell the patient:

NUMBER OF DESIGNS	

"Take a look at this picture." [Draw a hash sign and count the lines aloud as it is drawn]. "Now you must draw as many different figures as you can with 4 lines. I will only give you 1 minute. Here is another example." [Draw the stairs figure].

Provide a clean A4 sheet of paper. Inform the patient about incorrect responses during testing. If a design is rotated, score as correct.

23. REPRODUCTION DRAWINGS:

Ask the patient to copy the figures in Figure 8 to the best of his/her ability. Present one figure at a time. Score according to guidelines in Appendix I.

FIGURE	SCORE
Cross	
Arrow	
Cube	
TOTAL (MAX = 9)	

24. FAMOUS FACES

Ask the patient to name the famous faces on the figure sheet. Each correct answer scores 1 point.

FAMOUS FACE	CORRECT
A Hitler	
FW de Klerk	
Prinses Diana	
N Mandela	
D Tutu	
M Ali	
TOTAL (MAX = 6)	

APPENDIX I

I SCORING FOR FIGURES:

0	Poor	Given for a failure to recall or reproduce a design.
1	Fair	Given for recognisable but distorted, rotated, partially omitted, or confabulated features of a design.
2	Good	Given for easily recognisable designs with minor errors of integration, omission, or addition.
3	Excellent	Given for perfect (or near perfect) reproductions of the items with all appropriate components, placements, and integration.

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BEDSIDE COGNITIVE ASSESSMENT BATTERY (BCAB)

FIGURE SHEET

FIGURE 1

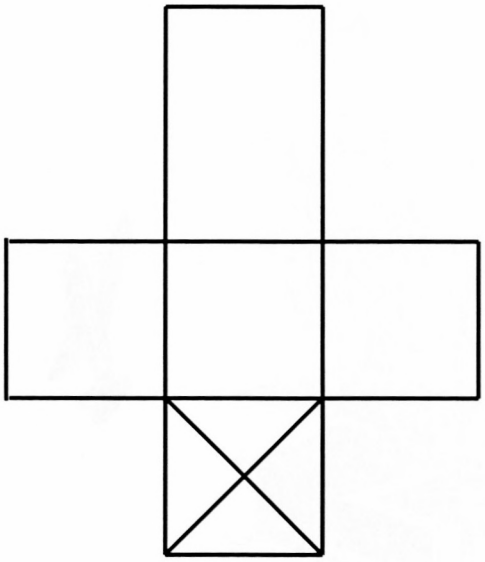


FIGURE 2

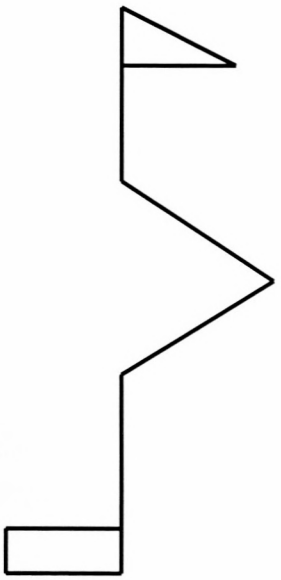


FIGURE 3

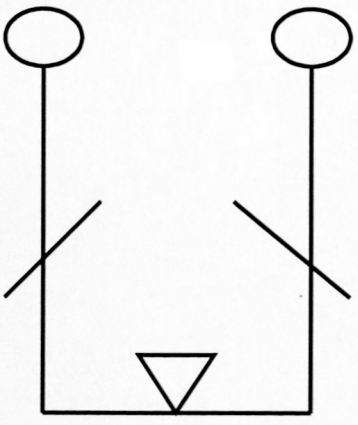


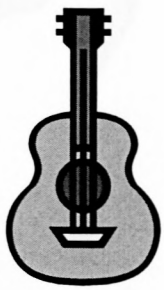
FIGURE 4

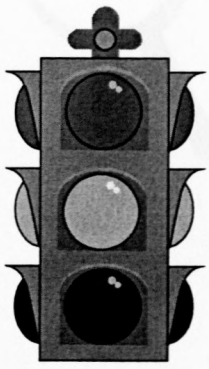
CLOSE YOUR EYES

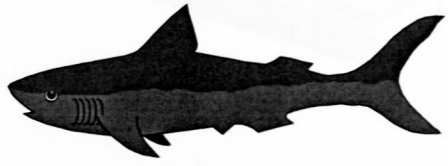
MAAK JOU OË TOE

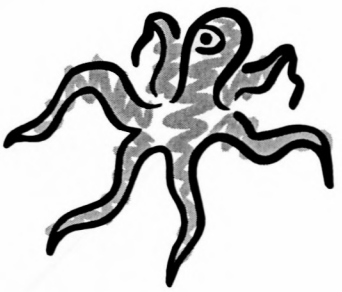
VALA AMEHLO

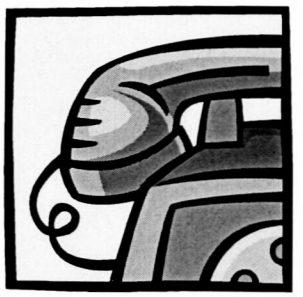
FIGURE 5











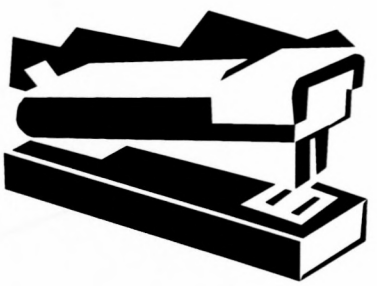


FIGURE 6

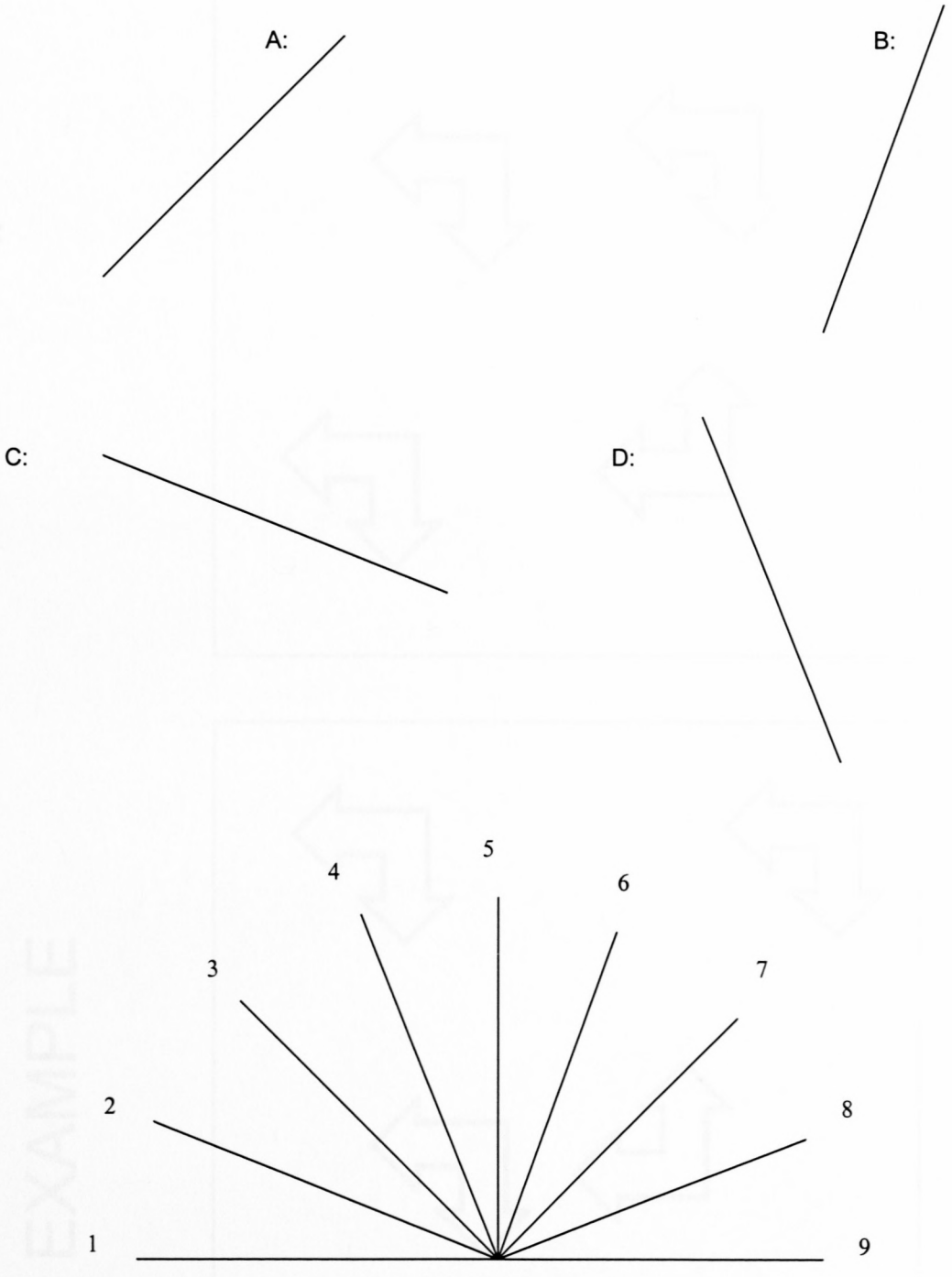
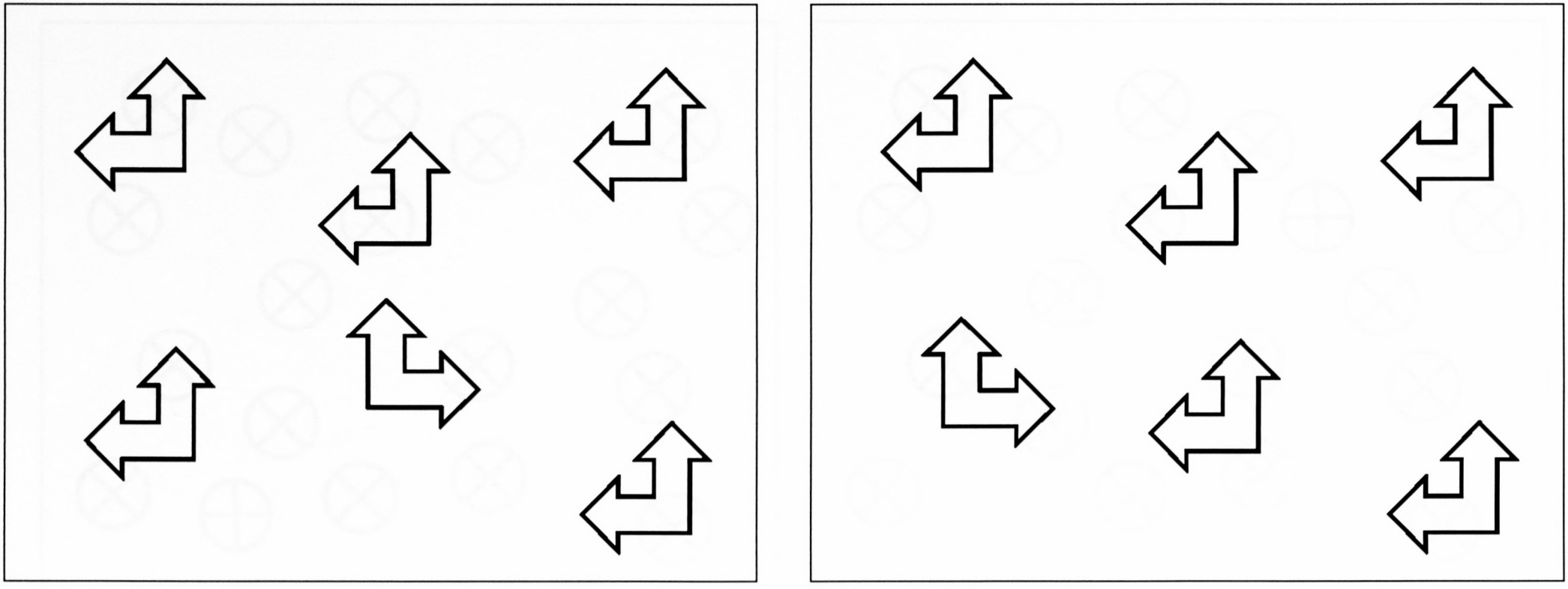
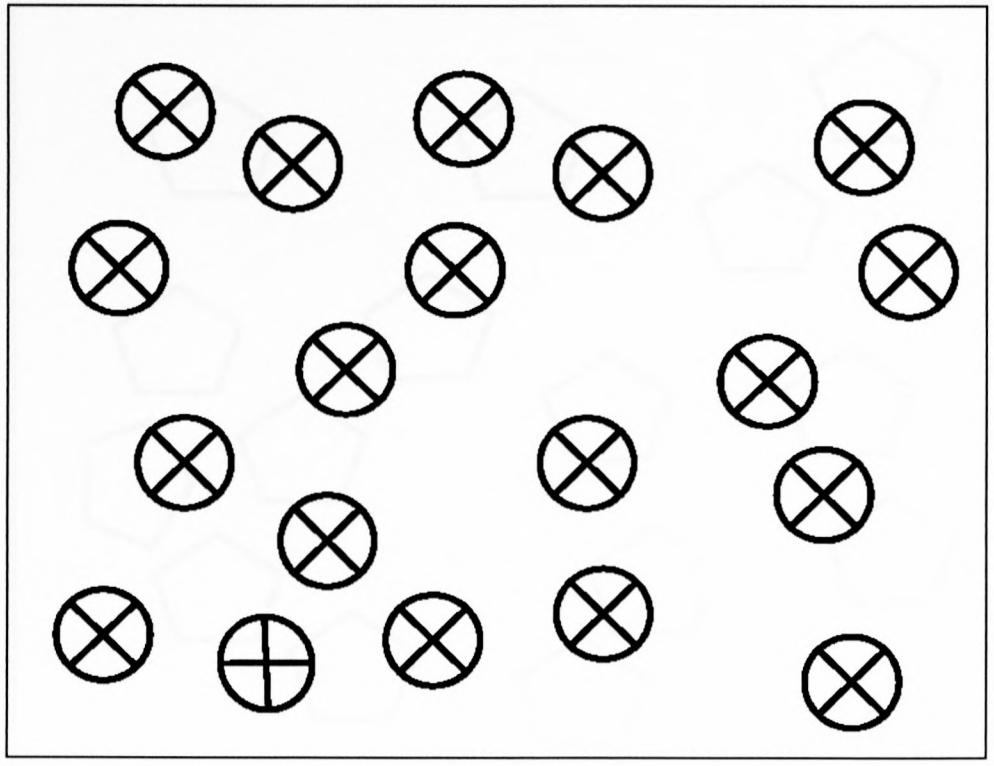


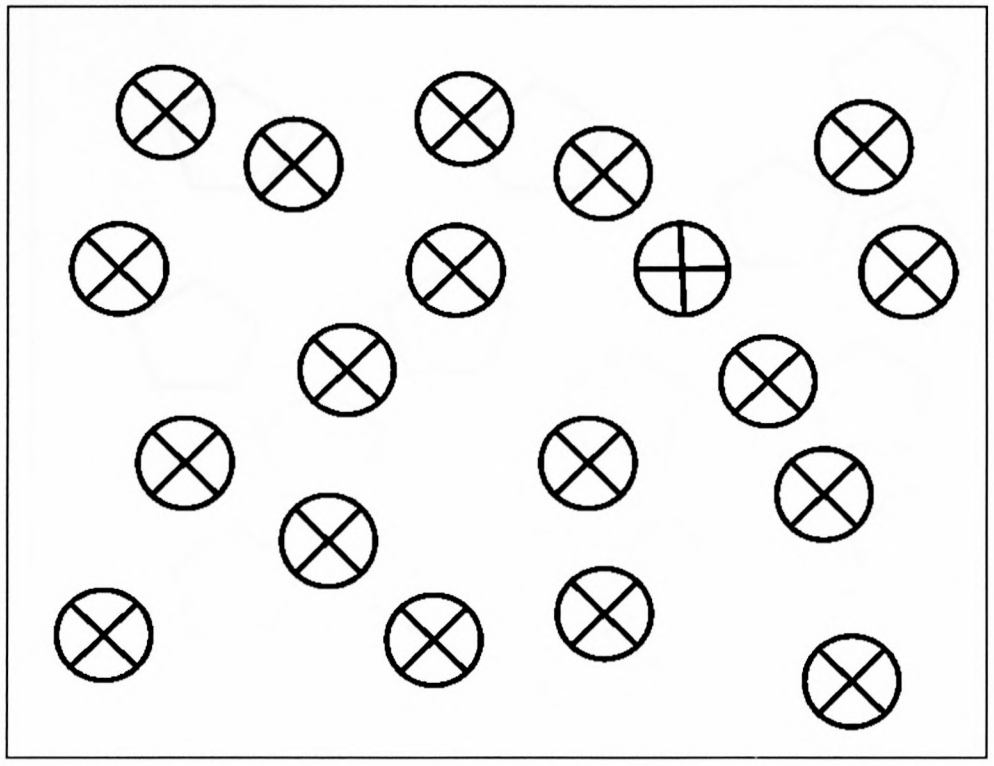
Figure 7:

EXAMPLE

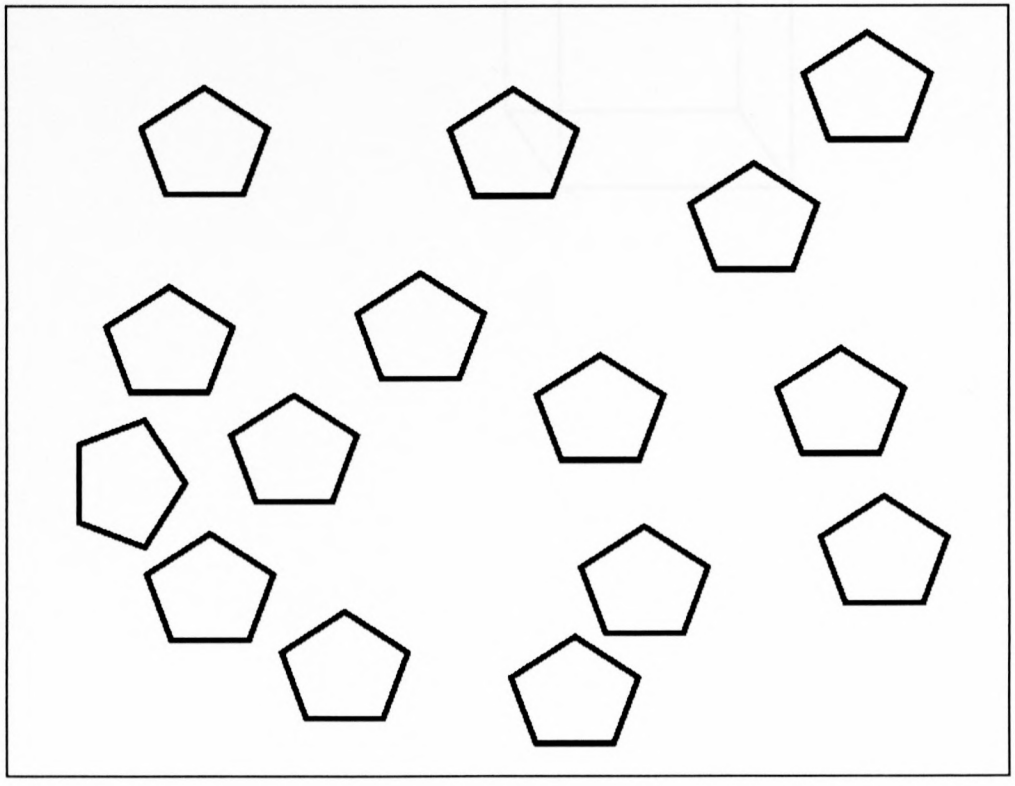


Top 1





Top 2



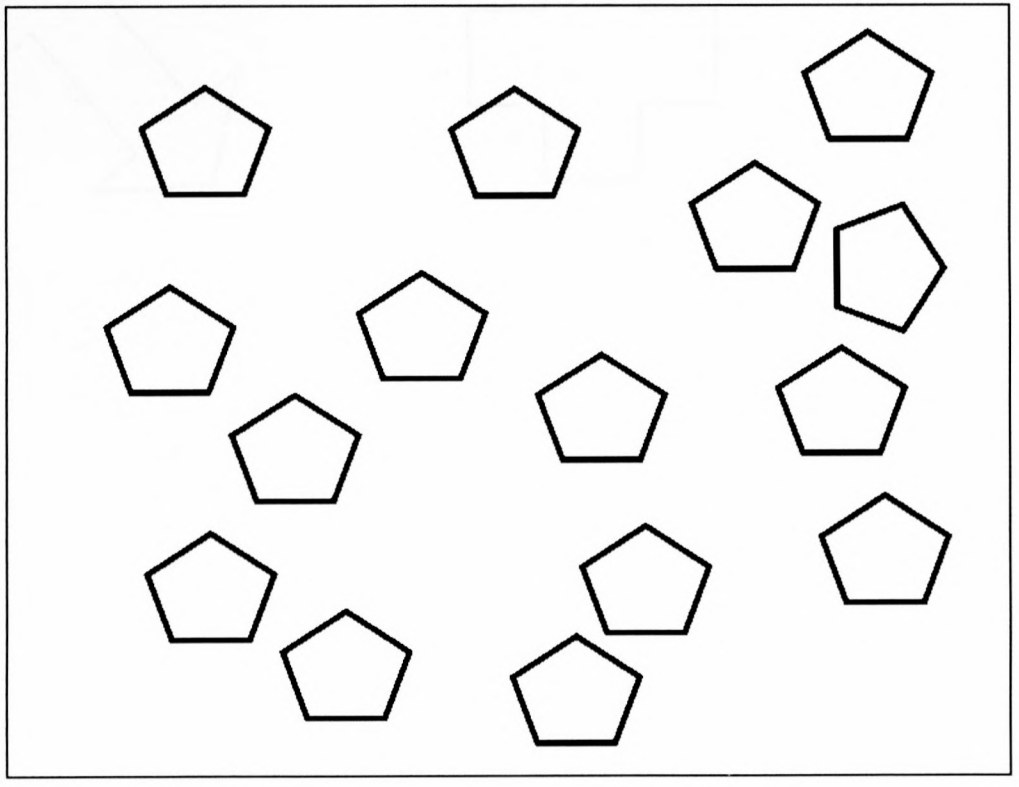
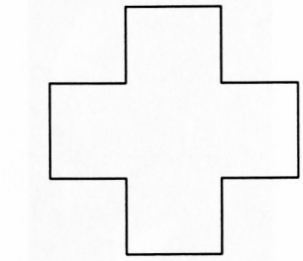
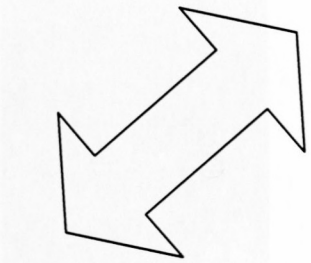
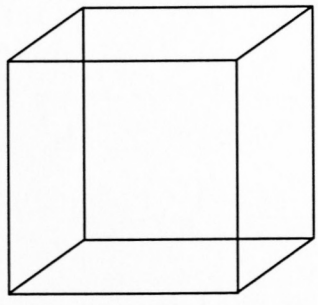
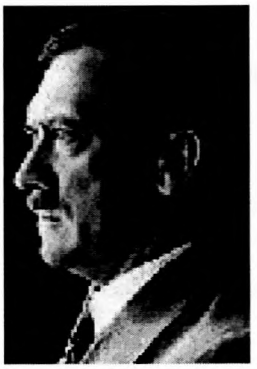


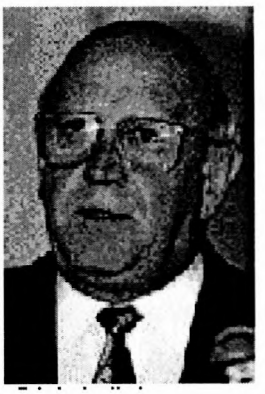
Figure 8











UNIVERSITY OF STELLENBOSCH
TYGERBERG MEMORY CLINIC
And
PANORAMA MEMORY CLINIC

BEDSIDE COGNITIVE ASSESSMENT BATTERY (BCAB) SCORING PAD

Frans J. Hugo , Annerine Roos, Sandra Brink, Frances Hemp, Helena Thornton, Dorothy Calata and Robin Emsley

Developed and compiled in 1995, Revised in 1997, Revised in 2001, This version revised 2002

NAME: _____

DATE OF BIRTH: _____ **GENDER:** _____

HOSPITAL NO: _____ **DATE:** _____

ASSESSED BY: _____

COGNITIVE FUNCTIONS:

IMPORTANT WARNING: The exact cut scores to distinguish between Normal, Borderline and Abnormal will be determined with a standardisation study. Here we provide approximate scoring guidelines.

ATTENTION & CONCENTRATION	BEDSIDE TEST	RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
	3. Vigilance Test	0-18		17-18=N;16=B; <16=A	
	9. Digit Repetition	0-8		6-8=N; 5=B; <5=A	
	TOTAL	0-4			

ATTENTION & CONCENTRATION SUMMARY	SYMBOL GUIDE (Use score from Total above)	SYMBOL
	4=N; 3=B; 0-2=A	

SPEECH	BEDSIDE TEST	RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
	4. Spontaneous	0-2		2=N; 1=B; 0=A	
	15. Animal Naming	0-30		>17=N; 15-17=B; <15=A	
	5. Comprehension	0-2		2=N; 1=B; 0=A	
	6. Repetition	0-2		2=N; 1=B; 0=A	
	19. Naming & Word Finding	0-15		14-15=N; 12-13=B; <12=A	
	7. Reading	0-2		2=N; 1=B; 0=A	
	8. Writing	0-2		2=N; 1=B; 0=A	
	TOTAL	0-14			

SPEECH SUMMARY	SYMBOL GUIDE (Use score from Total above)	SYMBOL
	13-14=N; 12=B; <12=A	

MEMORY	BEDSIDE TEST	RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
Verbal Working	1. Word List Trial 1	0-10		6-10=N; 5=B; <5=A	
	9. Digit Repetition	0-8		6-8=N; 5=B; <5=A	
	SUMMARY	0-4		4=N; 3=B; 0-2=A	SYMBOL:
Verbal Short-term	1. Word List Trial 2-4 Total Score	0-30		>20=N; 17-20=B; <17=A	SYMBOL:
Visual Working	2. Visual Design Reproduction Total Score	0-9		7-9=N; 6=B; 0-5=A	SYMBOL:
Visual Short-term	18. Delayed Recall of Figures	0-9		6-9=N; 5=B; 0-4=A	SYMBOL:

PRAXIS	BEDSIDE TEST		RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
	10. Ideomotor Apraxia	Right	0-2		2=N; 0=A	
		Left	0-2		2=N; 0=A	
	11. Successive Finger Taps	Right	0-30		14-30=N; 11-14=B; 0-10=A	
		Left	0-30		14-30=N; 11-14=B; 0-10=A	
	23. Reproduction Drawings		0-9		8-9=N; 7=B; 0-6=A	
	TOTAL		0-10			

PRAXIS SUMMARY	SYMBOL GUIDE (Use score from Total above)	SYMBOL
	8-10=N; 7=B; <7=A	

GNOSIS	BEDSIDE TEST		RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
	12. Finger Perception	Right	0-3		3=N; 0-2=A	
		Left	0-3		3=N; 0-2=A	
	19. Naming & Word Finding (Score spontaneous naming)		0-15		14-15=N; 13=B; 0-12=A	
	20 Line Orientation		0-4		4=N; 0-3=A	
	21. Design Distinction		0-60		30-60=N; 22-29=B; <22=A	
	23. Reproduction Drawings		0-9		8-9=N; 7=B; 0-6=A	
	24. Famous Faces		0-6		6=N; 5=B; <5=A	
	TOTAL		0-14			

GNOSIS SUMMARY	SYMBOL GUIDE (Use score from Total above)	SYMBOL
	13&14=N; 12=B; <12=A	

EXECUTIVE FUNCTIONS	BEDSIDE TEST		RANGE	RAW SCORE	SCORE GUIDE	N=2; B=1; A=0
	13. Luria I		0-2		2=N; 1=B; 0=A	
	14. Luria II	Right	0-2		2=N; 1=B; 0=A	
		Left	0-2		2=N; 1=B; 0=A	
	15. Animal Naming		0-30		>17=N; 15-17=B; <15=A	
	16. Number-Letter Task		0-10		10=N; 9=B; <9=A	
	22. Design Fluency		0-?		>7=N; 5-7=B; <5=A	
	TOTAL		0-12			

EXECUTIVE FUNCTIONS SUMMARY	SYMBOL GUIDE (Use score from Total above)	SYMBOL
	10-12=N; 9=B; <9=A	

Belangrike Waarskuwing

Hierdie toetsbattery kan net toegepas word deur persone met voldoende opleiding. Norms is nog nie beskikbaar nie en hierdie toets kan nie gebruik word vir medies-geregtelike werk nie. Die battery het heelwat beperkings en u word aangemoedig om die outeurs te kontak om dit te bespreek.

UNIVERSITEIT VAN STELLENBOSCH
TYGERBERG GEHEUEKLINIEK

&

PANORAMA GEHEUEKLINIEK

BEDKANT KOGNITIEWE EVALUERINGS BATTERY (BKEB)

ADMINISTRASIE BLAD

Frans J. Hugo , Annerine Roos, Sandra Brink, Frances Hemp, Dorothy Calata en Robin Emsley

Ontwikkel en saamgestel in 1995
Hersien in 1997
Hersien in 2001
Hierdie uitgawe hersien in 2002

NAAM: _____

GEB DATUM: _____ **GESLAG:** _____

HOSPITAAL NO: _____ **DATUM:** _____

JARE OPLEIDING: _____ **HUISTAAL:** _____

GETOETS DEUR: _____

BENODIGHEDE VIR AFNEEM VAN TOETS: Potlood, stophorlosie en 4 blanko velle A4 papier (geen lyne)

INSTRUKSIES: Bestudeer elke item in die KBEB deeglik vir korrekte administrasie prosedures voordat dit gebruik word vir die evaluering van kognitiewe funksies. Bied die toets items in dieselfde volgorde aan soos uiteengesit in die opvolgende gedeelte.

Erkenning vir Gebruik van Toets Items:
Visuele Ontwerp Reproduksie; Waaksaamheidstoets; Syferherhaling; Lynorïentasie: Strub, R.L., & Black, F. W. (1977). *The mental status examination in neurology*. Philadelphia: FA Davis Company.
Spontane Spraak; Begrip; Herhaling; Lees; Skryf; Ideomotoriese Apraksie: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Luria Handbeweging I; Luria Handbeweging II: Luria in: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Lynorïentasie: Benton, A.L., Varney, N.R., & Hamsher, K.de S. (1978). Visuospatial judgement: a clinical test. *Archives of neurology 35*(6): 364-367.
Opeenvolgende vingertik; Vingerpersepsie: Frances Hemp
Ontwerpskepping: Royall, D.R., Mahurin, R.K., & Gray, K.F. Bedside assessment of executive cognitive impairment: the executive interview. *Journal of the American Geriatric Society*. 1992; 40(12): 1221-6
Benoeming van Diere: Goodglass, H., Barton, M.I., & Kaplan, E.F. (1968). Sensory modality and object-naming in aphasia. *Journal of Speech and Hearing Research 11*(3): 488-496.

KOGNITIEWE EVALUERING:

1. WOORDLYSTE:

Gee vir die pasiënt die volgende instruksies:

"Ek gaan nou vir jou 'n lys woorde lees. Luister aandagtig sodat jy die woorde kan onthou. Wanneer ek klaar gelees het moet jy vir my soveel woorde moontlik, terugsê. Jy sal nou drie kanse hê om die woorde te memoriseer en ek gaan jou later weer vra om dit te onthou."

Lees die woorde teen 'n tempo van een woord per sekonde. Die pasiënt mag nie gelei word in die herroeping van woorde nie en ook nie reg gehelp word nie. Die woorde wat uitgelaat is mag ook nie bekend gemaak word nie.
Ken 1 punt toe vir elke woord wat korrek weergegee is.

Poging 1:

MOTOR WORTEL GROEN DONKIE KERK BOEK TAFEL HEMP SPIES SAMBREEL

Poging 2:

"Ek lees nou dieselfde woorde in 'n ander volgorde. Jy moet weer al die woorde wat jy kan onthou, noem."

DONKIE SPIES SAMBREEL MOTOR WORTEL HEMP KERK GROEN BOEK TAFEL

Poging 3:

"Ek lees nou dieselfde woorde in 'n ander volgorde. Jy moet weer al die woorde wat jy kan onthou, noem."

SPIES DONKIE BOEK KERK TAFEL SAMBREEL MOTOR WORTEL HEMP GROEN

POGING	TELLING
1	
2	
3	

2. VISUELE ONTWERP REPRODUKSIE:

Sien stimulus kaarte, figure 1-3. Die pasiënt moet elke ontwerp reproduseer op 'n wit vel papier na 'n 10 sekonde aanbieding en 'n 10 sekonde vertraging. Veelvoudige pogings moet nie aangemoedig word nie, maar as 'n pasiënt weer 'n ontwerp wil teken, word 'n tweede poging toegelaat. Gee die volgende instruksies:

FIGUUR	TELLING
1	
2	
3	
TOTAAL	

"Ek gaan nou vir jou enkele, eenvoudige ontwerpe wys. Jy sal 10 sekondes hê waarin jy deeglik moet kyk na elke ontwerp, om dit uit jou kop uit te kan teken. Ons gaan 10 sekondes wag voordat jy kan begin teken, dus moenie begin voordat ek nie gesê het nie. Onthou die ontwerpe, want later gaan ek jou vra om dit weer te teken."

Ken punte toe vir elke ontwerp soos beskryf in Bylae I.

3. WAAKSAAMHEIDSTOETS:

Gee vir die pasiënt die volgende instruksies:
"Ek gaan vir jou 'n lang lys letters lees. Elke keer as jy die letter A hoor, moet jy een keer op die tafel tik."

Lees die volgende lys letters in 'n normale stemtoon, teen een letter per sekonde. Tel hoeveel A's die pasiënt korrek identifiseer deur te tik op die tafel (maksimum telling = 18). Teken ook ekstra tikke aan (perseverasie).

L T P E A O A I C T D A L A A
A N I A B F S A M R Z E O A D
P A K L A U C J T O E A B A A
Z Y F M U S A H E V A A R A T

Aantal A's korrek:	
Aantal ekstra tikke:	

4. SPONTANE SPRAAK:

Verwysende na Figuur 4, versoek die volgende van die pasiënt:

"Vertel vir my 'n storie oor wat in die prentjie gebeur."

	Ja	Nee
Vertel spontaan 'n storie wat die toneel en minstens 2 karakters en 'n aksie beskryf		
Spraak vlot		
Normale artikulasie		
Parafasieë		
TELLING (SIEN RIGLYNE)		

Ingekorte vloeibaarheid en artikulasie, en die teenwoordigheid van parafasias is 'n aanduiding van abnormale, spontane spraak. Neem kennis of die pasiënt spontaan 'n storie vertel wat die toneel en minstens 2 karakters en 'n aksie beskryf. Neem kennis of aanmoediging nodig is om 'n storie te vertel, of, of die pasiënt misluk om 'n storie te vertel. Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

5. BEGRIP:

Pasiënt se respons op opdragte:
Versoek die pasiënt om na die volgende voorwerpe en liggaamsdele te wys. Teken die akkuraatheid van uitvoering aan na die pasiënt se eerste poging. Moenie visuele leidrade gee nie.

Finale telling: Beoordeel as normaal (2) as al die opdragte korrek uitgevoer is, grensgraad (1) as 5 opdragte korrek uitgevoer is, en abnormaal (0) as minder as 5 opdragte korrek uitgevoer is.

OPDRAG	MERK INDIEN KORREK
1. "Wys na die venster"	
2. "Wys na jou linker-elmboog"	
3. "Wys na jou ken"	
4. "Wys na jou regterwang"	
5. "Wys na die plafon en jou voorkop"	
6. "Tik elke skouer tweekeer met twee vingers terwyl jy jou oë toehou"	
TOTAAL KORREK	
FINALE TELLING (SIEN RIGLYNE)	

6. HERHALING:

Telling	

Versoek die pasiënt om die volgende sinne te herhaal. Verskaf addisionele woorde en sinne indien nodig. Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

Jannie speel graag sokker.

Nog vis, nog vlees, nog voël.

Ek gaan na die winkelsentrum om my geld te spandeer.

7. LEES:

Vra die pasiënt om die volgende te lees en daarop te reageer: MAAK JOU OË TOE. Sien blad met figure. Indien nodig, gebruik addisionele sinne. Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

Telling	

8. SKRYF:

Vra die pasiënt om 'n kort verstaanbare sin neer te skryf op 'n skoon vel papier. Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

Telling	

9. HERHALING VAN SYFERS:

Versoek die volgende van die pasiënt:

"Ek gaan vir jou 'n paar eenvoudige syfers lees. Luister goed daarna en as ek klaar is, sê dit agter my aan."

ITEM	1ste Poging	2de Poging	Ken 1 punt toe as korrek en 0 as verkeerd na twee pogings.
3-7			
5-4-9			
8-2-5-7			
5-9-6-8-3			
5-7-1-9-4-6			
8-2-9-3-6-5-1			
3-9-8-2-5-1-4-7			
7-2-8-5-4-6-7-3-9			
	TOTAAL (MAKS = 8)		

Bied die syfers in 'n normale stemtoon aan, teen een syfer per sekonde. Waak daarteen om die syfers te groepeer in pare of volgordes wat sal help met herhaling. As die pasiënt fouteer, noem dit, en herhaal dieselfde reeks. As die pasiënt die reeks steeds verkeerd herhaal, teken aan as foutief. Gaan oor na die volgende reeks. Stop as die pasiënt fouteer in twee opeenvolgende reekse. Die telling is gelykstaande aan die aantal reekse wat korrek herhaal is.

10. IDEOMOTORIESE APRAKSIE:

ITEM **"Wys vir my hoe jy die volgende sal doen:"**	REGTERHAND: MERK INDIEN KORREK	LINKERHAND: MERK INDIEN KORREK
1. Skink 'n koppie tee		
2. Gooi die suiker by		
3. Roer dit		
TOTAAL KORREK		
FINALE TELLING (SIEN RIGLYNE)		

Hierdie item gee 'n aanduiding van hoe vaardig 'n pasiënt is in die uitvoer van motoriese funksies op bevel. Neem kennis of denkbeeldige, of werklike gebruik van 'n voorwerp nodig was om uitvoering van opdragte te fasiliteer. Evalueer beide die regter- en linkerhand se funksie. Finale telling: Beoordeel as normaal (2) as elke stap korrek uitgevoer is en abnormaal (0) as enige stap verkeerd uitgevoer is.

11. OPEENVOLGENDE VINGERTIK:

Opeenvolgende vingertik:		
HAND	Tyd (sekondes)	Finale Telling = 30 – Tyd
REGS		
LINKS		

Vra die pasiënt om beide hande in die lig te hou met elmboë rustend op die tafel. Hy/sy moet elke vinger tik teen die duim, beginnende met die indeksvinger, heen-en-weer. Meet hoe lank dit neem om vyf siklusse te voltooi, verkieslik met 'n stophorlosie, in sekondes. Begin om die tyd te neem wanneer die indeksvinger die duim raak. As

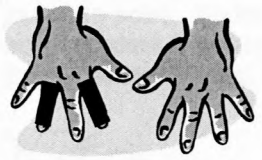
die pasiënt 'n vinger tweekeer tik (bv. indeks/pinkie), noem dat dit verkeerd is en dat elke vinger net een keer getik moet word. Let op na beweging in 'n hand wat nie deel vorm van die taak nie. Stop die taak as die pasiënt langer as 30 sekondes neem.

12. VINGERPERSEPSIE:

Vra die pasiënt om beide hande op die tafel te sit, voor jou.

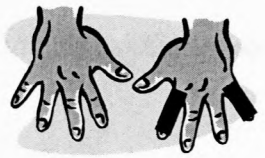
"Ek gaan nou twee van jou vingers aanraak en jy moet dan vir my sê hoeveel vingers tussen-in is".

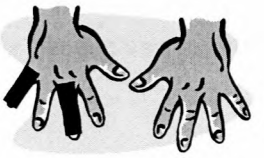
Raak aan die vingers soos aangedui in swart hieronder. Die pasiënt behoort "een" te antwoord.



1. "Maak nou jou oë toe vir die volgende deel. Hoeveel vingers is daar tussen-in dié wat ek aanraak?" Ken een punt toe vir 'n korrekte antwoord.

2. "En nou?"





3. "En nou?"

4. "En nou?"

5. "En nou?"

6. "En nou?"

PRENTJIE	TELLING REGS	PRENTJIE	TELLING LINKS
2.		1.	
4.		3.	
6.		5.	
TOTAAL (3)		TOTAAL (3)	

13. LURIA HANDBEWEGING I

TELLING	

Vra die pasiënt om die onderstaande handbeweging uit te voer. Foutlose uitvoering is normaal.
Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

14. LURIA HANDBEWEGING II

	TELLING
Linkerhand	
Regterhand	

Begin om die alternerende handbeweging uit te voer en vra die pasiënt om jou na te boots. Sodra die pasiënt sy/haar eie beweging begin, stop jou eie en beoordeel 3 siklusse. Suksesvolle uitvoering van hierdie taak is 3 foutlose siklusse. Toets beide die linker- en regterhand. Beoordeel as normaal (2), grensgraad (1) of abnormaal (0).

15. BENOEMING VAN DIERE:

Vra die pasiënt om so veel diere moontlik te noem met vier bene in een minuut.

AANTAL DIERE	

16. LETTER – NOMMER TAAK

"Ek gaan nou vir jou 'n patroon van letters en syfers lees en jy moet aandagtig luister sodat jy dit kan voltooi."

Lees die volgende stadig sonder om dit te groepeer in pare.

"A 1 B 2 C ? Goed. "

LETTER – NOMMER	MERK INDIEN KORREK	LETTER – NOMMER	MERK INDIEN KORREK
A		3	
1		D	
B		4	
2		E	
C		5	
TOTAAL (MAKS = 10)			

Verskaf die korrekte antwoord indien die pasiënt faal en herhaal weer die instruksies. As die pasiënt steeds nie die korrekte antwoord kan gee nie, ken 'n telling van 0 toe.

"Begin nou weer die reeks met A en gaan aan daarmee totdat ek vir jou vra om te stop."

17. HERROEPING VAN WOORDLYS NA ONGEVEER 30 MINUTE:

Versoek die pasiënt om weer die 10 woorde te herroep wat vroeër 3 maal gelees is.

TELLING	

SPIES DONKIE BOEK KERK TAFEL SAMBREEL MOTOR WORTEL HEMP GROEN

18. HERROEPING VAN FIGURE NA ONGEVEER 30 MINUTE:

Vra die pasiënt om weer figure 1-3 te herroep en te teken. Ken punte toe volgens riglyne in Bylae I.

FIGUUR	TELLING
1	
2	
3	
TOTAAL (MAKS = 9)	

19. BENOEMING EN VIND VAN WOORDE:

Wys vir die pasiënt 'n rooi gekleurde voorwerp, die liggaamsdele soos aangedui in die tabel, en die prentjies in Figuur 5. Vra hom/haar om dit te benoem. As die pasiënt nie 'n voorwerp kan benoem nie, vra hom/haar om dit te beskryf. Neem kennis of laasgenoemde lui tot identifikasie. Laastens, verskaf 'n fonetiese leidraad deur die eerste klank van die woord (foneem) uit te spreek.

Voorwerpe	**Spontane Benoeming**	**Korrekte Beskrywing**	**Benoeming na Fonetiese leidraad**
Die kleur rooi			
Toetser se kneukels			
Ringvinger van pasiënt se regterhand			
Kitaar			
Dobbelstene			
Kierie			
Kruiwa			
Verkeerslig			
Haai			
Seekat			
Telefoon			
Skaal			
Trofee			
Vergrootglas			
Krammasjien			
TOTAAL (MAKS = 15)			

20. LYNORIËNTASIE:

Vra die pasiënt om die teikenlyne, soos aangedui in Figuur 6, te pas by die 9 genommerde lyne. Die pasiënt moet, in antwoord, 'n nommer verskaf. Ken 1 punt toe vir elke lyn wat korrek benoem is.

LYNORIËNTASIE	TELLING
1. A (No 7)	
2. B (No 6)	
3. C (No 2)	
4. D (No 4)	
TOTALE TELLING (MAKS = 4)	

21. ONTWERPONDERSKEIDING:

Verduidelik aan die pasiënt:

"Ek gaan nou vir jou 'n bladsy met ontwerpe wys. Kies die ontwerp uit in elke raampie wat anders lyk as die res. Ek gaan kyk hoe lank jy neem om dit te doen, dus probeer om dit so gou as moontlik te vind. Die eerste prentjie is net 'n voorbeeld."

Wys die eerste prentjie (voorbeeld) terwyl die instruksies verduidelik word, en laat die pasiënt die taak uitvoer (sien Figuur 7). As hy/sy sukkel, help hom/haar. Maak seker dat die pasiënt verstaan hoe om die toets te doen voordat voort gegaan word.

ONTWERPONDERSKEIDING:				
	Beide uitstaan-ontwerpe korrek aangedui		Tyd om te antwoord (sekondes)	Finale Telling = 30 – Tyd
	Ja	Nee		
Fig 1 Sirkels				
Fig 2 Diamante				
			TOTAAL	

"Die toets sal nou begin. Probeer om so gou moontlik die ontwerp te identifiseer wat uitstaan of anders lyk as die res. Onthou dat ek gaan kyk hoe lank jy neem."

Stop die toets as die pasiënt dit nie kan voltooi na 30 sekondes nie.

22. ONTWERPSKEPPING:

Verduidelik aan die pasiënt:

AANTAL ONTWERPE	

"Kyk na hierdie prentjie." [Teken 'n hutsteken en tel elke lyn soos jy dit teken]. "Nou moet jy vir my so veel moontlik verskillende figure teken met 4 lyne. Ek gaan vir jou net 1 minuut tyd gee. Hier is nog 'n voorbeeld." [Teken die trap figuur].

Verskaf 'n skoon vel A4 papier. Lig die persoon in oor verkeerde figure gedurende toetsing. As 'n ontwerp geroteer is, neem dit as korrek.

23. REPRODUKSIE VAN TEKENINGE:

Vra die pasiënt om die figure in Figuur 8 tot die beste van sy/haar vermoë na te teken. Wys een figuur op 'n slag. Laat twee pogings toe. Beoordeel volgens riglyne in Bylae I.

FIGUUR	TELLING
Kruis	
Pyl	
Kubus	
TOTAAL (MAKS = 9)	

24. BEROEMDE GESIGTE

Vra die pasiënt om die beroemde gesigte op die figuurblad te benoem. Elke korrekte antwoord verdien 1 punt.

BEROEMDE GESIG	KORREK
A Hitler	
FW de Klerk	
Prinses Diana	
N Mandela	
D Tutu	
M Ali	
TOTAAL (MAKS = 6)	

BYLAE I

I FIGURE - RIGLYNE VIR PUNTETOEKENNING:

0	Swak	Toegeken as pasiënt misluk in die herroeping of reproduksie van 'n ontwerp.
1	Gemiddeld	Toegeken vir 'n herkenbare, maar verwronge, gedraaide, gedeeltelik weggelate, of verdraaide uitbeelding van 'n ontwerp.
2	Goed	Toegeken vir maklik herkenbare ontwerpe met geringe foute van integrasie, weglating, of byvoeging.
3	Uitstekend	Toegeken vir perfekte (of byna perfekte) reproduksie van ontwerpe met al die korrekte komponente, plasing, en integrasie.

Important Warning

This test battery can only be used by persons with adequate training.
Normative values are not yet available and this test cannot be used for medico-legal work. The battery has many limitations and you are encouraged to contact the authors for discussion of this.

UNIVERSITY OF STELLENBOSCH
TYGERBERG MEMORY CLINIC

&

PANORAMA MEMORY CLINIC

BEDSIDE COGNITIVE ASSESSMENT BATTERY
(BCAB)

XHOSA VERSION

ADMINISTRATION PAD

Frans J. Hugo , Annerine Roos, Sandra Brink, Frances Hemp, Dorothy Calata and Robin Emsley

Developed and compiled in 1995
Revised in 1997
Revised in 2001
This version revised 2002

NAME: _____

DATE OF BIRTH: _____ **GENDER:** _____

HOSPITAL NO: _____ **DATE:** _____

YEARS OF EDUC: _____ **MOTHER TONG:** _____

ASSESSED BY: _____

MATERIALS REQUIRED FOR TEST ADMINISTRATION: Pencil, stopwatch and 4 blank A4 pages (no lines)

INSTRUCTIONS: Carefully study each item for correct administration procedures before utilizing the BCAB as an assessment tool of cognitive functions. Present the BCAB test items in the order that it is set out in the following section.

Aknowledgements for Test Items:
Visual Design Reproduction; Vigilance Test; Digit Repetition; Line Orientation: Strub, R.L., & Black, F. W. (1977). *The mental status examination in neurology*. Philadelphia: FA Davis Company.
Spontaneous Speech; Comprehension; Repetition; Reading; Writing; Ideomotor Apraxia: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Luria Hand Sequence I; Luria Hand Sequence II: Luria in: Hodges, J.R. (1994). *Cognitive assessment for clinicians*. Oxford: Oxford University Press.
Line Orientation: Benton, A.L., Varney, N.R., & Hamsher, K.de S. (1978). Visuospatial judgement: a clinical test. *Archives of neurology 35*(6): 364-367.
Succesive Finger Taps; Finger Perception: Frances Hemp
Design Fluency: Royall, D.R., Mahurin, R.K., & Gray, K.F. Bedside assessment of executive cognitive impairment: the executive interview. *Journal of the American Geriatric Society*. 1992; 40(12): 1221-6
Animal Naming: Goodglass, H., Barton, M.I., & Kaplan, E.F. (1968). Sensory modality and object-naming in aphasia. *Journal of Speech and Hearing Research 11*(3): 488-496.

COGNITIVE ASSESSMENT:

1. WORD LISTS:

Give the patient the following instructions:

" Ndiza kufundela ngoku uluhlu lwamagama. Mamela ngononophelo ukuze ube nokukwazi ukukhumbula lamagama. Ndiza kucela ukuba undiphindele la magama emva kokuba ndikufundele wona. Uza kuba namathuba amathathu okufunda lamagama ngentloko, ndiza kuphinda ndikucele emva kwethuba uwakhumbule."

Read the words at a rate of one word per second. The patient must not be guided in recalling the words and may not be corrected. The words left out may also not be given to the patient. Score 1 for each word correctly given.

Trial 1:

IMOTO UMNQATHE LUHLAZA IDONKI ICAWA INCWADI ITAFILE IHEMPE

UMKHONTO ISAMBRELA

Trial 2:

"Ndiza kufunda ngoku kwalamagama ngohlobo olwahlukileyi. Uze undiphindele kwakhona onke amagama owakhumbulayo."

IDONKI UMKHONTO ISAMBRELA IMOTO UMNQATHE IHEMPE ICAWA LUHLAZA

INCWADI ITAFILE

Trial 3:

"Ndiza kufunda ngoku kwalamagama ngohlobo olwahlukileyi. Uze undiphindele kwakhona onke amagama owakhumbulayo."

UMKHONTO IDONKI INCWADI ICAWA ITAFILE ISAMBRELI IMOTO UMNQATHE

IHEMPE LUHLAZA

TRIAL	SCORE
1	
2	
3	

2. VISUAL DESIGN REPRODUCTION:

See stimulus cards, Figures 1-3. The patient is required to reproduce each of the three designs on a piece of white paper after a 10 second presentation and 10 second delay. Multiple attempts are not encouraged, but if the patient wants to redraw a design then a second attempt is allowed. The following instructions are given:

FIGURE	SCORE
1	
2	
3	
TOTAL	

"Ngoku ndiza kubonisa imifanekiso elula. Ndifuna ujonge umfanekiso ngamnye ngononophelo, ukuze ube nokuzoba le nnto uyibonileyo ngentloko. Musa ukuzoba de ndikuxelele ukuba

ungaqala, njengoko siza kulinda imizuzwana elishumi. Khumbula imifanekiso, kuba ndiza kuphinda ndikucele ukuba uyizobe kwakhona emva kwethuba."

Score the designs as described in Appendix I.

3. VIGILANCE TEST:

Tell the patient:

"Ndiza kufundela uthotho loonobumba. Naninina xa usiva unobumba u-A, bonisa ngokuthi ubethe ngomnwe edesikeni.."

Read the following letter list in a normal tone at a rate of one letter per second. Count the number of As that were correctly indicated by a tap from the patient (maximum score = 18). Also, count the number of extra taps (perseverations).

L T P E A O A I C T D A L A A
A N I A B F S A M R Z E O A D
P A K L A U C J T O E A B A A
Z Y F M U S A H E V A A R A T

Number of As correct:	
Number of extra taps:	

4. SPONTANEOUS SPEECH:

Refer to Figure 4 and ask the patient to

"Ndibalisele ibali ngokwenzeka kulomfanekiso."

	Yes	No
Tells a story spontaneously that describes the setting, names at least 2 characters and describes an action		
Fluent speech		
Normal articulation		
Paraphasias		
SCORE (SEE GUIDELINES)		

Abnormal spontaneous speech is shown by impaired fluency, articulation and the presence of paraphasias. Note if the patient tells a spontaneous story which describe the setting, names at least 2 characters and describes an action. Note if the patient tells a story with prompting, or fails to tell a story. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

5. COMPREHENSION:

Patient's response to pointing commands:

"Ndicela ukhombe ezi zinto okanye la malungu omzimba alandelayo"

Record the adequacy of performance. Score on the patient's first try. Do not give visual cues.

Final score: Score as normal (2) when all the commands are executed correctly, borderline (1) when 5 commands are correct, and abnormal (0) when less than 5 commands are correct.

COMMAND	MARK IF CORRECT
1. "Khomba efestileni"	
2. "Khomba esilingini"	
3. "Khomba isilevu sakho"	
4. "Khomba isidlele sakho sasekunene"	
5. " Khomba ingqiniba yakho yasekhohlo"	
6. "Chatha igxalaba ngalinye kabini ngeminwe yakho ngexeshe uvale amehlo akho."	
TOTAL CORRECT (MAX = 6)	
FINAL SCORE (SEE GUIDELINES)	

6. REPETITION:

Score	

Ask the patient:

" Ndicela uphinde ezi zivakalisi emva kwam."
(Sebenzisa amanye amagama okanye ezinye izivakalisi xa kuyimfuneko.)

uSam uthanda ukudlala umdlalo womboxo.

Akukho nto yokuba bekutheni okanye kungathangani

Ndiya kwindawo yeevenkile ukuya kuchitha imali yam.

Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

7. READING:

Score	

Ask the patient:

"Funda wenze oku kwesi sivakalisi "

VALA AMEHLO.
(Sebenzisa ezinye izivakalisi xa kuyimfuneko.)

Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

8. WRITING:

Score	

"Bhala isivakalisi esifutshane esinentsingiselo kweliphepha lize."
Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

9. DIGIT REPETITION:

Tell the patient:

"Ndiza kubizela amanani alula. Mamela ngononophelo ukuze xa ndiqgibile ubizele amanani emva kwam."

ITEM	1st Attempt	2nd Attempt	Score 1 for correct and 0 for incorrect after two attempts.
3-7			
5-4-9			
8-2-5-7			
5-9-6-8-3			
5-7-1-9-4-6			
8-2-9-3-6-5-1			
3-9-8-2-5-1-4-7			
7-2-8-5-4-6-7-3-9			
		TOTAL (MAX = 8)	

Present the digits in a normal tone of voice at a rate of one digit per second. Take care not to group digits either in pairs or in sequences that could serve as an aid to repetition. If the patient makes a mistake then inform him so and repeat the same series. If the patient is incorrect again then score as incorrect. Carry on to the next series. Stop if the patient is incorrect on two consecutive series. The score equals the number of sequences correctly recalled

10. IDEOMOTOR APRAXIA:

This item describes the adequacy of the patient's performance in carrying out motor acts to command. Note if imitation or use of a real object was necessary to facilitate performance. Test both right and left handed function. Final score: Score as normal (2) when every step is performed correctly and abnormal (0) when any step is performed incorrectly.

ITEM **"Ndibonise ungenza njani xa u:"**	RIGHT HAND: MARK IF CORRECT	LEFT HAND: MARK IF CORRECT
1. Thulula ikomityi yeti		
2. Galela iswekile		
3. Zamisa		
TOTAL CORRECT		
FINAL SCORE (SEE GUIDELINES)		

11. SUCCESSIVE FINGER TAPS:

Ask the patient:

"Ndicela ubeke izandla zakho zombini emoyeni, iingqiniba zayame etafileni. Kufuneka uchathe umnwe ngamnye kubhontsi, qala kwisalathiso umana usiya phambili ubuye umva."

Successive finger taps:		
HAND	Time (seconds)	Final Score = 30 – Time
RIGHT		
LEFT		

Measure the time for each hand to complete five cycles, preferably with a stopwatch, and in seconds. Start measuring when the index finger touches the thumb.

Finger tapped 2x: **"Akufuneki umnwe omnye uphinda-phindwe kabini ngexesha, kufuneka uchathwe kanye."**

Observe for movement in the hand that is not involved in the task. Stop the task if the patient takes longer than 30 seconds.

12. FINGER PERCEPTION:

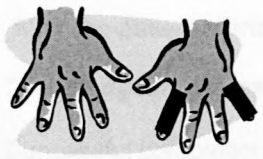
Ask the patient:

"Ndicela ubeke izandlo zakho apha phambi kwam phezukwetafile."

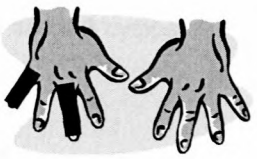
"Ndiza kuchatha ngoku iminwe yakho emibini, wena kufuneka undichazele ukuba mingaphi iminwe ephakathi kwayo"

Touch the fingers indicated in black below. The patient should answer one.

1. "Vala amehlo ngexesha ndiqhuba olu viwo. Mingaphi iminwe ephakathi kwale ndiyichathayo?"A correct answer scores one point.



2. "Ngoku?"



3. "Ngoku?"

4. "Ngoku?"

5. "Ngoku?"

6. "Ngoku?"

PICTURE	SCORE RIGHT	PICTURE	SCORE LEFT
2.		1.	
4.		3.	
6.		5.	
TOTAL (3)		TOTAL (3)	

13. LURIA HAND SEQUENCE I

SCORE	

Ask the patient:

" Ndicela ulinganise oku ngezandla zakho."

Faultless performance is normal. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

14. LURIA HAND SEQUENCE II

Start the alternating hand sequence and ask the patient:

	SCORE
Left hand	
Right hand	

" Ndicela ulinganise oku ngesandla sakho sasekhohlo."

After the patient starts his own sequence, stop yours and score 3 cycles.

"Yenza ngesandla sasekunene."

Successful completion of this task is 3 cycles without error.
Test both left and right hands. Score according to clinical judgement as normal (2), borderline (1) or abnormal (0).

15. ANIMAL NAMING:

Ask the patient:

"Ndicela ubize amagama ezilwanyana ezinemilenze emine abemaninzi kangangoko kwithuba lomzuzu."

NUMBER OF ANIMALS	

16. LETTER – NUMBER TASK

"Ngoku ndiza kubizela uluhlu lwamagama namanani, kufuneka umamele ngononophelo ukuze ukwazi ukugqibezela."

Read the following slowly without grouping in pairs.

"A 1 B 2 C ? Kuhle. "

LETTER – NUMBER	MARK IF CORRECT	LETTER – NUMBER	MARK IF CORRECT
A		3	
1		D	
B		4	
2		E	
C		5	
TOTAL (MAX = 10)			

Provide the correct answer if the patient cannot and again repeat the instructions. If the patient still cannot provide the correct answer, then score 0.

"Ngoku, qala ku A uqhubekeke ngoluhlu ndide ndikucele ukuba upheze."

17. RECALL OF WORDLIST AFTER APPROX. 30 MINUTES:

Prompt by asking patient to recall the 10 words read previously on 3 occasions.

SCORE	

"Ndicela undibizele la magama ali10 ebefundwe izihlandlo ezi3."

UMKHONTO IDONKI INCWADI ICAWA ITAFILE ISAMBRELI IMOTO UMNQATHE

IHEMPE LUHLAZA

18. RECALL OF FIGURES AFTER APPROX. 30 MINUTES / UKUKHUMBULA IMIFANEKISO EMVA KWEMIZUZU E30:

Ask the patient to again recall and draw Figures 1-3. Score according to guidelines in Appendix I.

FIGURE	SCORE
1	
2	
3	
TOTAL (MAX = 9)	

19. NAMING AND WORD FINDING:

Show the patient a red coloured object, the body parts indicated in the table, and the pictures in Figure 5.
"Ndicela uchaze ezi zinto zilandelayo."

"Ngowuphi lo mbala?"(colour)

"Ziintoni ezi?" (what are these?)

"Yintoni le" (what is this)

If the patient cannot name an object, ask him/her to describe it. Note whether this will lead to identification. Lastly, provide a phonic clue by pronouncing the first sound (phoneme) of the word.

Objects	**Spontaneous Naming**	**Correct Description**	**Naming on Phonic clue**
Umbala **obo**mvu			
Ama**quph**ele omhloli			
Umnwe **womse**sane (wesandla sesigulane sasekunene)			
Ikatala/ **isig**inkci			
Idayisi/ **indaw**ule			
Isambreli / umsimelelo			
Ikiliva			
Irobhothi			
Ukrebe			
Ihamile			
Intsimbi			
Isikali			
Indebe			
Isilanga **esand**isayo/ **ig**lasi**eyand**isayo			
Isiteyipla/ isixhobo sokudibanisa **amaph**epha			
TOTAL (MAX = 15)			

20. LINE ORIENTATION

Ask the patient:

"Ndicela uthelekise umgca ngamnye kule ilithoba iboniswa apha ngezantsi." (Isazobe 6)

LINE ORIENTATION	SCORE
1. A (No 7)	
2. B (No 6)	
3. C (No 2)	
4. D (No 4)	
TOTAL SCORE (MAX = 4)	

The patient must answer by providing a number. Score 1 for each named correctly.

21. DESIGN DISTINCTION:

Tell the patient:

"Ndiza kubonisa icwecwe elinemifanekiso. Khetha umfanekiso obonakala wohlukile kweminye kwifreyimi nganye. Ndiza kulinganisa ithuba olithathayo ukwenza oku, ngoko zama ukukhawuleza kangangoko unakho. Umfanekiso wokuqala uza kuba ngumzekelo kuphela."

Show the first picture (example) while giving the instructions, and allow the patient to perform the task (see Figure 7). If he/she struggles then help him. Make sure he understands how to complete the test before continuing.

DESIGN DESTINCTION:				
	Both standout designs correctly identified		Time to respond (seconds)	Final Score = 30 – Time
	Yes	No		
Fig 1 Circles				
Fig 2 Diamonds				
			TOTAL	

" Uviwo luza kuqala ngoku. Chonga ngokona kukhawuleza umfanekiso owohlukileyo kweminye. Khumbula ukuba ndiza kuthabatha ixesha olithathileyo."

Stop the test if the patient cannot complete the task after 30 seconds.

22. DESIGN FLUENCY:

Tell the patient:

NUMBER OF DESIGNS	

"Ndiza kunika umzuzu ubemnye uzobe imifanekiso emininzi okanye imifanekiso engeyiyo kagangoko ukwazi. Unelungelo lwemigca emine kuphela kumfanekiso ngamnye yaye umfanekiso ngamnye kufuneka wahluke. Le migca kumele iqhagamshelane ngohlobo oluthile yaye kufuneka ndikwazi ukuyibala imigca."

Give the patient two examples (hash sign and steps) and count the lines aloud as it is drawn. Inform the patient about incorrect responses during testing. Provide a clean A4 sheet of paper. If a design is rotated, score as correct.

23. REPRODUCTION DRAWINGS:

Ask the patient:

" Nceda ukhuphele lo mzobo ngolona hlobo ukwazi ngalo."
Present one figure at a time. Score according to guidelines in Appendix I.

FIGURE	SCORE
Cross	
Arrow	
Cube	
TOTAL (MAX = 9)	

24. FAMOUS FACES

Ask the patient

"Nceda ukhankanye aba bantu badumileyo kweli cwecwe."

Each correct answer scores 1 point.

FAMOUS FACE	CORRECT
A Hitler	
FW de Klerk	
Princess Diana	
N Mandela	
D Tutu	
M Ali	
TOTAL (MAX = 6)	

APPENDIX I

I SCORING FOR FIGURES:

0	Poor	Given for a failure to recall or reproduce a design.
1	Fair	Given for recognisable but distorted, rotated, partially omitted, or confabulated features of a design.
2	Good	Given for easily recognisable designs with minor errors of integration, omission, or addition.
3	Excellent	Given for perfect (or near perfect) reproductions of the items with all appropriate components, placements, and integration.

Informed Consent Document for a Research Project

Compiled According to guidelines provided by the University of Stellenbosch Faculty of Health Sciences Ethics Committee

Validation of a rating scale for bedside cognitive assessment:

This consent form are presented to participants before evaluation of cognitive functions with the Bedside Cognitive Assessment Battery (BCAB) for the compilation of normative data.

Declaration by Participant:

I, the undersigned, ...(ID:.....) the participant.....(Address), ...(Contact details)

A. Certify that:

1. The Department of Psychiatry of the University of Stellenbosch invites me to participate in a research project which aims to provide normative values for a bedside cognitive assessment battery. These values will improve diagnosis and management of patients. The instrument will also be validated by test-retest procedures.

2. It has been explained to me that:

   2.1 I can participate in a research project that tests cognitive (intellectual) functions of the brain. It is pen and paper tests that take about 30-40 minutes to administer. Functions such as attention, concentration and memory are tested.

   2.2 Approximately 1080 persons will be approached for this study.

3. This study does not involve any invasive procedures and does not test any medications.

4. All information will be treated as confidential. The results of this study will be reported in a medical journal. My name will not appear in the publication and it will not be possible to identify me in this publication.

5. The results of the study will be computed at a later stage and I will not have access to this.

6. I can refuse participation in this project and such denial will not effect treatment at this facility if needed.

7. The information above has been explained to me in English.

8. I have not been forced into participation in this project and I can stop my participation at any moment without any consequences.

9. Participation in this project will not lead to any extra costs for me.

10. I will not be paid to participate in this study, but an amount of R20.00 will be paid to cover my expenses.

11. This study will be conducted according to the Declaration of Helsinki, MRC and ICH guidelines.

12. This research project has been evaluated and approved by Subcommittee C of the Research Committee of the University of Stellenbosch.

B. I hereby give my voluntary permission to participate in the above-mentioned project.

Signed at ..... on .....

Participant's signature .....

Witness: .....

Declaration by/on behalf of Researcher:

I, ..., declare that:

1. I explained the information contained in this document to .....;
2. He/she was requested to put questions to me in the event of my misunderstanding;
3. This conversation took place in English.

Signed at ..... on .....

Researcher.....

Witness: .....