Normative Indications for Xhosa-speaking Unskilled Workers on the Trail Making Test and the Stroop Test

by

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ABSTRACT

The aim of the study was to produce preliminary normative indications for the Trail Making Test and the Stroop Test, administered in English, on a non-clinical sample of black, Xhosa-speaking, unskilled individuals ($N = 33$), with an educational level of 11 – 12 years, in two age categories (18 – 29 and 30 – 40 years). The sample was equally distributed for gender and level of education. Participants, who were required to have a basic proficiency in English, were from traditionally black township schools with relatively disadvantaged quality of education. Within-sample age and gender effects were investigated. There were no significant age effects on the Trail Making Test, whereas there was one significant difference between age groups on the Stroop Test with respect to the Color-Word task, and a result that strongly approached significance on the Word task, with the younger group performing better than the older group. There were no significant gender effects on the Trail Making Test, whereas there was one significant difference between genders on the Stroop Test with respect to the Word task, and a result that approached significance on the Color task, with females performing better than males. Normative indications for both measures were compared to available normative data on western populations with higher levels and more advantaged quality of education. This comparison revealed consistently poorer performances for both the Trail Making Test and the Stroop Test, confirming the need for localised normative datasets to facilitate accurate neuropsychological diagnoses on culturally disadvantaged individuals.

For David

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Chapter 1: Literature Review

The purpose of this study was to derive preliminary normative data for a young-adult, relatively disadvantaged, Xhosa-speaking population on two neurocognitive tests falling within the functional domain of attention and concentration, namely the Trail Making Test and the Stroop Test. The study formed part of a wider cross-cultural norming study on a spectrum of neurocognitive functional modalities, including that of the present study. This chapter considers the use of cross-cultural norms in neuropsychological assessment and examines the implications of recent research findings, before introducing the two tests which form the focus of this study (the Trail Making Test and the Stroop Test). The following points will be discussed in turn:

Neuropsychological assessment will be briefly defined, to contextualize the use of normative data. The use of norms will then be explained, followed by an overview of the challenges in general that are associated with selecting the best norms to use for a particular person. The use of incorrect norms in terms of the possible repercussions for patients and their families is considered. The need for localized norms will then be outlined, and this discussion will include the problems with cross-cultural assessment in general and the ethical responsibility of the psychologist versus the hard realities of the modern assessment context. The current challenges to neuropsychology in general, but particularly in South Africa, will then be outlined. In light of recent research, the relevance of a particular demographic, being the quality of education, will be examined in the South African context. After that, the critical need for the field of neuropsychological research to provide local norms is emphasized, and the focus of this study is contextualized within the broader research effort of which it forms a part. Finally, two of the most popular and commonly used neuropsychological tests available in the field, being the Trail Making Test and the Stroop Test, will be introduced and the rationale and hypotheses for the present study will be outlined.

1.1 Neuropsychological Assessment

Neuropsychological assessment involves the investigation of psychological and behavioral manifestations of neurological dysfunction (Lezak, Howieson, & Loring, 2004). Typically, such investigation answers questions about the existing cognitive status of a client for placement purposes, assists in the differential diagnoses for a complaint, or establishes the

extent of cognitive impairment due to known neuropathology. Part of this assessment process is the careful choice, motivated from the clinical history, of internationally recognized, standardized, reliable and well-researched neuropsychological tests from those available in the field (Mitrushina, Boone, Rozani, & D'Elia, 2005). Such tests are used as a means of further investigation to gain important information about the client's neurocognitive status. Accordingly, the results of these tests play a key role in building a coherent clinical picture of a person upon which to base clinical judgments and recommendations. It is important to note that even with appropriate and well-matched norms available, test results might be interpreted in different ways because a test never taps into only one cognitive function, but always requires different skills for completion (Rios, Perianez, & Munoz-Cespedes, 2004). Therefore, a comprehensive neuropsychological assessment typically comprises a number of neurocognitive tests that tap into a range of functional modalities.

A meticulously selected neuropsychological test battery is considered an essential part of neuropsychological assessment, and would typically include tasks grouped under broad cognitive functional modalities. Invariably, as neurocognitive tests tap into more than one cognitive function, there are subtle variations both in how the authors of the seminal neuropsychological texts conceptualize the broad functional modalities, and in which modalities particular tests are placed. For example, the Stroop test is conceptualized as a test of executive functioning by Strauss, Sherman, and Spreen (2006), as a test of attention, concentration, and tracking by Lezak et al. (2004), and as a test of attention and concentration by Mitrushina et al. (2005). Similarly, the Trail Making Test is understood as a test of attention by Strauss et al. (2006), as a test of attention, concentration, and tracking by Lezak et al. (2004), and as a test of attention and concentration by Mitrushina et al. (2005).

Generally, therefore, it is evident that the authors of these three seminal North American neuropsychological test compendiums (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006) emphasize an approach to neuropsychological assessment that aims to gather a broad spectrum of information in order to answer the assessment question appropriately, by conducting a series of tests that tap into each of the functional modalities. For the purposes of the larger norming project of which this thesis formed a part, a series of tests falling within functional modalities broadly conceptualized according to the three aforementioned texts, were derived as follows: 1) Attention and Concentration: Visual and Auditory; 2) Language; 3) Visual Perception; 4) Verbal Memory; 5) Visual Memory; and 6) Motor Function.

1.2 The Use of Normative Data

When designing a test battery, it is vital to consider the functional modalities that must be covered (as outlined above); however, another crucial factor in the selection of which tests to use is the availability of normative data (Mitrushina et al., 2005). This is because test results are only meaningful when compared to normative data. Normative data captures the range of performance on a psychometric test in respect of medically and psychiatrically healthy individuals, and these data provide a standard for a nonclinical population against which a testee's performance can be compared. However Nell (1999) cautions that, while for many tests there are plentiful norms available, "good norms are indeed rare" (p. 94). To Strauss et al. (2006), it is most important to know the specific characteristics of any normative dataset. Clear and extensive demographic information about the sample should be detailed as fully as possible, including information about geographic location. The inclusion and exclusion criteria for the sample should also be fully outlined. The test(s) should be uniformly administered in a standardized format and scored according to clear quality control measures (Nell, 1999). Strauss et al. (2006) point out that the selection of appropriate normative data is as important as the selection of which tests to use. The current thinking is that norms should either reflect the general population as far as is possible or that norms should be as closely aligned to the demographic profile of the person being tested as far as is possible. Which norms to choose must depend on the purpose of testing. For example, where the goal is to map out an individual's relative strengths and weaknesses, to plan specific interventions or to assess the extent of disability relative to pre-morbid functioning (for a disability or injury claim after a neurological event such as a traumatic brain injury), the individual must be compared to the best-matched demographic subgroup available.

There are various challenges associated with the selection of appropriate normative datasets for clinical use. For example, there may be alternative sets of norms available for comparison with a particular test, and this can result in dramatically different interpretations. Norms can be outdated or badly researched (Strauss et al., 2006). Norms are also scarce and may be difficult to find as they may be embedded within clinical studies in the literature (Mitrushina et al., 2005). Tests are often developed and normed in Europe or the U.S., and this presents a particular problem from the socio-cultural perspective when applying these norms to other contexts. Yet these challenges must be carefully considered. The potential cost of comparing test results against incorrect normative data is high, as it may lead to fallacious conclusions

being drawn (false positive or false negative diagnoses). In practical terms, deficits may be over or underestimated leading to incorrect and possibly even damaging interventions, placements, and treatment plans. Individuals may fall just above or just under specified cut-offs that determine whether they qualify for specific types of financial compensation, rehabilitation, or placement in a particular facility (Strauss et al., 2006). Incorrect judgments based on interpretation of neuropsychological tests may negatively impact an individual's life, and have a ripple effect into other lives. The American Psychological Association's code of ethics demands that psychologists assume the ethical responsibility for selecting the most applicable norms for a particular individual, and make special mention of the demographic factors that must be considered in such a selection (Mitrushina et al., 1999), and this viewpoint is reiterated in the Health Professions Council of South Africa's Rules of Conduct Pertaining Specifically to Psychologists (PsySA, 2004).

1.3 The Reality of the Assessment Context and the Need for Localized Norms

The problems that are inherent in cross-cultural testing have been extensively documented (Ardila, 1995; Ardila & Moreno, 2001; Manly et al., 1998; Nell, 1999; Shuttleworth-Edwards et al., 2004). In practical reality, however, diagnostic decisions in the clinical setting have to be made in terms of what standard psychological tests are currently accessible. Kaliski (2006) notes that mental health professionals have become increasingly involved in legal proceedings. Lezak et al. (2004) point out that neuropsychological assessment is relatively common in the legal context, and in compensation cases, the decision about payment may hinge on the neuropsychologist's report. Mitrushina et al. (1999) note that informed attorneys now regularly demand that neuropsychologists produce the normative datasets upon which they base their opinions. It is clear that all types of assessments, but particularly assessments done in the medico-legal context, demand not only a thorough, systematic investigation but also an internationally recognized and acceptable diagnosis or assessment report (Kaliski, 2006).

To Mitrushina et al. (1999), a neuropsychological report must be meaningful to other professionals in order to be useful. The data presented therein should be obtained from frequently used and standard tests administered in a standard way that can be expected to be familiar to, or can easily be referenced by, other clinicians reading the report. In initial examinations of patients, the use of standard tests is especially important in order to establish

a meaningful baseline of results, against which later results from the same tests can be compared to establish whether or not the person's condition has improved or deteriorated. This is also important for long-term care, as a patient may need to be re-evaluated over time.

For these reasons, it would be clearly illogical for clinicians in the field to abandon the excellent, internationally recognized tests which are often accompanied by a vast body of research data, despite the fact that many of these standard tests can only be considered to be "quasi experimental" when utilized in assessing any individual who does not speak English as a first language (Mitrushina et al., 1999, p. 10). A number of practitioner-researchers in clinical neuropsychology have provided collations of normative research studies for use in clinical settings, in respect of key neurocognitive tests commonly used in modern approaches to clinical neuropsychology (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006). However, in these seminal North American texts very few specifically cross-cultural norms are available. Thus, researchers agree that there is a critical need for localized normative data, and encourage the development of culturally apposite norms on internationally relevant tests (Mitrushina et al., 1999; Shuttleworth-Edwards et al., 2004; Shuttleworth-Jordan, 1996; Strauss et al., 2006).

1.4 The Current Challenge to Neuropsychology in South Africa

It is generally accepted that culture may have a major impact on test performance, and South African researchers have emphasized cross-cultural differences in attitudes towards test-taking ('test-wiseness') and in acquired cognitive skills, as well as the impact of socio-cultural issues on test performance (Nell, 1999; Shuttleworth-Edwards et al., 2004). Yet ethnic or cultural groups are not necessarily homogenous, and there may be very different factors that influence such groups. Thus, the results of recent research (Nell, 1999; Shuttleworth-Edwards et al., 2004) caution against assumptions of homogeneity of socio-cultural factors within ethnic groups and point rather to the critical role played by education that is likely to be a more potent influence on cognitive test performance than ethnicity in itself. It is generally accepted that the impact of educational levels on test performances is so great that individuals with a low education may be cognitively intact yet achieve lower scores than patients with a higher education who are impaired (Lezak et al., 2004). Cross-cultural researchers emphasize further that *quality* of education may be an even more potent variable than level of education on test performance, and that cognitive tests are likely to be culturally

loaded against those with relatively poor quality schooling (Manly, Byrd, Touradji, Sanches, & Stern, 2004; Shuttleworth-Edwards et al., 2004).

In South Africa, this is particularly relevant because during the years of the apartheid regime, education was stratified along racial lines. Blacks were educated in "DET" (Department of Education and Training) schools, which followed different syllabus and examination systems, and were seriously under-resourced. The negative effects of this system on the educational achievement of under-privileged black pupils are well documented. Despite the democratization of South Africa, the situation has not yet been remediated and is not expected to do so for possibly decades to come, especially in the rural, impoverished Eastern Cape area (Shuttleworth-Edwards et al., 2004). Rather, this state of affairs has worsened. While the dismantling of the apartheid regime has enabled more socially advantaged black children to access relatively higher quality education at historically advantaged schools, many children continue to attend the former DET schools, and unfortunately, one of the legacies of apartheid is that the previously disadvantaged schools have become even further disadvantaged. These prior DET schools remain under-funded; they have fewer resources and offer a relatively poorer quality of education to learners (Cooper, 2004). A recently published editorial comment noted that the schools previously administered by the former Bantu education or homelands systems are worst affected by the current problems in the Eastern Cape education department, thus further disadvantaging previously disadvantaged children in this area (After 13, 2008). The situation in the Eastern Cape education department has been labeled "a joke" (Education, 2008, p. 7), and various serious resource problems such as the paucity of teachers and administrative staff as well as scarce buildings, textbooks, and stationery have been found to be negatively impacting the quality of education offered at these schools (Eastern Cape, 2008). Other negative factors that are currently influencing the quality of education in the Eastern Cape are the strikes that plague schools (How the strike, 2008), as well as vandalism, administration, and resource-shortage problems (Education, 2008).

Accordingly, recent research by Shuttleworth-Edwards et al. (2004) has demonstrated that black South Africans, tested in the medium of English, who were educated in historically privileged English medium schools, achieve test results on the Wechsler Adult Intelligence Scale-III (WAIS-III) that accord with American standardization data, whereas a comparable group who were educated in historically relatively disadvantaged DET-type schools achieved

15 to 20 IQ points lower than this. The deleterious effect was more pronounced for those with a lower educational level (Grade 12 group) compared with those with tertiary education (Graduate group). Specific results on a test which taps into the cognitive modality of attention and concentration, being the Digit Symbol subtest, indicated that this task was one that was particularly affected by poorer quality education. On the basis of their research Shuttleworth-Edwards et al. (2004) have provided a normative base on the WAIS-III for black South Africans with such relatively disadvantaged education. Albeit on a relatively small sample (n = 10 per group) these data have been considered of relevance to the international knowledge base on effects of ethnicity (Strauss et al., 2006).

In addition to the WAIS-III research, Shuttleworth-Jordan (1996) has provided limited indications of performance for a small number of regularly employed neuropsychological tests in respect of black and white individuals with at least Grade 12 education. These norms also imply that equivalence for relatively high quality of education tends to reduce effects of ethnicity on neurocognitive test performance. Essentially all of these research indications confirm the need for localized indications on neuropsychological test performance due to the potential for highly variable socio-cultural influences, with deleterious effects particularly in evidence amongst black South African individuals with lower levels and relatively poorer quality of education. Strauss et al. (2006) note that the field of neuropsychological research is slowly beginning to respond to the need for demographically specific, closely representative norms, and many studies are adding new norms to existing datasets (Lezak et al., 2004). However, as can be seen from the above discussion, there is a clear need for normative indications in the South African context, in terms of selected tests that generally fall within the broad spectrum of functional modalities as discussed above (section 1.1). Two such tests, which assess the cognitive area of attention and concentration and which are both strongly favored for clinical use in the neuropsychological field (Mitrushina et al., 2005; Strauss et al., 2006; Lezak et al., 2004), are the Trail Making Test and the Stroop Test.

1.5 The Trail Making Test: An Overview

The Trail Making Test is one of the five most frequently used neuropsychological tests (Camara, Nathan, & Puente, 2000; Lezak et al., 2004; Rabin, Barr, & Burton, 2005; Thompson et al., 1999). Mitrushina et al. (2005) confirm that it is one of the most popular tests in use, and Strauss et al. (2006) rate it as the top measure of attention and the fourth

most frequently used test of executive function. The Trail Making Test generally and consistently indicates neurological integrity and, because it requires a complex set of skills to successfully complete, is highly sensitive to neurological impairment. Strauss et al. (2006) note that Parts A and B of the Trail Making Test correlate reasonably well, suggesting that these two aspects of the test measure related functions, although Trail B is a more complex measure that requires greater visual search and motor speed. The Trail Making Test taps into various cognitive abilities, involving multiple systems distributed throughout the brain (Coffey et al. 2001). It measures attention, including visual search and visual-spatial sequencing as well as processing speed, and it correlates well with other tests of speeded processing. It also taps into executive functioning, although Trail B of the test is more sensitive to this aspect of cognition. The alternation of sequencing required for Trail B loads on a higher attention factor (O'Donnell, McGregor, Dabrowski, Ostreicher, & Romero, 1994), and places demands on executive function, which accounts for the longer time required to complete the task.

Derived scores can be calculated from the two parts of this test, which are based on the differences in performance times for parts A and B, being the B:A ratio (Trail B divided by Trail A) and the B - A difference (Trail A subtracted from Trail B). Golden (1981) found that both high and low ratio scores indicate cognitive impairment, with a ratio score lower than 2 signifying a deficient performance on Trail A and a ratio score greater than 3 signifying deficient performance on Trail B. Lamberty, Putnam, Chatel, Beliauskas, and Adams (1994) examined the use of ratio measures. These researchers concluded that ratio measures had application in screening assessments which lacked good diagnostic information, and suggested a normative ratio performance of 2.0 – 2.5, with a cutoff of 3.0 for neuropsychological impairment. However, this finding was contradicted by Drane, Yuspeh, Huthwaite, and Klingler (2002), who found that the 3.0 cutoff resulted in high false-positive misclassifications, as well as by Martin, Hoffman, and Donders (2003), who concluded that use of the B:A ratio failed in terms of being sensitive to the severity of traumatic brain injuries. A recent study by Egeland and Langsjaeran (2007) proposed that a ratio lower than 2.5 may be indicative of malingering.

Larger than normal differences between Part A and Part B scores may suggest difficulties in executive function, and some authors (Golden et al., 1981; Hester, Kinsella, Ong, & McGregor, 2005; Lamberty et al., 1994) propose that this difference score is useful when

analyzing Trail Making Test results. This score essentially eliminates the aspect of speed from the Trail Making Test, and according to Lezak et al. (2004), it correlates highly with scores on other tests of mental ability and cognitive impairment. Heaton et al. (1985) found the B - A difference to be a useful measure of cognitive efficiency. Error analysis of Part B may be a useful measure as well – Stuss et al. (2001) found that all patients who made more than one error on Trail B had frontal lesions. However, another study by Ruffolo, Guilmette, and Willis (2000) found that approximately 12% of normal control subjects made at least one error on Trail A and 35% of normal control subjects made at least one error on Trail B. Mitrushina et al. (2005) conclude that a review of the available research findings suggests that while error analysis is unlikely to be useful in identifying cognitive deficits related to head injury or substance use, it may be useful in diagnosing dementia, and may contribute to indications of localized impairments in the frontal lobe area, especially when used together with times to completion. This aspect of the Trail Making Test can also be used as a means of detecting malingering. According to Strauss et al. (2006), research demonstrates that it is unusual even for patients with moderate to severe traumatic brain injuries to make errors on this measure, thus a large number of errors may alert the tester to the possibility of malingering. However, such results must never be considered in isolation, but must always be considered in the light of the individual's clinical context and the results of other malingering tests.

The Trail Making Test is affected by motor speed and dexterity, and age related slowing has been attributed to reduced abilities in these areas as well as impaired working memory, poor visual scanning or a combination of cognitive deficits. LoSasso, Rapport, Axelrod, and Reeder (1998) found that subjects can use their non-preferred hand without a significant performance decrement, thus the test may be very useful in certain patients with dominant hand paralysis. The analysis of times to completion of Trails A and B is highly sensitive to neurocognitive deficits and to closed-head injury, with increased completion times associated with increased injury severity. In terms of mild head injury, the test has high specificity and is thus very useful in terms of ruling *in* postconcussion syndrome. It is also sensitive to dementias such as Alzheimer's disease. The Trail Making Test has been used in populations of patients with schizophrenia, obsessive compulsive disorder, and major depressive disorder, all of which negatively impact performance.

Despite the Trail Making Test's high level of sensitivity to neurological impairment, a major limitation is the fact that it is difficult to be certain of the reason(s) for poor performance (Strauss et al., 2006). Another limitation is the somewhat imprecise scoring system as noted by Lezak et al. (2004). However, while poor performance on the Trail Making Test must be viewed as a non-specific finding due to the intricate mechanisms of the brain that contribute to test performance, Mitrushina et al. (2005) conclude that the Trail Making Test, a "standard component" in test batteries designed to detect cognitive impairment (p. 60), is most sensitive to impairments in terms of attention and concentration as well as to psychomotor slowing. Placed within a carefully selected battery of neuropsychological tests which tap into the cognitive functional modalities as previously discussed (section 1.1), the Trail Making test provides important clinical indications in the neuropsychological assessment context.

1.5.1 Demographic Effects on the Trail Making Test

While Bornstein (1985) found that men performed faster on Trail B, according to the literature surveyed by Mitrushina et al. (2005), in general there have been no consistent gender differences in terms of normal participants. The most important demographic effects on Trail Making Test results include age and education, both of which highly affect test performance. Specifically, on the basis of their extensive literature reviews, Lezak et al. (2004), Mitrushina et al. (2005), and Strauss et al. (2006) agree that the speed of Trail Making Test performance tends to decline with age; although accuracy remains unaffected, performance times are significantly slowed with each advancing decade. It is interesting to note, however, that a study by Yeudall, Reddon, Gill, & Stefanyk, (1987) with a sample age range from 15 – 40 years did not find any age effects, and an examination of the datasets provided by Goul & Brown (1970, as cited in Mitrushina et al., 2005) as well as by Stuss, Stethem, and Poirier (1987, as cited in Mitrushina et al., 2005), suggests that the age-related decline in performance appears to begin to occur only after the age of 40 years and possibly even as late as after the age of 60 years. With reference to the effect of education on Trail Making Test results, a review of many studies by Mitrushina et al. (2005) found a strong relationship between poorer test performance and lower levels of educational achievement. Bornstein and Suga (1988) concluded specifically that subjects with 11 years or more of formal education performed significantly better than those with ten years or less of formal education.

In addition, Strauss et al. (2006) note the influence of other demographic effects in terms of cultural and linguistic factors, and state that poor performance may not be a reliable indicator of cognitive dysfunction in certain cultural groups, as this may reflect the fact that some cultures do not place emphasis on speed. Other related factors may include information processing modes, perceived task relevance, the importance of precision, and quality of education. Some studies have found that culture and acculturation has a significant effect on Trail Making Test performance (Arnold, Montgomery, Castaneda, & Longoria, 1994, as cited in Mitrushina et al., 2005). A review of demographic effects by Soukup, Ingram, Grady, and Schiess (1998) suggested the importance of using sample-specific normative comparisons when considering Trail Making Test results.

There are various other cross-cultural sets of normative data cited by Mitrushina et al. (2005), but no specific details of the data outcomes are included in the text. These include the following studies: Stewart et al. (2001) administered the test to older African-Caribbean participants; Vlahou and Kosmidis (2002) provided data from Greek adults aged 18 – 89; Giovagnoli (1996) administered the test to healthy Italian adults aged 15 – 79; Nielsen et al. (1989) provided data from Danish adults aged 20 – 54; Lannoo and Vingerhoets (1997) reported on Flemish subjects aged 18 – 74; Lee, Cheung, Chan, and Chan (2000) administered the Trail Making Test to Chinese-English bilingual and English monolingual subjects aged 20 – 50 to examine the effects of different language backgrounds, and in another study Lee et al. (2002) provided data for Cantonese-speaking Chinese subjects aged 13 – 46. Lu and Bigler (2000) administered the Trail Making Test to American and Chinese students aged 12 – 32, wherein English letters were replaced by numbers in Chinese characters for the Chinese students, and presented the results as *T* scores. In a follow up study, Lu and Bigler (2002) collected normative data from adults born in China, Taiwan or Hong Kong but living in the U.S.A., aged 21 – 75, who spoke Chinese as their first and primary language. The Trail Making Test has also been wholly or partially translated into Arabic and Hebrew. As mentioned above, the details of the direction of effects are not supplied in this review by Mitrushina et al. (2005). However, none of the ethnic groups studied had application to the present study, with the possible exception of Stewart et al. (2001) on African-Caribbean participants; however the sample was restricted to older age groups and therefore did not have direct relevance to the 18 – 40 age group of the present sample.

In sum, despite a relatively large number of published normative studies in relation to the Trail Making Test as comprehensively reviewed in the frequently cited seminal neuropsychological test compendiums, and despite a wide-ranging literature review of online databases conducted by the researcher ("Academic Search Premier", "PsycArticles", "PsycInfo" and "Medline"), no published normative datasets specifically developed for this test in the South African context could be located. Thus, there is a clear need for normative research to be conducted on this test.

1.6 The Stroop Test: An Overview

The Stroop Test is a very well-known technique that was initially developed in the late 19th century and is a popular neuropsychological assessment method (Lezak et al., 2004). Referred to as the "gold standard of attentional measures" (MacLeod, 1992, p. 441), it is considered to be a classic neuropsychological test. Mitrushina et al. (2005, p. 109) place the Stroop test paradigm "among the oldest in experimental psychology", with active interest dated for over a century. It is one of the most long-standing and pervasive techniques that measures both attention and response inhibition (Strauss et al., 2006). The Stroop test measures the speed at which a person 1) reads the names of colors, 2) names the colors of XXX's printed on a page, and 3) names the color of the ink used to print a color word (e.g. The word 'red' printed in blue ink must be named as blue). The third task is an interference task in that it requires the person to consciously override their automatic reading response, and this cognitive conflict is known as the Stroop effect.

MacLeod (1992) states that the Stroop Test is a topic of continuing research interest, in that more than 700 studies that directly researched an aspect of the famous Stroop effect had been published at the time of writing his article. Lezak et al. (2004) note that this phenomenon has been interpreted in a number of ways: 1) to slowing due to a response conflict; 2) to failing to inhibit a response or; 3) to a failure of selective attention. Individuals who perform poorly on this task tend to experience concentration difficulties and be easily distracted. Mitrushina et al. (2005) state that this interference or Stroop effect, because it requires cognitive inhibition of a learned response in favor of an unusual response, has been traditionally viewed as a measure of executive functioning. Persons thought to have problems in terms of executive functioning tend to demonstrate increased interference, and a poor result on the interference section of the

Stroop is associated with left frontal lobe pathology, anterior cingulated and/or frontal cortex activation (Strauss et al., 2006).

Patients who have suffered head injuries typically demonstrate slowed responses on all of the test tasks, but as there are various psychological mechanisms which underlie the Stroop task, including working memory, processing speed, and semantic activation; a generally weak performance on the Stroop is additionally associated with frontal lobe lesions and seizures, frontotemporal dementia, white-matter hyperintensities, Klinefelter's syndrome, left and right cerebrovascular accident, memory impairment associated with age, transient global amnesia, depression, schizophrenia, psychosis, attention-deficit hyperactivity disorder, and being exposed to alcohol in utero. Increased interference has also been associated with dementia, and the Stroop is useful for the early detection of Alzheimer's disease (Mitrushina et al., 2005; Strauss et al., 2006). In terms of mild head injury, the test may be useful in terms of ruling *in* postconcussion syndrome. The Stroop Test can also be a useful means of detecting malingering in the form of patients who claim illiteracy. These subjects can be asked to perform the color-word interference task. If they are genuinely unable to read, they will not commit errors on this task by reading the written words (Strauss et al., 2006).

Strauss et al. (2006) indicate that various forms of the test have been developed, and different versions may tap into different underlying cognitive processes, thus it is clearly important to relate normative datasets and versions. Mitrushina et al. (2005) agree that there is no one recognized standard version of the Stroop test, and the presence of three commercially published and various other versions of this test is a major problem when reviewing the literature. They (Mitrushina et al., 2005) conclude however, that on compilation of the datasets available, only the Golden version had a large enough sample to be included in the meta-analyses. Thus, for the purposes of this study, the frequently used Golden version (Golden, 1978) will be described. The Golden version of the Stroop Test yields three scores as well as a derived interference score. This derived interference score is considered to have poor reliability, thus it will not be examined in this thesis. A final limitation of this test is the problem, when interpreting Stroop results, of how to allocate the effects of slowed information processing between lowered scores on the first two parts of the test and the color-interference score on the third part, to obtain a more specific understanding of impairments of executive function (Mitrushina et al., 2005). Thus it is important to note that Stroop Test

results should always be interpreted within the context of clinical and other test information about an individual.

Fundamentally, however, the Stroop Test measures the ability of a person to sort information and selectively react to this information, thus it is useful in highlighting a wide range of psychological processes. Mitrushina et al. (2005) place this test, frequently included in neurocognitive test batteries intended to identify neurological impairment, under the functional area of attention and concentration, and Lezak et al. (2004) agree that the technique makes a valuable contribution to neuropsychological assessment as a measure of concentration. Placed within a carefully selected battery of neuropsychological tests which tap into the cognitive functional modalities as previously discussed (section 1.1), the Stroop Test provides important clinical indications in the neuropsychological assessment context.

1.6.1 Demographic effects on the Stroop Test

Some studies (Martin & Franzen, 1989, as cited in Mitrushina et al., 2005; Moering et al., 2004) found that gender influenced overall Stroop performance, with women performing generally better than men. Other studies confined this advantage to women performing better on the color naming task (Golden, 1978; Stroop, 1935; Strickland, D'Elia, James, & Stein, 1997) and/or on the word reading task (Strickland et al., 1997). Moering et al. (2004) suggests that a female gender effect is only likely to occur in samples with 12 years or greater than 12 years of education. The literature taken as a whole, however, appears to suggest that while gender is related to Stroop performance, it plays a minor role. The most important demographic effects on the Golden version of the Stroop Test are age and education/IQ, with possible influences in terms of ethnicity/language (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006).

Ivnik, Malec, Smith, Tangalos, and Peterson (1996) found that age had a strong impact on performance on the Golden version of the Stroop, and the literature as a whole reviewed by Mitrushina et al. (2005), found a clear age effect which slowed the color naming performance and increased the Stroop interference effect. However, it is worth noting the hypothesis that a portion of this age effect might be attributable to decline in visual function. In adults, the slowed performance associated with advancing age appears to be linked with a decrease in color-naming speed, and an increased Stroop interference effect. When children are beginning to read, the interference effect is minimal but it increases as children gain in

reading ability (Golden, 1978). Thereafter it gradually declines until children show adult levels at approximately 13+ years of age, after which age-related declines in performance can be anticipated. According to Golden and Golden (2002), the correlation between age and the interference score in children is 0.29. Researchers (Anstey, Matters, Brown, & Lord, 2000; Barbarotto et al., 1998; Houx, Jolles, & Vreeling, 1993) agree that there is a significant education/IQ effect, in that persons with higher IQ and higher levels of education generally perform better on the Stroop tasks. Studies on African American participants conducted by Moering, Schinka, Mortimer, and Graves (2004), and Lucas et al. (2005) also found that education had a strong effect on Stroop performances, accounting for approximately 8% of the variance of performance on the interference task. Moering et al. (2004) found that even when education was taken into account, African Americans performed at a lower level than Caucasians.

Finally, in terms of cross-cultural factors, a study by Roselli, Santisi, Areceo, Salvetierra, and Conde (2002) found that increased time is associated with testing bilinguals in their second language, with a 10 – 15% increase in time for color naming and a 5 – 10% increase in time for color interference, pointing to the possible influence of language in Stroop results. There are few normative datasets available for the Golden version of the Stroop Test, with a total of only 10 datasets detailed in Mitrushina et al. (2005). Of these, there is only one cross-cultural set of normative data of the Golden version of the Stroop Test administered in English to subjects from another culture. Daigneault, Braun, and Whitaker (1992, as cited in Mitrushina et al., 2005) obtained data on 128 French-speaking participants, but presented results only for the color-interference portion of the test, for two broad age groups. Other studies which investigated demographic effects on the Stroop Test are referred to by Mitrushina et al. (2005). These include Doan and Swerdlow (1999) who administered a Vietnamese version of the Stroop on 30 Vietnamese speaking participants and the standard English version on 30 English-speaking participants. This study found no significant differences between the Vietnamese and English speakers, or between bilingual Vietnamese-English speakers and monolingual Vietnamese speakers. Lopez-Carlos, Salazar, Villasenor, Saucedo, and Pena (2003, as cited in Mitrushina et al., 2005) administered a Spanish version of the Stroop on Monolingual Spanish speakers with less than or equal to 10 years of education, in order to test demographic variables, especially education, on test performance. Results were stratified by education and found significant differences in terms of individuals with higher levels of education performing better than individuals with lower levels of education.

In sum, despite its popularity, there are relatively few normative studies published in relation to the Golden version of the Stroop Test as comprehensively reviewed by the frequently cited seminal neuropsychological test compendiums, and none specific to the South African context. Further, a wide-ranging literature review of online databases conducted by the researcher ("Academic Search Premier", "PsycArticles", "PsycInfo", and "Medline") also found a dearth of published normative data specifically developed for this test in the South African context. Thus, there is a clear need for normative research to be conducted on this test.

1.7 Rationale and Hypotheses for the Present Study

In conclusion, it is evident from the review of the literature that the Trail Making Test and the Stroop Test (both falling within the broad cognitive functional modality of tests of attention and concentration), are considered to be highly sensitive to neuropsychological impairment, and are commonly employed in the neuropsychological assessment arena. Furthermore, while evidently there are a limited number of cross-cultural studies done on these tests in western contexts such as North America, none that have been conducted in the South African context could be located by the researcher.

Prior research on the WAIS-III in South Africa by Shuttleworth-Edwards et al. (2004) reveals substantial lowering, by 15 - 20 IQ points, of the scores achieved by participants with poorer quality education when compared to American norms. But participants with higher quality education achieved reasonable equivalence of scores across all racial groups, demonstrating that relatively high quality education reduces the effects of ethnicity. Therefore, it would be anticipated that, in terms of other frequently used cognitive tests, individuals with higher quality and higher levels of education can be appropriately assessed with the available European or North American norms. However, the group with the most potential for differences from these available normative datasets is the group with lower levels and relatively poorer (disadvantaged) quality of education. Foxcroft and Roodt (2001) report that personal injury cases, predominantly head injuries following a motor vehicle accident, form a large proportion of psycho-legal work undertaken by South African psychologists. According to Nell and Ormond Brown (1991), the demographic group of people most at risk of experiencing traumatic brain injuries is that of black men aged between 25 and 44 years,

followed by coloured men and white men aged between 15 and 25 years, thus there is a specific need for normative datasets in these age groups. Furthermore, there is a need to extend the research base in terms of the WAIS-III cross-cultural research to include normative indices from additional key neurocognitive tests that tap into the broad functional modalities as outlined in the above discussion (section 1.1).

Specifically, therefore, this study aimed to provide preliminary normative indications in respect of a nonclinical sample of black Xhosa-speaking South African individuals between the ages of 18 and 40, with a relatively low level of education and relatively disadvantaged quality of education, for the Trail Making Test and the Stroop Test, administered in English, that pertain to the cognitive modality of attention and concentration. Based on the preceding literature review, the following hypotheses are proposed:

1) There will be no significant age effects on parts A and B of the Trail Making Test, whereas it is likely that significant age effects will occur in terms of the overall performance of the Stroop Test, or on one or more aspects of the Stroop Test.
2) There will be no gender effects on either part of the Trail Making Test, whereas it is likely that significant gender effects will occur in terms of the overall performance of the Stroop Test, or in one or more aspects of the Stroop Test.
3) There will be a lowering of performance on both parts A and B of the Trail Making Test, and on the overall performance of the Stroop Test, or on one or more aspects of the Stroop Test, for participants with relatively disadvantaged quality and lower levels of education, when compared with the available norms in the literature derived from the performances of participants in other studies with relatively advantaged quality and higher levels of education.

Chapter 2: Methodology

This study aimed to provide preliminary normative indications, appropriate for clinical use in the Eastern Cape area, on two tests, administered in English, which assess the cognitive area of attention and concentration, being the Trail Making Test and the Stroop Test. The data derived from these two specific tests forms part of a broader South African cross-cultural research project to develop preliminary normative indications in respect of a nonclinical sample of black Xhosa-speaking South African individuals aged 18 – 40, with a relatively low level of education and relatively disadvantaged quality of education, for a series of 10 commonly employed neuropsychological tests, that tap into a cross-section of functional modalities in addition to that of attention and concentration. A subsidiary aim was to investigate any age effects within this adult sample (18 – 29, 30 – 40) and any gender effects. The other functional modalities assessed in the broader project were language; visual perception; verbal memory; visual memory; and motor function. The study was conducted by four researchers (including the present researcher) under the research coordination of Professor Ann Edwards, and funded by a Rhodes University Council research grant.

2.1 Participants

The sample comprised 33 participants in total, 21 females and 12 males, all of whom were born in the Eastern Cape. All participants spoke Xhosa as their first language and English as their second language. The age range was 18 - 40 years (mean age 28.39, standard deviation 5.99). All participants had been educated in the Eastern Cape up to at least Grade 11 but not more than Grade 12 level, and were currently residing in Grahamstown, in the Eastern Cape.

2.1.1 Language

Xhosa is the indigenous language spoken in the Eastern Cape region. In order to ensure that the participant group was as homogenous as possible, one of the inclusion criteria was that all participants spoke Xhosa as their first language. All participants were required to have basic proficiency in the English language, and in order to ensure this, each participant was required to have passed English as a second language at the Grade 11 or Grade 12 level, and to be either currently employed in an English-speaking environment or have previously been employed in an English-speaking environment. Additionally, at the time of testing a subjective rating of English ability was obtained from the participants themselves, and each

participant gave their assurance that they were confident that their English was of a standard to enable them to be tested in English. Researchers also assessed each person's level of English ability, and recorded their clinical judgment of a participant's English fluency on a separate form (Appendix A). It was not necessary to exclude any participant on the basis of English proficiency.

2.1.2 Level of Education

In contrast to the study conducted by Shuttleworth-Edwards et al. (2004), which compared the test performances of graduates versus individuals with Grade 12, all participants in the present study had completed not less than Grade 11 and not more than Grade 12 level of education, in order to attain a restricted sample in terms of level of education. To be sure that the variable of level of education was not confounding the investigation, equivalence of distribution of participants with Grade 11 and Grade 12 education was ensured between all comparison groups. Please see the chi square analysis reported below under the headings 'Age' and 'Gender'.

2.1.3 Quality of Education

Officially, the DET-type (Department of Education and Training) education system no longer exists. However, as previously discussed in the literature review (section 1.4), its legacy is that the prior DET schools remain disadvantaged by various shortcomings, which negatively impact the quality of education offered to learners. Thus, for the purposes of this thesis, those schools placed in township areas will be referred to as DET-type schools. All participants in the sample attended DET-type schools throughout high school, which meant in all probability that they had also attended DET primary schools, although the latter information was not specifically elicited.

2.1.4 Age

The age range of the sample was 18 - 40 years (mean age 28.39 years, standard deviation 5.99). This age range locates all the participants within the broad age range of the group most likely to be at risk for traumatic brain injury (Nell & Ormond Brown, 1991). The participant group was sufficiently large enough for stratification into two age groups, being 18 – 29 and 30 – 40 years. There was no significant difference in terms of distribution of gender between these two age groups (p = .554). Similarly, there was no significant

difference in terms of distribution of level of education between these two age groups (p = .619). See Tables 1 and 2 below.

Table 1

Gender Distribution of Sample across Two Age Groupings (18 – 29, 30 – 40)

Age Group		Gender		
		Female	Male	Total
18 - 29	*n*	10	7	17
	% within Age Group	58.8%	41.2%	100.0%
30 - 40	*n*	11	5	16
	% within Age Group	68.8%	31.2%	100.0%
Total	*n*	21	12	33
	% within Age Group	63.6%	36.4%	100.0%

Note. There was no significant difference in gender distribution across the two age groupings (p = 0.554)

Table 2

Level of Education Distribution of Sample across Two Age Groupings (18 – 29, 30 – 40)

Age Group		Highest Grade		
		11	12	Total
18 - 29 yrs	*n*	4	13	17
	% within Age Group	23.5%	76.5%	100.0%
30 - 40 yrs	*n*	5	11	16
	% within Age Group	31.2%	68.8%	100.0%
Total	*n*	9	24	33
	% within Age Group	27.3%	72.7%	100.0%

Note. There was no significant difference in level of education distribution across the two age groupings (p = .619)

2.1.5 Gender

The sample was comprised of 33 participants. The participant group was then stratified into two groups according to gender, being 21 females and 12 males. There was no significant difference in terms of distribution of age between these two gender groups (p = .554). Similarly, there was no significant difference in terms of distribution of level of education between these two gender groups (p = .555). See Table 3 (below) and Table 4 (p. 21).

Table 3

Age Distribution of Sample across Gender Groupings

Gender		Age Group		
		18 - 29 yrs	30 - 40 yrs	Total
Female	*n*	10	11	21
	% within Gender	47.6%	52.4%	100.0%
Male	*n*	7	5	12
	% within Gender	58.3%	41.7%	100.0%
Total	*n*	17	16	33
	% within Gender	51.5%	48.5%	100.0%

Note. There was no significant difference in age distribution across the gender groupings (p = .554)

2.1.6 Exclusion Criteria

A self–report in the form of a biographical questionnaire was completed by each potential participant (Appendix B). In addition, a detailed screening questionnaire was conducted by the researcher on the day of testing (Appendix C). In order to ensure a non-clinical population, all individuals included in this study did not report any history of neurological disorder or head injury with loss of consciousness for longer than one hour, or the presence of a past or current psychiatric disorder. No history of prenatal or birth complications, learning disability, education in a special-needs facility, or more than two repeated school grades was reported by any participant. Further, there was no history of alcohol or substance abuse. No participant reported even recreational drug use in the year prior to testing, and there were no admissions to any psychiatric unit or substance abuse treatment unit. There were no severe medical illnesses reported and none of the participants used psychotropic medications.

Table 4

Level of Education Distribution across Gender Groupings

Gender		Highest Grade		
		11	12	Total
Female	*n*	5	16	21
	% within Gender	23.8%	76.2%	100.0%
Male	*n*	4	8	12
	% within Gender	33.3%	66.7%	100.0%
Total	*n*	9	24	33
	% within Gender	27.3%	72.7%	100.0%

Note. There was no significant difference in level of education distribution across the gender groupings ($p = .555$)

2.2 Procedure

The research project was conducted in Grahamstown, Eastern Cape. As previously discussed, a review of the literature suggested that in the rural, impoverished Eastern Cape area, quality of education was likely to be a potent variable influencing test results. Rhodes University was chosen as the research site for convenience purposes, and permission was duly obtained from the Registrar to utilize it in this way. The researchers then liaised with the Human Resources Department and the result of various discussions held was the recommendation to use Rhodes casual workers, as this group was most likely to fulfill the inclusion criteria. Permission was granted to the research team to gain access to the entire database and paper files of Rhodes casuals. The researchers compiled a list of casual workers with grade 11 or grade 12 level of education, then telephoned each person on the list and invited them to one of two presentations held on separate occasions, during which the research was fully explained. After having listened to an outline of the purpose and nature of the research, prospective participants were invited to complete the biographical questionnaire (Appendix B). Complete confidentiality of information provided was guaranteed at all stages of the project, and the voluntary nature of participation was emphasized. On the basis of the completed questionnaires, those prospective participants who fit the inclusion criteria were contacted

and invited to take part in the research project, and a Steers voucher in the value of one hundred rands (R100.00) was offered to facilitate enrollment in the project. On completion of this process it became apparent that the sample size was insufficient for our purposes. Thereafter, snowball sampling was used to identify possible further participants (Terre Blanche, Durrheim, & Painter, 2006). Researchers then contacted these new prospective participants and requested that they complete the biographical questionnaire. Once again, those who met the inclusion criteria were contacted and invited to participate in the research project, and were offered a Steers voucher in the value of R100.00 to facilitate enrollment in the project.

2.2.1 Data Collection

Participation was voluntary and prior to testing, a consent form was fully explained to each participant before being signed by both the participant and the researcher (Appendix D). The research team was made up of four intern psychologists, being three intern clinical psychologists and one intern counseling psychologist, who were trained by Professor Ann Edwards in the standard administration and scoring of the test battery. The four intern psychologists practiced administering the entire battery on each other, to ensure standardized administration. The total sample was then randomly divided amongst the four researchers into four sub-groups of research participants. Each intern psychologist then administered the pre-screening questionnaire and the full battery of tests, in English, to their participant sub-group. Strict protocol was adhered to in terms of order of administration of tests across all participants, with the Trail Making Test being administered as the 5th test and the Stroop Test being administered as the 13th test in the series of tests. The full battery administered, in accordance with the cognitive functional modalities conceptualized for the purposes of this study as previously discussed in the literature review (section 1.1), was as follows: 1) Attention & Concentration: Visual and Auditory: Stroop Test (Golden, 1978), Trail Making Test (Reitan, 1956); 2) Language: Words in One Minute: Unstructured Verbal Fluency Test (Baker & Leland, 1967), "S" Words-in-a-minute (Benton, Hamsher, & Sivan, 1994); 3) Visual Perception: Rey Complex Figure Copy (Osterreith, 1944); 4) Verbal Memory: Digit Span Forwards and Backwards (Wechsler, 1997), Wechsler Memory Scale (WMS) Paired Associates Immediate and Delayed Recall (Wechsler, 1945); 5) Visual Memory: WMS Reproduction for Designs Immediate and Delayed Recall (Wechsler, 1945), Rey Complex Figure Delayed Recall (Osterreith, 1944) and; 6) Motor Function: Successive Finger Tapping Test (Denckla, 1973), Purdue Pegboard (Tiffin & Asher, 1948). In addition, there were two

tests for malingering, being the Rey 15-Item Memory Test (Rey, 1964) and the Test of Memory Malingering (TOMM) (Tombaugh, 1996).

2.2.2 Instruments Analyzed for the Purposes of This Thesis

2.2.2.1 Trail Making Test: Administration and Scoring.

The Trail Making Test was administered and scored according to the standard guidelines set out in Strauss et al. (2006). In the standard procedure of Part A, the person being tested uses a pencil to draw lines to connect 25 encircled numbers randomly arranged on a page, starting at 1 and ending at 25. In Part B, the person being tested must connect 25 encircled letter and numbers in alternating order. Practice exercises for both Parts A and B are provided, and the test takes approximately 5 – 10 minutes to administer. Each part of the test yields a score in terms of completion time in seconds. Two derived scores are calculated, which are based on the differences in performance times for parts A and B, being the B: A ratio (Trail B divided by Trail A) and the B - A difference (Trail A subtracted from Trail B). See Appendix E for the test protocol used.

2.2.2.2 Stroop Test: Administration and Scoring.

The Golden version of the Stroop Test was administered and scored according to the guidelines set out in Strauss et al. (2006). The Golden version consists of 3 printed pages of columns in a booklet, being: 1) a Word page with 100 color words (red, green, blue) printed in black ink; 2) a Color page with 100 X's printed in either red, green or blue ink; and 3) a Color-Word page with 100 color words (red, green, blue) printed in colored ink, in which the words and the color do not match. The person being tested looks at each sheet in turn, reading the words or naming the color as fast as they can down the columns, within a 45 second time limit for each page. Three raw scores, being the Word score, the Color score, and the Color-Word score are then calculated from the test (Strauss et al., 2006). See Appendix F for the test protocol used.

2.2.3 Data Processing

Each intern psychologist scored the full battery of tests for their allocated participants, according to the standardized guidelines as referenced. To ensure standardization of scoring, another member of the research team then rescored all tests, and any discrepancies were resolved between the two scorers. Finally, two participant test batteries were selected

randomly and rescored by a third member of the research team. No further discrepancies were found on the Trail Making Test and the Stroop Test.

2.2.4 Data Analysis

The purpose of this study was to obtain normative data for a specific population group, for both the Trail Making Test and the Stroop Test. Therefore, the results of each test were analyzed by using descriptive statistics. The sample was sufficiently large for stratification into two age groups (18 – 29 and 30 – 40 years) for one set of analyses to examine possible age effects. Within age group comparisons, the distribution of gender and level of education was well controlled as discussed above. The sample was then stratified by gender for a second set of analyses to examine possible gender effects, and again, within gender comparisons, the distribution of age and level of education was well controlled as discussed above. An alpha level of .05 was used for all statistical tests, to establish significance of results. The data derived in respect of both tests were subjected to the following analyses:

1) Means and standard deviations were calculated.
2) Independent *t*-test analyses were employed to investigate the effects of age and gender.
3) Descriptive normative data for each of the two age groups in terms of means and standard deviations were tabulated together with comparable age-related data available in the seminal North American compendiums (Mitrushina et al, 2005; Strauss et al., 2006), for purposes of descriptive comparison between these normative data available in the literature and age-related data arising out of the present study.

Chapter 3: Results

The results for each of the two tests, being the Trail Making Test and the Stroop Test, will be presented under separate sections 3.1 and 3.2.

- In each section the performances of the two age groupings, being 18 – 29 years and 30 – 40 years, will be compared to determine any significant differences between the groups.
- In each section the performances of the two gender groupings, being males and females, will be compared to determine any significant differences between the groups.

3.1. The Trail Making Test

3.1.1 Comparison of Trail Making Test Results across Two Age Groupings (Table 5)

The ***t***-test comparisons of the two age groupings (18 – 29 and 30 – 40) are presented in Table 5 (p. 27) for Trail A, Trail A Errors, Trail B, Trail B Errors, for the difference between Trail B and Trail A performances (B – A) and finally, for the ratio score (B: A). No significant differences were found between the two age groups. While not approaching significance, a small but consistent trend was noted in terms of speed, in that the younger group tended to perform slightly better than the older group in both Trail A and Trail B. There was no consistent indication for either group to perform better in terms of error scores. The older group performed better in terms of errors for Trail A, but the younger group had fewer errors in terms of Trail B. There were no significant differences between the two age groups in terms of the B – A score or the ratio score (B: A).

3.1.2 Comparison of Trail Making Test Results across Gender Groupings (Table 6)

The *t*-test comparisons of the two gender groupings (males and females) are presented in Table 6 (p. 27) for Trail A, Trail A Errors, Trail B, Trail B Errors, for the difference between Trail B and Trail A performances (B – A) and finally, for the ratio score (B: A). No significant differences were found between the genders, and there were no consistent trends. Males performed better than females on Trail A, but females performed better than males on Trail B. Males made fewer errors on Trail A and Trail B, but the difference in both cases did not approach significance (p = .642 and p = .685 respectively). There was no significant

difference between the two age groups in terms of the B – A score (p = .155.) or in terms of the ratio score (p = .094).

Table 5

***T*-Test Comparison of Trail Making Test Performance across Two Adult Age Groupings (18 – 29, 30 – 40)**

	18 – 29 years Mean education: 11.76 years			30 – 40 years Mean education: 11.69 years			
Task	***n***	**M**	**(SD)**	***n***	**M**	**(SD)**	***p***
Trail A	17	35.73	14.72	16	43.83	16.56	.147
Trail A Errors	17	0.24	0.44	16	0.19	0.40	.747
Trail B	17	88.72	35.50	16	91.69	37.90	.818
Trail B Errors	17	1.18	1.29	16	1.44	3.08	.750
B – A	17	52.99	33.10	16	47.86	32.76	.658
B: A	17	2.74	1.44	16	2.22	0.95	.229

Note. Means (M) and Standard Deviations (SD) represent time in seconds to complete each task.

Table 6

***T*-Test Comparison of Trail Making Test Performance, by Gender**

	Male Mean education: 11.67 years			Female Mean education: 11.76 years			
Task	***n***	**M**	**(SD)**	***n***	**M**	**(SD)**	***p***
Trail A	12	35.01	10.73	21	42.31	17.96	.210
Trail A Errors	12	0.17	0.39	21	0.24	0.44	.642
Trail B	12	96.23	38.33	21	86.69	35.30	.474
Trail B Errors	12	1.08	1.31	21	1.43	2.73	.685
B – A	12	35.01	10.73	21	42.31	17.96	.155
B: A	12	2.97	1.51	21	2.22	0.90	.094

Note. Means (M) and Standard Deviations (SD) represent time in seconds to complete each task.

3.1.3 Synthesis of Trail Making Test Results

While there were no significant differences between the age groups, a small tendency in terms of an age effect was noted, in that the younger group consistently performed faster than the older group on Trail A and Trail B. There were no significant differences between the performances of the two gender groupings.

3.2. The Stroop Test

3.2.1 Comparison of Stroop Test Results across Two Age Groupings (Table 7)

The *t*-test comparisons of the two age groupings (18 – 29 and 30 – 40) are presented in Table 7 below for the Word score, the Color score, and the Color-Word score. There was one significant difference in terms of the Color-Word task (p = .038), where the younger group performed significantly better than the older group. For the Word task, the difference between the groups strongly approached significance (p = .059), with the younger group again performing better than the older group. Finally, the Color task results, while not approaching a significant difference, reveal a slightly better performance of the younger group compared to the older group (p = .331). Taken overall, these results indicate an age effect where younger individuals perform better than older individuals in terms of the Color-Word task, and indicate a tendency, on the other two tasks of the Stroop test, towards an age effect in the same direction.

Table 7

***T*-Test Comparison of Stroop Test Performance across Two Adult Age Groupings (18 – 29, 30 – 40)**

	18 – 29 years Mean education: 11.76 years			30 – 40 years Mean education: 11.69 years			
Task	***n***	**M**	**(SD)**	***n***	**M**	**(SD)**	***p***
Word	17	92.12	12.82	16	82.44	15.45	.059
Color	17	58.47	9.89	16	54.62	12.42	.331
Color-Word	17	37.00	7.06	16	29.88	11.43	.038

Note. Means (M) and Standard Deviations (SD) represent number of correct responses for each task.

3.2.2 Comparison of Stroop Test Results across Gender Groupings (Table 8)

The *t*-test comparisons of the two gender groupings (males and females) are presented in Table 8 below for the Word score, the Color score, and the Color-Word score. There was one significant difference in terms of the Word task (p = .027), where females performed significantly better than males. For the Color task, the difference between the groups approached significance (p = .128), with females again performing better than males. There was no significant difference between the genders in terms of the Color- Word task results (p = .931). Taken overall, these results confirm a gender effect where females perform better than males on the Word task, and indicate a tendency for females to perform better than males on the Color task. However, no indication of a gender effect was noted on the Color-Word task.

Table 8

***T*-Test Comparison of Stroop Test Performance, by Gender**

	Male			Female			
	Mean education: 11.67 years			Mean education: 11.76 years			
Task	***n***	**M**	**(SD)**	***n***	**M**	**(SD)**	***p***
Word	12	80.00	7.83	21	91.67	16.23	.027
Color	12	52.67	10.03	21	58.86	11.40	.128
Color-Word	12	33.75	6.78	21	33.43	11.55	.931

Note. Means (M) and Standard Deviations (SD) represent number of correct responses for each task.

3.2.3 Synthesis of Stroop Test Results

A comparison of the two age groupings revealed an age effect in terms of the Color-Word task, with younger individuals performing better than older individuals on this aspect of the test. This was supported by a consistent tendency towards an age effect in the same direction, in the other two tasks of the Stroop test. A comparison of the two gender groupings revealed a gender effect where females perform better than males in terms of the Word task. This was supported by a tendency on the Color task towards a gender effect in the same direction. However, no indication of a gender effect was noted on the Color-Word task.

3.3 Synthesis of All Test Results

No significant age effects were noted on the Trail Making Test, whereas there was one significant age effect on the Stroop Test with respect to the Color-Word task and a result that strongly approached significance on the Word task, in the direction of the younger group performing better than the older group. There were no gender effects on the Trail Making Test, and no trends were identified. On the Stroop Test, there was one significant gender effect with respect to the Word task, in the direction of females performing better than males. This result was supported by a trend that approached significance on the Color task, in the same direction.

Chapter 4: Discussion

The primary objective of this study was to provide preliminary normative indications appropriate for clinical use in the Eastern Cape, for two tests that assess the cognitive area of attention and concentration, being the Trail Making Test and the Stroop Test, administered in English to a nonclinical sample of black, Xhosa-speaking South African individuals aged 18 – 40 with a relatively low level of education and relatively disadvantaged quality of education, who were currently working or had previously worked in the medium of English. More specifically, the sample was divided into two groups which were analyzed in terms of age and gender, to investigate any influences of these two variables. With respect to age effects, the hypotheses that there would be no significant age affects on parts A and B of the Trail Making Test, and one or more significant age effects (in the direction of the younger group performing better than the older group) on the Stroop Test, were both supported by the results of the present study. With respect to gender effects, the hypotheses that there would be no significant gender effects on either part of the Trail Making Test, but one or more significant gender effects (in the direction of females performing better than males) on one or more aspects of the Stroop Test, were confirmed by present study scores. Finally, it was hypothesized that there would be a lowering of performance on both the Trail Making Test and the Stroop Test, when participants in the present study, with relatively disadvantaged quality and lower levels of education, were compared with participants in other studies with relatively advantaged quality and higher levels of education. Present study results supported this premise. Each of these points is discussed in detail below.

4.1 Within Study Indications: An Examination of the Effects of Age and Gender

4.1.1 Age Indications: Trail Making Test

With respect to the Trail Making Test, it was hypothesized that there would be no significant differences between the two age groups (18 – 29 and 30 – 40). As discussed in the literature review chapter, researchers (Goul & Brown, 1970; Stuss et al., 1987, as cited in Mitrushina et al., 2005) who found that an age effect would only become likely after the age of 40 years and possibly much later than that. In support of these findings, results revealed no significant differences between the two age groups for Trail A and Trail B (p = .147 and p = .818 respectively). However, an analysis of the data did suggest a small but consistent tendency towards an age effect in the direction of the younger group performing better than the older group in terms of speed of completion of Trail A and Trail B, thus pointing to a tendency for

slowing at this early stage that appears to become more significant at more advanced ages, that has not been previously noted in the literature. The tendency for slowing at this early stage as seen in the present study would be explicable in terms of the tenets of brain reserve capacity theory (Jordan, 1997; Satz, 1993). A group of relatively disadvantaged individuals in terms of both level and quality of education such as applied to the present sample, would be more vulnerable to revealing slowing due to age at an earlier age stage than would apply to samples with a higher level and better quality of education. There were no consistent indications for either group to perform better in terms of error scores. The older group performed better in terms of errors for Trail A, but the younger group had fewer errors in terms of Trail B. There was no significant difference between the two age groups with reference to the ratio score (B: A) or the difference score (B – A).

4.1.2 Age Indications: Stroop Test

With respect to the Stroop Test, on the basis of studies reviewed (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006) it was hypothesized that, unlike the Trail Making Test, there would already be significant differences between these two relatively young age groups (18 – 29 and 30 – 40), in the direction of the younger group performing better than the older group on one or more aspects of the test. In accordance with this hypothesis, results revealed one significant difference on the Color-Word task (p = .038), where the younger group performed significantly better than the older group. Furthermore, tendencies in the expected direction were noted. The difference between the performances of the groups strongly approached significance on the Word task (p = .059), with the younger group again performing better than the older group. Finally, while the difference did not approach significance on the Color task (p = .331), the younger group also performed slightly better than the older group on this task.

4.1.3 Synthesis of Age Indications: Trail Making Test and Stroop Test

Overall, therefore, Trail Making Test results revealed small indications of a tendency towards an age effect in the direction of the younger group performing better than the older group, although no significant differences between the two age groups were noted. In terms of the Stroop Test, results revealed that age effects, in the direction of the younger group performing significantly better than the older group, were a robust feature of influence on this test with one significant result on the Color-Word task and one result that strongly approached significance on the Word task.

4.1.4 Gender Indications: Trail Making Test

With respect to the Trail Making Test, it was hypothesized that there would be no significant differences for gender, as an overview of the literature by Mitrushina et al. (2005) found the gender effect to be generally negligible or non-existent. The test results of the present study were found to be commensurate with this hypothesis in that there was no significant effect for gender on either Trail A or Trail B, and moreover, there were no consistent trends in evidence. Males performed better than females on Trail A, but females performed better than males on Trail B. The present study thus contradicts the finding by Bornstein (1985) that males perform faster on Trail B, as females performed slightly faster on this task in the present study. There were also no gender effects in terms of errors made, as while males made fewer errors on both Trail A and Trail B, the differences in both cases did not approach significance (p = .642 and p = .685 respectively).

4.1.5 Gender Indications: Stroop Test

With respect to the Stroop Test, it was hypothesized that there would be some significant differences between genders, in the direction of females performing better than males on one or more aspects of the test. Some studies (Martin & Franzen, 1989, as cited in Mitrushina et al., 2005; Moering et al., 2004) found that overall, women performed better than men on all aspects of the test, while other studies confined this advantage to women performing better on the word reading task (Strickland et al., 1997) and/or on the color naming task (Golden, 1978; Stroop, 1935; Strickland et al., 1997). The results of the present study confirm a significant gender effect in terms of the Word task (p = .027), adding support to the finding by Strickland et al. (1997) that suggests a female advantage on this word reading task. The results of the present study also suggested a tendency for females to perform better than males on the Color task, with the difference approaching significance (p = .128), adding some support to the findings of Golden (1978), Stroop (1935), and Strickland et al. (1997). In terms of the Color-Word task, males performed very slightly better, but there was no significant difference for gender (p = .931). Thus, the results of the present study do not support the notion that women perform better on all aspects of the test. Rather, the results of the present study support literature that suggests that the gender effect is confined to the word reading and color naming aspects of the Stroop Test, in the direction of females performing better than males.

4.1.6 Synthesis of Gender Indications: Trail Making Test and Stroop Test

Overall, therefore, Trail Making Test results did not reveal any indications of a gender effect in that there were no significant differences for gender, and no consistent trends. Males and females were inconsistently favored on the speeded tasks and there were no significant differences in terms of errors made on either parts of the Trail Making Test. With reference to the Stroop Test, results revealed one significant gender effect on the Word task, in the direction of women performing better than men, which was supported by a trend approaching significance on the Color task, in the same direction. No gender effect was noted in terms of the Color-Word task.

4.2 Comparisons of Present Study and Other Published Normative Indications

4.2.1 The Trail Making Test (Table 9)

A collation of the relevant available norms for the Trail Making Test from the seminal North American test compendiums (Mitrushina et al., 2005, Strauss et al., 2006) is presented in Table 9 (p. 35), together with the results of the present study. All comparable norms appearing in these two texts were extracted for the purposes of this discussion, and were therefore required to meet the following criteria: 1) data applied to both Trail A and Trail B; 2) data were displayed according to time to completion in seconds; and 3) data were stratified similarly to the age groups in the present study (18 – 29, 30 – 40).

A review of many studies (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006) found a strong relationship between poorer test performance and lower levels of educational achievement. In terms of quality of education, the results of local WAIS-III research by Shuttleworth-Edwards et al. (2004) suggested that the variable of quality of education would additionally negatively impact test scores. The outcome anticipated by the literature is supported by present study results, in that the effect of level and quality of education can be seen to combine to negatively influence Trail Making Test results, in the direction of poorer scores for the present study participants (with lower levels and disadvantaged quality of education) when compared with the results of other studies. With reference to Table 9 (below), it is apparent that the present study results are the poorest of those available for comparison. However, this consistent decrement in comparison with the more advantaged groups is not more than two or three standard deviations apart, despite the *cumulative* disadvantage of lower levels and poorer quality of education for the present study sample.

Table 9

Trail Making Test: A Comparison of Present Study Results and Other Published Normative Indications for Two Adult Age Groupings (18 – 29, 30 – 40)

Study	n	Age Group	Education	Trail A M (SD)	Trail B M (SD)
Kennedy, 1981[1]	30	20 – 29	13.73	25.03 (8.94)	59.58 (28.78)
	30	30 – 39	13.53	28.88 (9.70)	70.28 (27.79)
Stuss et al., 1987[1]	10	20 – 29	14 – 18	18.5 (5.1)	41.6 (11.4)
		23.0 (2.67)	16.2 (1.39)		
	10	30 - 39	10 – 20	21.9 (6.3)	46.3 (13.7)
		33.9 (2.88)	16.7 (3.86)		
Stuss et al., 1988[1]	30	16 – 29	14.1 (1.34)	21.48 (6.44)	48.77 (18.66)
		22.43 (2.67)			
	30	30 – 49	14.9 (3.95)	27.58 (9.43)	61.30 (17.88)
		40.63 (2.97)			
Selnes et al., 1991[1]	229	36.1 (7.4)	13.7 (1.2)	22.8 (7.1)	51.8 (20.7)
	302	38.4 (7.8)	18.6 (1.3)	20.1 (5.5)	50.2 (15.8)
Drane et al., 2002[1]	39	20 – 29	12.98 (2.65)	26.12 (9.78)	60.92 (33.17)
	53	30 – 39	12.98 (2.65)	28.02 (8.78)	72.30 (28.55)
Present Study	17	18 – 29	11.76 (0.44)	35.73 (14.72)	88.72 (35.50)
	16	30 – 40	11.69 (0.48)	43.83 (16.56)	91.69 (37.90)

Note. Means (M) and Standard Deviations (SD) represent time in seconds to complete each task.

[1] (as cited in Mitrushina et al., 2005).

4.2.1.1 Other Indications from Trail Making Test Results.

1) Trail Making Test Derived Scores: Ratio and Difference (Table 10)

With respect to the derived ratio score (B: A), Lamberty et al. (1994) suggested a normative ratio performance of 2.0 – 2.5, with 3.0 being the cutoff for neuropsychological impairment. However, the results of the present study as presented in Table 10 (p. 37) contradict this finding and concur with the findings of Drane et al. (2002) who concluded that the cutoff of 3.0 would result in high false-positive misclassifications. In terms of the study by Egeland and Langsjaeran (2007), who proposed that a ratio lower than 2.5 might be indicative of malingering, the results of the present study do not concur, as taking into account scores falling within one standard deviation below the norm, this cutoff is too high. Thus the results of the present study suggest the impact of the demographic factors at play in the sample (level and quality of education, language), which render the suggested normative cutoffs for neuropsychological impairment and for malingering inapplicable to this group.

In terms of the derived difference score, where the Trail A result is subtracted from the Trail B result (B – A), it is proposed that this difference score is useful when analyzing Trail Making Test results (Golden et al., 1981; Hester et al., 2005; Lamberty et al., 1994), and larger than normal differences between Part A and Part B scores may suggest difficulties in executive function. It can be seen from Table 10 (p. 37) that the results of the present study fall approximately within 1 standard deviation below the comparative normative data presented. The present study sample has a similar level of education to the comparison sample, thus this low-normal result suggests the negative impact of the demographic factor of quality of education on the Trail Making Test difference score.

Table 10

Trail Making Test: Present Study Difference and Ratio Results Compared to Other Published Normative Indications for Two Adult Age Groupings (18 – 29, 30 – 40)

Study	n	Age	Education	Ratio M (SD)	Difference M (SD)
Drane et al., 2002	39	20 – 29	12.98 (2.65)	2.36 (0.78)	35.31 (27.72)
	53	30 - 39	12.98 (2.65)	2.72 (1.21)	44.13 (26.72)
Present Study	17	18 – 29	11.76 (0.44)	2.74 (1.44)	52.99 (33.10)
	16	30 - 40	11.69 (0.48)	2.22 (0.95)	47.86 (32.76)

Note. Means (M) and Standard Deviations (SD) represent ratio (B: A) and difference (B–A) performances

2) Trail Making Test: Error Scores

As previously discussed (section 1.5), the literature proposes two uses for error scores. Firstly, error analysis of both Trail A and Trail B is considered to be a useful indication of possible malingering, in that even patients with moderate to severe traumatic brain injuries do not make a large number of errors on this measure (Strauss et al., 2006). Thus, many errors on either or both Trails in the Trail Making Test may alert the examiner to the possibility that the test subject might be malingering. A non-clinical sample who have no motivation to malinger, would thus be expected to make few errors. The present study found low error results for both Trail A and Trail B. These results are thus commensurate with this expectation, and add support to the use of number of errors in the Trail Making Test as a means of alerting an examiner to the possibility of malingering. However, it is worth reiterating the important note that such a result must never be considered in isolation, but must form part of other malingering indications. Secondly, an error analysis of Trail B is indicated to be useful, as research by Stuss (2001) found that all patients who made more than one error on Trail B had frontal lesions. This finding is not supported by the present study results, wherein both age groups scored higher than one error on Trail B. The younger group (18 – 29) scored a mean of 1.18 (standard deviation 1.29) and the older group (30 – 40) scored a mean of 1.44 (standard deviation 3.08). In terms of gender, both genders also scored higher than one error on Trail B. Males scored a mean of 1.08 (standard deviation 1.31), and females scored a mean of 1.43 (standard deviation 2.73). This consistent finding indicates that, contrary to other research findings, greater than one error on Trail B does *not* indicate frontal lesions in this demographic group. Rather, this finding adds support to the results of the study by

Ruffolo et al. (2000), which found that it is not uncommon for normal control subjects to make at least one error on Trail A (12%) and Trail B (35%).

4.2.2 The Stroop Test

A collation of the relevant available norms for the Stroop Test from the seminal North American test compendiums (Mitrushina et al., 2005, Strauss et al., 2006) is presented in Table 11 (p. 39), together with the results of the present study. All comparable norms appearing in these two texts were extracted for the purposes of this discussion, and were therefore required to meet the following criteria: 1) data displayed means and standard deviations; and 2) data were stratified similarly to the age groups in the present study (18 – 29, 30 – 40).

A review of many studies (Lezak et al., 2004; Mitrushina et al., 2005; Strauss et al., 2006) found a strong relationship between poorer test performance and lower levels of educational achievement. Further, a study by Moering et al. (2004) found that even when level of education was taken into account, African Americans performed worse than Caucasians, pointing to the negative impact of other factors on their performance. Shuttleworth-Edwards et al. (2004) found that quality of education was a potent variable that negatively influenced WAIS-III scores in the South African context. Thus, it was hypothesized that lower levels and poorer quality of education would negatively impact test scores on the Stroop Test, and results were commensurate with this hypothesis. As previously discussed, all participants in the present study were educated at DET-type disadvantaged schools that offered a relatively disadvantaged quality of education. It can be seen from the data presented in Table 11 (p. 39) that the results of the present study are generally the poorest of those available for comparison on all aspects of the test.

The negative comparison is especially marked on the Color task of the Stroop test. Even when compared to the results achieved in the Lopez-Carlos et al. (2003, as cited in Mitrushina et al., 2005) study, in which the sample was tested in their own language (Spanish) and had still lower levels of education than the present sample, the results of the present study were poor. In extensive reviews of Stroop Test studies, there were some indications that language might play a role in influencing Stroop test results (Lezak et al., 2004; Mitrushina et al., 2005, Strauss et al., 2006). The findings of the present study add support to this notion and point to the impact of testing individuals in their second language. While all participants

in the present study had worked in an English environment and expressed their confidence in using the language, English was their second language. Roselli et al. (2002) found a detrimental impact, associated with testing bilingual persons in their second language, on the Color and Color-Word tasks of the Stroop Test, and the present study findings add support to this conclusion. Despite the combined variables of a relatively lower level and disadvantaged quality of education together with being tested in a second language, which resulted in comparatively poorer Stroop Test performances for the present study sample, the decrements were consistent but were not as marked as might have been expected, i.e. scores in excess of two standard deviations apart.

Table 11

Stroop Test: Present Study Results Compared to Other Published Normative Indications for Two Adult Age Groupings (18 – 29, 30 – 40)

Study	*n*	Age Group	Education Level	Word M (SD)	Color M (SD)	C-W M (SD)
Ingraham et al., 1988[1]	46	28.4 (3.2)	≥College	99.6 (11.0)	77.0 (10.4)	47.1 (10.1)
Connor et al., 1988[1]	40	18 – 25	College Students	113.52 (14.72)	81.22 (9.38)	49.75 (7.53)
Doan and Swerdlow, 1999[1]		31.2 (11.9)	15.4 (1.6)	108.5 (12.22)	76.25 (10.79)	44.50 (9.93)
Rapport et al., 2001[1]	32	33.2 (13.2)	14.8 (2.5)	100.9 (13.4)	80.3 (10.4)	
Lopez-Carlos et al., 2003[1]	41	18 - 29	7 – 10	105.45 (15.65)	71.40 (16.99)	44.85 (13.54)
Present Study	17	18 – 29	11.76 (0.44)	92.12 (12.82)	58.47 (9.88)	37.00 (7.01)
	16	30 - 40	11.69 (0.48)	82.44 (15.45)	54.62 (12.42)	29.88 (11.43)

Note. Means (M) and Standard Deviations (SD) represent number of correct responses for each task (Word, Color, and CW [Color-Word])

[1] (as cited in Mitrushina et al., 2005).

4.3 Synthesis of Findings

Overall, the hypotheses posed for the present study were supported. As hypothesized, the results of the present study revealed no significant age effects on the Trail Making Test, whereas there was one significant age effect on the Stroop Test with respect to the Color-Word task and a result that strongly approached significance on the Word task, in the direction of the younger group performing better than the older group. As further hypothesized, there were no gender effects on the Trail Making Test, whereas on the Stroop Test, there was one significant gender effect with respect to the Word task and a result that approached significance on the Color task, in the direction of females performing better than males. Finally, as hypothesized for both tests, on a descriptive comparison of the present study results to the available normative data, there was a clear pattern of poorer performance for the present study, who had the lowest level of education and who were further disadvantaged in terms of quality of education. This was with the exception of the Lopez-Carlos et al. (2003) study, but the present study sample had the added disadvantage of being tested in their second language.

However, given the disadvantage of the present study in terms of both quality and level of education, the decrements in evidence on the Trail Making Test and the Stroop Test were not as marked as might have been anticipated, i.e. scores were generally not more than two standard deviations apart. The clinical implication of this is that neither test reveals the danger of a floor effect (i.e. the test(s) is unreasonably difficult and is therefore unscorable), which would render these tests unsuitable for use on this population. Clearly, however, without the current norms, an individual with the demographic characteristics of the present study sample might be incorrectly classified as being impaired when compared to the available norms.

4.4 Strengths and Limitations of the Study

This study was carried out in order to establish preliminary normative indications in respect of a nonclinical sample of black South African individuals with a relatively low level of education and relatively disadvantaged quality of education, on two commonly used neurocognitive tests that assess the cognitive area of attention and concentration, being the Trail Making Test and the Stroop Test. As discussed in the literature review chapter of this

thesis, at the time of writing the author was not aware of any published cross-cultural norming studies in respect of these two tests that had been done in the South African context. Strengths of the study include its internal validity, explained by Terre Blanche and Durrheim (1999) as applying to a study's findings that follow in a "direct and unproblematic way" from its methods (p. 29). The results of this study are sustained by the coherence of its research design, which guided data collection and analysis in a manner that combined relevance to the research question with economical procedures. Limitations of the study are acknowledged in terms of the relatively small sample size, as this may affect the validity of the findings as data yielded may reflect idiosyncratic sample characteristics rather than being more broadly representative of the larger population. Further, the specificity of the geographical area may be understood to limit the generalisability of the findings, as research participants were drawn from only one specific area within the Eastern Cape Province. The sample was drawn from the Rhodes pool of casual workers, which, despite the researchers' oft-repeated emphasis on the confidentiality of all information, may have resulted in the under-reporting of drug use in the participants' self-reports. Finally, all research participants spoke Xhosa as their first language, but there are many other indigenous first languages spoken in South Africa. Watkins et al. (2003) report that there is considerable evidence that generalizations cannot be made across such populations. However, with respect to many normative studies on neurocognitive tests, normative data results obtained from small, well-stratified samples have been considered to be of relevance to the existing international knowledge base. Further, as clearly stated by Mitrushina et al. (2005), *all* normative data are of limited use - to persons whose demographic characteristics are similar to those of the normative data sample, and where identical administration and scoring procedures in respect of the specific test were used. Thus, it is concluded that the results and findings of this study make a significant contribution to the existing literature, and provide a basis for future research endeavors.

4.5 Recommendations for Future Research

Further investigations are warranted in order to add to the contribution made by this thesis. Testing on a much larger sample size would provide confirmation of the preliminary normative indications. It would also be useful for future research projects to draw study participants from other geographic areas of South Africa, in order to provide comparative findings. This study utilized participants with educational levels Grade 11 and Grade 12, but many South Africans achieve much lower levels of education before leaving schools, thus

future studies might provide normative indications for populations with even lower levels of education. Studies utilizing participants that speak other indigenous South African languages as their first language would be most useful in terms of providing a broader cross-cultural base of normative data. Finally, while the local WAIS-III study by Shuttleworth-Edwards et al. (2004) and other preliminary indications by Shuttleworth-Jordan (1996) indicated that individuals with higher quality of education can be relatively appropriately assessed using available North American or European norms, further testing on comparison samples is required in order to confirm this hypothesis with regards to the Trail Making Test and the Stroop test.

4.6 Final Synthesis

In conclusion, some limitations to this research thesis are acknowledged, and further research is needed in this area in order to confirm the thesis findings and to add to the knowledge base in the literature. It is evident that this study has accomplished its aims and has provided an extremely useful addition to the growing information base of norms that are being developed specifically for a relatively disadvantaged, Xhosa-speaking population, in the South African context. In absence of such norms, individuals from this demographic group would be likely to be misclassified as impaired on both the Trail Making Test and the Stroop Test, in relation to any of the existing normative data in the literature.

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APPENDIX A

General Behavioural Observations

GENERAL BEHAVIOURAL OBSERVATIONS

Participant:

Tester:

Language ability (including English fluency and articulation)

Physical appearance

Visual/auditory/motor problems (were problems corrected? E.g. with glasses, hearing aids)

Attention and concentration

1

GENERAL BEHAVIOURAL OBSERVATIONS

Attitude towards testing (e.g. rapport established, eager to speak, working habits, interest, motivation, reaction to success/failure)

Affect/Mood

Unusual behaviours/verbalisations (e.g. perseverations, stereotypic movements, bizarre and atypical verbalisations)

Other notes

2

APPENDIX B

Biographical Questionnaire

General Information Questionnaire:

Please Note: All information that you write on this report is strictly CONFIDENTIAL and will ONLY be used for the research project. It will NOT be passed onto any employers.
Your ANONYMITY will be maintained.

Demographic Information:

Name: _____

Gender: _____

Age: _____

Date of Birth: _____

Place of Birth (City & Country):

_____

Occupation (Employment at present time):

_____

E-mail Address: _____

Contact Number:_____

First Language:_____

Education History:

1. Name, location and dates of **High School** (s**) (Secondary School)** attended:

1: Name: _____ **3. Name:** _____

Location: _____ Location: _____

Dates: _____ Dates: _____

2. Name: _____ **4. Name:** _____

Location: _____ Location: _____

Dates: _____ Dates: _____

3. **Highest Level of Education** (Highest Grade Reached):
Tick appropriate level.

3.1. Grade 10: _____ Grade 11: _____ Grade 12: _____

3.2. **YEAR** that you finished school? _____

3.3 If you **TICKED Grade 10** or **Grade 11**, what was the reason you left before completing Grade 12?

_____

_____

_____

3.4 What **symbol** (eg, D, E, F) did you get for **English** at School?

_____

Socio-Economic Information:
Please answer this section **WHEN YOU WERE AT SCHOOL**, not at PRESENT
Please answer YES or No/

1. When you were still at SCHOOL, did you have:

1a: Electricity at home? _____

1b: Running water?_____ _____

1c: Did you have your own room?_____

1d: Did you have at least 2 meals per day? _____

1 e: Did you have your own toys worth in total over R50? _____

1 f: What was the attitude of your parents towards your schooling?

Positive, negative or neutral? _____

General Information:

1.a. Did you **fail or repeat** any **grades** at school? _____

b. If **YES, which grade** and **how many times** did you fail or repeat? _____

2. Have you ever been diagnosed with a **learning problem** (e.g. dyslexia), or received treatment
for a learning problem? Please give details.

_____

3. Have you ever been admitted to a **psychiatric (mental) hospital** or unit? Please give details.

_____

3. Are you currently taking any **medications** (tablets, injection) for a **psychological** or **psychiatric disorder** (mental illness)? Please give details.

_____

_____

4. Have you ever taken any **medications** (tablets, injection) for a **psychological** or **psychiatric disorder** (mental illness) in the **PAST?** Please give details.

_____

_____

6. Do you suffer or have you ever suffered from any **serious illnesses**? Please give details.

_____

_____

7. Have you ever suffered any form of **head injur**y (eg. hit your head after falling off a bicycle, injured your head in a car accident or during sports)? Please give details, including whether or not you **lost consciousness** and for **how long** you lost consciousness (minutes or hours).

_____

_____

8. Do you know if there were any **complications** (things went wrong) during your mother's **pregnancy** and/or **your birth**? Please give details.

_____

_____

9. Do you **drink alcohol** at all? Please give specific details of **how much** you drink and **how often**
(eg. 3 beers every day or 8 beers once a week etc.).

_____

_____

10. Have you ever used any **drugs** (eg. dagga, mandrax, ecstasy, glue or paint thinners)? Please give specific details of **frequency** (how much) of use and when you **began** using (eg. a packet of dagga every day since you were 15 etc.).

_____

_____

11. Is there any other **educational** or **medical** information that you think might have a detrimental (negatively or badly) affect your performance on a cognitive test? Specify.

_____

_____

_____

_____

APPENDIX C

Pre-Test Screening Questionnaire

Encourage participant to answer as accurately as possible. Tick the option that applies and elaborate when requested. If some questions do not apply to the participant or she/he does not know the answer, record N/A if not applicable, or UK if unknown. Assure participants that information obtained will be kept in the strictest confidence.

Tester: _____

Biographical information

Name:				
Gender:	**M**	**F**		
Age:		**Date of Birth:**		
Handedness:	**Right**	**Left**		
First Language:				
English Proficiency:	**Poor 1**	**Average 2**	**Good 3**	**Excellent 4**
Elaborate:				
Test Date:				

General

1. Have you had something eat this morning?
   - Yes
   - No

2. Have you slept well?
   - Yes
   - No

3. Do you wear glasses?
   - Yes
   - No

4. Do you experience any problems with your eyes?
   - Yes
   - No

5. Do you have a problem with hearing?

- Yes
- No

6. Have you ever broken an arm?
   - Yes
   - No

7. If yes, which one?
   - Right
   - Left

Remedial treatment for learning disabilities

Did you experience any difficulties or problems with learning at school?
- No
- Yes

If yes, elaborate

_____
_____
_____
_____
_____

Did you receive any extra help for those problems or difficulties from someone other than your teacher like an Occupational Therapist, Psychologist, Doctor etc?
- No
- Yes

Neurological

1. Have you had any head injuries or any other problem that might have effected your brain?
   - No
   - Yes

2. If yes,

(To researcher, if yes, indicate number of previous head injuries sustained by participants and type of head injury. (eg: MVA, fall, assault, gunshot wound etc,)

Pathology Type	**1**	**2**	**3**
Date (month/year)			
Type			
Hospitalized (Yes/No)			
Length of Unconsciousness			
Duration of stay in hospital			

3. When you left the hospital, did you have to continue to see the doctor as an outpatient?

- o Yes
  If yes, for how long? _____
- o No

4. Are you experiencing any problems related to this injury currently?

- o No
- o Yes

If yes, please give further information

_____
_____
_____
_____
_____

Education

1. What was the last grade you **passed**? (NB, not just started)

- o Grade 10
- o Grade 11
- o Grade 12

2. Did you fail or repeat any grades at school?

- o Yes
- o No

3. If YES, which grade and how many times did you fail or repeat?

- o Once
- o Twice
- o 3 times or more

4. What was the reason you failed/repeated?

- o Financial
- o Family responsibilities
- o Lack of interest
- o Political unrest/Strike, School closing
- o Poor academic performance

- o Other:
  _____
  ____

Substance Use

1. How often do you have a drink containing alcohol?

- Never
- Monthly or less
- Once a week
- 2 or 3 times a week
- 4 or more times a week

2. How many drinks containing alcohol do you have on a typical day of drinking?

- 1 or 2
- 3 or 4
- 5 or 6
- 7 to 9
- 10 or more

3. How long have you been drinking in this way?

- Within the past 6 months
- From 6 months to 5 years
- More than 5 years

4. How often have you needed a drink in the morning to get yourself going after a heavy drinking session?

- Never
- Within the past 6 months
- From 6 months to 5 years
- More than 5 years

5. Are there financial, legal or family problems related to your drinking?

- No
- Yes, but not in the past year
- Yes, during the past year

6. Has a relative, friend, doctor or health worker been concerned about your drinking or suggested you cut down?

- No
- Yes, but not in the past year
- Yes, during the past year

7. Have you ever gone to anyone for help about your drinking?

If **YES**, who? _____

- Within the past 6 months
- From 6 months to 5 years
- More than 5 years

8. Have you ever been admitted to hospital for substance use?

If **YES**,

- Within the past 6 months
- From 6 months to 5 years
- More than 5 years

OPTIONAL as directed by information contained on questionnaire

9. Have you ever used any **drugs** (eg. dagga, mandrax, ecstasy, glue or paint thinners)? Please give specific details of **frequency** (how much) of use and when you **began** using (eg. a packet of dagga every day since you were 15 etc.).

_____
_____
_____
_____
_____

APPENDIX D

Consent Form

RHODES UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
PARTICIPANT CONSENT FORM

I, _____ have been informed of the nature of the research in which I will participate. I understand that two intern clinical psychologists from Rhodes University, Karen Anne Hope Andrews and Andrea Jane Wong, will be administering some neuropsychological tests on me, and I hereby agree to participate in this project.

I understand that:

1) The above-mentioned intern clinical psychologists are conducting research as a requirement for a Masters degree in clinical psychology at Rhodes University. Their aim is to provide preliminary normative data on various neuropsychological tests for black South African people who speak an indigenous South African language as their first language.

2) The research will involve willing, black, indigenous South African language speakers with a Grade 10 – 12 education, from a former Department of Education and Training (DET)-type school.

3) Participants will be assessed using various commonly used neuropsychological tests.

4) Participation in the research is completely voluntary and I have the right to withdraw from the study at any stage.

5) The information collected on individual participants will be strictly confidential, with no personal information being disclosed. Access to this data will be restricted to members of the research team.

6) No individual test results will be given to me or to any other person outside of the research team. The information collected will be used for research purposes only by the researchers and will not be made available to my employers under any circumstances.

7) Data arising out of this project may be used anonymously for thesis and publication purposes.

_____ _____

Signed Date

_____ _____

Name Email

_____ _____

Address Contact Telephone Number(s)

APPENDIX E

Trail Making Test Protocol

Trail Making Test: Administration Instructions

Full Name: _____ Clinician: _____ Date: _____

Requirements: Test Sheets (4 pages)
Pencil
Stop Watch

TIMED: **Time (in seconds) to complete each trail – No Time Limit.**

TRAIL A

SAMPLE: *Showing the subject the sample sheet and pointing out the first 3 or 4 circles which must be joined, give the following instruction:*

"Draw a line to connect the circles consecutively form 1 to 8, without lifting your pencil, as fast as you can."

If the subject makes a mistake, point it out and explain it, then continue. If subject still cannot complete Sample A, take their hand and guide the pencil (eraser end down) through the trail, before they attempt again. Repeat until subject succeeds or it becomes evident that they cannot do it.

If correct, continue to test.

TEST: *Showing the subject the test sheet and pointing out the first 3 or 4 circles which must be joined, give the following instruction:*

"Now draw a line to connect the circles consecutively from 1 to 25, without lifting your pencil, and do it as fast as you can."

Record time taken to join all the circles in the correct order

Note: If subject makes a mistake, do not stop timing; point out mistake immediately and see that subject corrects error and carries on.

TRAIL B

SAMPLE: *Showing the subject the sample sheet*

"Draw a line to connect the circles consecutively by alternating between numbers and letters starting with 1 then A, without lifting your pencil, as fast as you can."

If the subject makes a mistake, point it out and explain it, then continue. If subject still cannot complete Sample B, take their hand and guide the pencil (eraser end down) through the trail, before they attempt again. Repeat until subject succeeds or it becomes evident that they cannot do it.

If correct, continue to test.

TEST: *Showing the subject the test sheet and pointing out the first 3 or 4 circles which must be joined, give the following instruction:*

"Draw a line to join the circles consecutively, by alternating between numbers and letters starting with 1 then A, and finishing with 13. Do it as fast as you can."

Record time taken to join all the circles in the correct order

Note: If subject makes a mistake, do not stop timing; point out mistake immediately and see that subject corrects error and carries on.

SCORE:

Trail A: _____ Errors made on Trail A: _____

Trail B: _____ Errors made on Trail B: _____

APPENDIX F

Stroop Test Protocol

STROOP (Golden Version): Administration Instructions

The subject is given all 3 pages, with Page 1 on top directly followed by pages 2 and 3. The sheets are placed directly in front of the subject on a flat surface. The subject may be allowed to rotate the sheets up to 45 degrees to the right or to the left, but may not be allowed to rotate the paper to a greater degree or to lift the paper off the flat surface in front of the subject. Pages 2 and 3 must be done in the same fashion. None of the pages must be covered in any way whilst reading (e.g. using 1 hand to cover other columns).
After the subject is given the test booklet, the following instructions are read:
"This is a test of how fast you can read the words on this page. After I say begin, you are to read down the columns starting with the first one (point to the left-most column) until you complete it (run finger down the column) and then continue without stopping down the remaining columns in order (run your finger down the 2nd column, then the 3rd, then the 4th and 5th columns). If you finish all the columns before I say "Stop" then return to the first column and begin again (point to the 1st column). Remember, do **not** stop reading until I say "Stop" and read out loud, as quickly as you can. If you make a mistake, I will say "No" to you. Correct your error and continue without stopping. Are there any questions?"
Instructions may be repeated or paraphrased if necessary so that the subject understands what is to be done. Then continue. "Ready? Then begin." As the subject starts, begin a stopwatch. After 45 secs, say "Stop. Circle the item you are on". (If subject finished the entire page and began again, ask him/her to put a '1' by his/her circle. Then turn to 2nd page.)

The instructions for the 2nd page are identical, except the first sentence reads:
"This is a test of how fast you can name the **colours** on this page." (If the subject is largely intact, the remaining instructions can be given briefly) "You will complete this page just as you did the previous page, starting with this 1st column. Remember to name the colours out loud as quickly as you can." (As with the 1st page, the subject should be allowed 45 seconds.)

At the beginning of the 3rd page, the following instructions should be used:
"This page is like the page you just finished. I want you to name the **color of the ink** the words are printed in, **ignoring the word** that is printed in each item. For example (point to the first item of the first column), this is the first item: what would you say?" If the subject is correct, go on with the instructions. If incorrect, say: "No, that is the word that is spelled there. I want you to say the color of the ink the word is printed in. Now, (pointing to the same item) what would you say to this item? That's correct." (Point to the second item) "What would be the response to this item?" If correct, proceed; if incorrect repeat above as many times as necessary until the subject understands or it becomes clear that it is impossible to go on.

"Good. You will do this page just like the others, starting with the first column (pointing) and then going on to as many columns as you can. Remember, if you make a mistake, just correct it and go on. Are there any questions?"
(As with the other 2 pages, the instructions can be repeated or paraphrased as often as necessary.)

"Then begin." Time for 45 seconds then say "Stop. Circle the item you are on".