THE ESTABLISHMENT OF NORMATIVE DATA ON XHOSA-SPEAKING HIGH SCHOOL LEARNERS USING THE ImPACT 3.0 PROGRAMME.

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ABSTRACT

Concussion is a common form of brain injury, especially amongst sports players of all age groups. ImPACT is a valid and reliable measure of a variety of cognitive functions commonly affected by such injuries, which allows for objective return-to-play decision making (Iverson, Lovell, & Collins, 2003). However, studies show that the transfer of such tests from one ethnic group to another without appropriate standardization is highly problematic (Ardila, 1995). Thus, the relative absence of South African normative data for the ImPACT 3.0 programme is an issue for concern.

Consequently, this study aimed to establish norms for semi-rural Xhosa-speaking schoolboys with an advantaged education (ages 14, 16 and 18) for the ImPACT 3.0 programme as administered in English. Administrative and linguistic difficulties that were experienced by individuals during completion of the battery were also identified. Finally, the study included a comparison of the percentile scores of this sample to the USA norms for boys of a similar age group.

Subtests scores were generated for 70 schoolboys and the data were then subjected to statistical analysis. A significant difference between English proficiency of the Grade 8 and Grade 12 boys was found. This indicates the importance of including an English proficiency test with the ImPACT battery when assessing such populations. No other significant differences were found between these age group samples. Although this requires further investigation, the comparison of the USA and SA percentiles suggests the use of local norms for this population. South African boys in this study consistently scored lower than the USA sample. Finally, it is recommended that symptom self-reports should be verbally investigated with each boy after testing, given indications of comprehension problems. In closing, limitations and future possible studies are discussed.

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Chapter 1

Introduction

The lack of available norms for testing the neuropsychological effects of brain injury in the black South African population inspired the researcher to conduct a study with the specific aim to develop norms for semi-rural Xhosa-speaking boys with an advantaged education. This study falls within the context of computerized assessment and, specifically, the need to establish culturally relevant norms using the ImPACT 3.0 (Immediate Post-Concussion Assessment and Cognitive Testing) programme. Computer-based neuropsychological tests, such as ImPACT 3.0 and Headminder, both from the United States of America, and CogSport from Australia, have over the past few years gradually been replacing traditional pencil and paper neuropsychological testing methods, and have been found to be extremely sensitive to subtle acute and chronic effects of brain injury (Scolero, Moser & Schatz, 2002).

Computerized neuropsychological testing is cost and time effective and can be administered in a group setting. ImPACT 3.0 is acknowledged as one of the most widely researched programmes in the field of concussion assessment and is used worldwide to monitor concussion recovery in national, university and high school sports teams, as well as for concussion follow-up in sports medicine centers and neuropsychological clinics (Iverson, Lovell, & Collins, 2003a). It consists of a demographic questionnaire, a symptom score form, which consists of 22 common concussion symptoms, and six test modules which provide composite scores for the neuropsychological functions found to be most affected by concussion: Verbal Memory, Visual Memory, Visual Motor Speed, Reaction Time, Impulse Control and Symptom Score (Iverson et al., 2003a). An athlete's individualized baseline can be compared with that athlete's post injury results and, if no baseline testing has been done, an athlete's post injury test results can be compared with the age-equivalent (United States) ImPACT 3.0 normative database. This normative database is available for, amongst others, 13-15 and 16-18 age ranges. The ImPACT battery has been subjected to multiple reliability and validity studies, and has demonstrated strong reliability and validity (Iverson et al., 2003a). It is a stable measure with good consistency, even across multiple administrations (Iverson et al., 2003a). The programme has been translated into seven languages but not into Afrikaans or any of the South African indigenous languages.

There is currently no published material on available South African normative data for ImPACT 3.0, and hence it was decided to initiate the process of gaining normative indications in this country on a population of semi-rural Xhosa-speaking boys with an advantaged education, across three age stages of 14, 16, and 18, for the programme as administered in English. Following this a comparison can be made between the norms developed from the current study and those of the existing ImPACT 3.0 United States norms for a similar age and gender group. An experiential report from the individuals will be noted during the completion of the test, for example how did they find the testing, and with which tests did individuals experience difficulties? Furthermore, the need for local norms can be justified on political and cultural grounds, a point which will be explored in the following paragraphs.

The need for local norms can be justified on political and cultural grounds, in that South Africa's complex socio-political history has produced educational disparities in the population along racial lines, which makes the application and interpretation of neuropsychological tests a challenging task (Claasen, Krynauw, Hotzhausen & Mathe, 2001). The effects of social oppression and racism are complex, and cannot be ignored as this would mean that a critical aspect of data collection would be missed (Butchart, Nell, Yach & Brown, 1991).

In a broader review of the existing concerns in mainstream South African cross-cultural assessment, Retief (1988) concludes that, despite its historically racist origins, considerable progress has been made in eradicating obstacles to the practice of fair cross-cultural psychometric assessment. A review of the international literature reveals that the most important obstacles identified as crucial and as playing a role in any form of cross-cultural assessment are: (1) language and translation (Bracken & Barona, 1991; Reddy, Knowles & Reddy, 1995); (2) a lack of familiarity with the testing situation and process (Lonner, 1990; Merender, 1994); (3) content method and cultural bias (Poortinga, 1995; Van de Vijver & Poortinga, 1995); and finally a shortage of appropriate normative data (Geisinger, 1994; Helms-Lorenz & Van de Vijver, 1995).

Foxcroft asserts that:

> A larger storehouse of appropriate measures for use in South Africa should be created by developing culture-fair tests with appropriate norms for diverse groups of children and adolescents in our country; adapting and norming useful tests that have been developed overseas (Foxcroft, 1996, pp.12-13).

She argues further that the range of the term “assessment” should be broadened to include appropriately normed screening measures that could be used effectively in the testing of large groups of children (Foxcroft, 1996, pp.12-13).

With specific reference to the South African context, Shuttleworth-Jordan (1996) argues against the abandonment of existing tests on the grounds that they have not been designed for application among a particular population, or because appropriate normative data are not yet available. She argues that although this stance has relevance when dealing with rural and illiterate or semi-illiterate populations, the processes of acculturation taking place within urbanized South African populations must be acknowledged as having a strong mediating influence on test performance. She argues, therefore, that in respect of more literate and advantaged populations the norming of existing well-researched tests is likely to be the more useful route to take.

To conclude, although ImPACT is used extensively, especially in sport for concussion assessment across a wide variety of settings in South Africa, there are currently no available South African norms for the ImPACT 3.0 test battery. The present study aimed to initiate the process of norming this test using an adolescent Xhosa-speaking population with a relatively advantaged education.

Chapter two reviews the literature on the statistics of head injury and concussion in South Africa, with a particular focus on sports related concussion. The chapter discusses: the definition and classification of concussion in sport; neuropsychological sequalae of concussion including cognitive deficits and postconcussive symptoms followed by discussion of concussion management in sport; and the role of neuropsychological assessment in concussion management. It also reviews traditional pen and pencil tests, and compares these to computerized assessment tools. With regard to ImPACT as an assessment tool, reliability, validity and other research are reviewed. Cultural aspects or influences in education, language and neuropsychological assessment, and its effects on education and language are finally reviewed. This is followed by a conclusion incorporating the aims of the study.

Chapter three covers the methodology adopted in this study. The sampling procedures, method of test administration and statistical procedures in the analysis of data are outlined in detail.

Chapter four provides an overview of the results of the analysis, whilst, chapter five summarizes the main findings of the study and discusses their implications. Furthermore, the limitations of the study are discussed and recommendations for future studies are proposed.

Chapter 2

Concussion Assessment

2.1. Introduction

This chapter will begin with a consideration of the occurrence of brain injuries in South Africa, especially in sport. Having established this broader context, an overview of the definition of concussion and the neuropsychological sequalae of concussion, including cognitive deficits and post concussive symptoms, will be given. This is followed by a discussion of concussion management in sport and the role of neuropsychological assessment in such management. Here traditional paper and pencil measures will be compared to computer-based assessment. The ImPACT programme as a specific computerized neuropsychological tool in the sports arena is then discussed, prior to a discussion of the role of culture in assessment. Finally, the above is drawn together as the aims of the study are articulated.

2.2 Brain injuries in South Africa

According to Brown and Nell (1991), head injury in South Africa is being ignored and health care professions harbour misconceptions about such injuries. The same perception or mentality pervades the South African sports field.

> In South Africa, where the average male is an aspirant springbok rugby player, there is a myth that real men do not suffer concussions; a Hollywood fantasy that the time it takes to stand up, dust yourself down, and ride off into the sunset (Brown & Nell, 1991, p.34).

Brown and Nell (1991) argue that only a Glasgow Coma Scale (GSC) of 15\15 implies that there will be no long-term neuropsychological sequalae of head injury. It is important to note that if a blow to the head results in momentary confusion and a gap in memory based on these facts, head injury should be taken seriously (Brown & Nell, 1991). This is the kind of injury that often occurs on the sports field.

Brain injury is often referred to as a “silent epidemic” that affects the lives of thousands of people but is seldom acknowledged. It also is not an isolated problem. One study shows that 25% of those who had sustained brain injuries had previously been professionally treated for alcohol abuse, 11% had a psychiatric history, and 31% had previous head injuries (Brown & Nell, 1991). A national South African study of the epidemiology of head injuries has not been undertaken since a study completed in 1990, which was part of a broader research project into fatal and non-fatal injuries. In this study, 697 cases of recorded GCS scores in Johannesburg were analyzed. It was found that 88% were mild (GCS 13-15), 8% were moderate (GCS 7-12) and 5% were severe (GCS 3-6). Diagnostic classification coded 89% of these cases as concussions, 7% as intracerebral haemorrhages and 2% as open head injuries (Brown & Nell, 1991). Concussions thus appear to be the most common local form of brain injury.

Internationally, the neuropsychological assessment of concussion, especially in sport, is growing. In 1997, the National Hockey League (NHL) was given the authority to test all its athletes (Barth, Macchiocchi, & Jane, 1989). A standardized battery of tests was adopted and a network of neuropsychologists was recruited throughout the United States and Canada. Baseline testing was conducted with all the NHL players before the beginning of the 1997-1998 season. Until now, the program has resulted in the baseline evaluation of over 2000 athletes, and test results have been utilized as an important component of the return-to-play decision-making process. Within South Africa only some baseline and post concussion evaluations have been conducted in some of the sporting codes, for example, rugby (Shuttleworth-Edwards, Border, Reid & Radolf, 2004). This needs to be developed further in other sporting codes like boxing, football, hockey, cricket and others. Furthermore, development at both high school and professional levels is needed. This will make it easier for the country to have its own standardized battery which can be utilized as an important component of the return-to-play decision-making process.

Prior to elaborating on local needs and factors, the next section provides an overview of concussion, its definition and presentation.

2.3 Concussion

According to Kashluba, Paniak and Blake (2004), cerebral concussion has gained increased attention in the area of sports medicine and neuropsychology. There is currently no universal agreement on the definition of concussion (Cantu, 2001; Covassin, Swanik & Sachs, 2003). Amongst others, there is considerable variation in what constitutes a concussion, confounding epidemiological studies, and evaluation and management guidelines disputes (LeClerc, Lassonde, Delaney, Lacroix, & Johnston, 2001).

2.3.1 Defining concussion

Concussion is generally considered to be a disturbance in brain functioning that occurs after either a blow to the head or as a result of the violent shaking of the head (Aubry, Cantu, Kelly & Lovell, 2002). Following concussion there is a temporary disruption of energy utilization in the brain that does not appear to produce any permanent injury in the majority of cases (McCrory & Johnston, 2002). However, research also suggests that repeated injury, particularly during the recovery period, may result in more severe and, in some rare cases, life-threatening injury (Kelly, 2001). Furthermore, concussion is a metabolic rather than a structural injury, and traditional neurodiagnostic techniques (e.g. CT scan, MRI) are usually normal following a concussive injury (Cantu, 2001). However, it should be emphasized that these neurodiagnostic techniques are invaluable in ruling out more serious difficulties (e.g. cerebral bleeding, skull fracture) that may also occur with head trauma (Aubry et al., 2002).

Concussion is often the result of trauma to the head in contact sports, but it can occur in non contact sports and activities as well, usually as a result of falls (Kelly, 2001). It can occur without a direct blow to the head if sufficient forces are applied to the brain (for example, a whiplash injury). Kelly (2001) indicates that a concussion may or may not involve a loss of consciousness. Thus, immediate consequences can range in severity from a brief feeling of being dazed to an immediate loss of consciousness.

Over 35 years ago, the committee on head injury nomenclature at the Vienna Conference of Neurological Surgeons proposed a 'consensus' definition of concussion (Aubry et al., 2002). Given that this definition had a number of limitations in its accounting for the common symptoms of concussion (Aubry et al., 2002), the second international conference, held in Prague in 2004, proposed a revised definition:

> Sports concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biochemical process. Several common features that incorporate chemical and biochemical injury include: Concussion may be caused either by direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. Concussion may result in neuropathological changes where the acute clinical symptoms largely reflect a functional disturbance rather than structural injury. Concussion results in a graded set of clinical and cognitive symptoms typically following a sequential course. Concussion is typically associated with grossly normal structural neuroimaging studies (McCrory et al., 2005, pp. 48-49).

The difference between the definition emerging from the two conferences is the observation that postconcussive symptoms "may be persistent" in certain cases (McCrory, Johnston, Aubry & Cantu, 2005)

2.3.2 Grading concussions

Traumatic brain injury (TBI) involves the effects on the brain of closed and open head injuries, bumps that are so mild that they do not leave any behavioural traces (Lezak, 1995). Authors sometimes interchangeable refer to the terms such as "mild head injury", "mild brain injury" "concussion" or "mild traumatic brain injury" (MTBI) interchangeably

(Bohnen, Jolles, & Twijnstra 1992). As indicated, concussion is a metabolic disturbance rather than a structural injury (Lovell, 2002). It represents a continuum with varying severity of injury, neuropsychological impairments, and neurobehavioural outcomes (Chen, Ratcliff, & Ganguli 2002). The condition is usually considered to be mild if the confusion and disorientation resolves within hours or days. In concussion generally the recovery process is relatively quicker than in more severe brain injuries (Lezak, 1995). There are numerous signs that a more severe injury may be present and the physician or health professional should be aware of the warning signs of a more severe injury (Chen et al., 2002). Any penetrating injury to the skull signifies a more severe head injury that should lead to immediate transportation to the hospital. Any loss of consciousness or a decline in mental status in minutes should also be evaluated in an emergency room. In addition, although a headache is common following concussion, a very severe headache that continues to increase in intensity should prompt a visit to an emergency room and consideration of a CT scan to rule out bleeding or brain swelling within two hours of the injury (Lezak, 1995). Finally, sensory or motor loss in limbs may be an indicator of spinal injury or of a subdural or epidural haematoma and should be evaluated immediately (Iverson, Lovell, & Collins, 2003b).

Despite the aforementioned definition, there is little clarity regarding grading of concussion injuries and various symptoms (Theye & Mueller, 2004). The Glasgow Coma Scale (GSC) has been used to classify MTBI according to the incidence, degree and loss of consciousness (LOC) (Hannay, Howieson, & Lezak 2004). Clinical symptoms include physical signs, cognitive impairment and loss of consciousness. In 1986, Cantu's concussion grading scheme was supported by the Congress of Neurological Surgeons (Enchemedia & Julian, 2001). Cantu defined a Grade 1 (mild) concussion as one with confusion, or a brief less than 30 minutes period of amnesia and no LOC (Bailes & Hudson, 2001), and mild concussion is most commonly seen in athletes. Grade 2 (moderate) concussion is defined as one with less than a minute period of loss of consciousness or posttraumatic amnesia with a duration between 30 minutes and 24 hours. Grade 3 (severe) concussion is one with loss of consciousness longer than 5-60 minutes or more than 24 hours posttraumatic amnesia (Bailes & Hudson, 2001). This new grading system incorporated posttraumatic amnesia to better define "transient neurological disturbance" (Cantu, 2001; Covassin, Swanik, & Sachs, 2003).

It should be noted that the American Academy of Neurology considers any loss of consciousness as a Grade 3 or severe concussion (Bailes & Hudson, 2001). Despite distinctive recovery rates, there is scientific evidence that concussion associated with loss of consciousness (LOC) represents a more severe brain injury than a concussion without LOC (Kelly, 2001). In terms of continuing symptoms, an athlete may appear to have made a complete clinical recovery, but may continue to complain of a variety of physical and emotional difficulties (Richardson, 1990). In fact, various studies (Grindel, 2001; Lovell, & Collins, 2002; Richardson, 1990; Slobounov, 2002) have shown that athletes who suffer multiple concussions may develop postconcussive syndrome (PCS). PCS is characterized by the development and persistence of various symptoms including headache, dizziness, disorientation and impaired balance, slowing of motor function, information processing, attention difficulties and memory problems. Postconcussive syndrome is fairly uncommon in most collision and contact sports, although there have been insufficient studies that have traced athletes for significant periods (McCrory & Johnston, 2002). There is ongoing debate, including disagreement regarding the permanent neurophysiological and neuropsychological effects of PCS (Slobounov, 2002). Furthermore, McCrory (2001) argues that this bringing together of symptoms indicates a global cerebral dysfunction, rather than focal injury.

Although current classification systems offer a helpful means for communication regarding concussion injury and return-to-play decisions (Echemendia & Julian, 2001), Cantu (2001) cautions that they may underplay the diverse presentation and combination of post concussive signs and symptoms. For example, Scolero, Moser and Schatz (2002) express concern that the "fleeting bell-ringing" symptom is often under reported or dismissed. Furthermore, McCrory (2001) asserts that guidelines pertaining to severity of TBI are mostly controversial and lack a valid empirical foundation.

2.3.3 Symptoms and signs of concussion

The sequelea of MTBI may be divided into two categories: (i) neurocognitive or neuropsychological deficits and (ii) postconcussive symptoms (PSC). A differentiation between neurocognitive or neuropsychological deficits and postconcussive symptoms is that neuropsychological deficits are measured objectively using psychometric testing (King, 1997), whilst postconcussive symptoms are based on an athlete's self-reports (Bohnen & Joles, 1992).

A thorough assessment of all common signs and symptoms associated with concussion should be conducted with every concussed athlete (Barth et al., 1989). Headache is the most commonly reported symptom of injury and may be seen in over 70% of athletes who sustain a concussion. There is a strong possibility of neuropsychological impairment following mild traumatic brain injury (Barth et al., 1989), including deficits in attention and concentration, memory information, processing speed, planning and cognitive flexibility (Barth et al., 1989; Erlanger, 2001; Guskiewicz, 2001).

According to Barr (2003), symptoms of concussion are subjective and most often vague. Richardson (1990) argues that an athlete may clinically appear to have made a complete clinical recovery, but may continue to complain of a variety of physical and emotional difficulties. On the other hand, it is also evident that athletes are hesitant to bring to attention minor head injuries for fear they will be removed from play (Richardson, 1990).

Although these symptoms commonly resolve after a few days, they can persist for a number of weeks, or even months following the injury (Richardson, 1990), and thus subjective reports should be carefully detailed and assessed. Headache is the most common symptom, although concussion may occur without headache. Often athletes will experience blurred or fuzzy vision, changes in peripheral vision or other visual disturbances. Memory complaints, a sense of confusion, and feeling dizzy may often persist for a longer period of time (Aubry et al., 2002).

A history of concussion seems to increase the athlete's susceptibility to the acute effects of a subsequent concussive injury (Aubry, Cantu, Kelly & Lovell, 2002). High school athletes with a history of prior concussion were more than nine times more likely than those with no prior concussion to show three or four of the field abnormal markers of injury when they experienced a subsequent concussion (Aubry et al., 2002).

Turning now to objective assessments, it is not uncommon that cognitive impairments may follow a head injury, even where the injury has been minor and does not require assessment or management (Bohnen, & Jolles, 1992). In the first few days following a minor head injury, subacute disturbance in attention, memory and informantion processing efficiency has been measured (Barth et al.,1989). Deficits in reasoning and visuospatial processing are also reported (Erlanger et al., 2003). Bohnen, and Joles (1992) report that, whereas they found no evidence of gross deficits in intelligence or memory, subtle deficits were found which appear to selectively impair attention and information processing. However, not all athletes present significant problems in all these areas (Szymanski, & Linn, 1992).

Neuropsychological deficits in memory and attention are common in the early stages of concussion. The results of a three-centre study, conducted by Ruff, Levin, and Mattis (1989), found that generally, patients who had sustained a single uncomplicated mild head injury, showed compromised memory functioning when tested within one week of injury. The athlete's memory for visual and verbal information was significantly below that of the controls. However, within one month following the injuries, this situation improved to where they were no longer significantly lower than the control group (Ruff et al., 1989).

2.3.4 Recovery from concussion

Full recovery from neurocognitive deficits following a mild head injury usually occurs within three months post-injury (Barth et al. 1989; Macchiocchi, 1996; Maroon, 2000). However, a residue of isolated neurobehavioural defects may occasionally persist for a longer duration (Levin, Mattis, & Ruff 1987). Gronwall and Wrightson (1975) reported slower neurocognitive recovery in athletes with a history of previous concussion than in patients with a single mild head injury. However, Binder (1986) and King (1997) reported that these authors did not take into account practice effects in their study which could have resulted in an underestimation of deficits.

2.3.5 Post-concussive Syndrome

Various studies have shown that athletes who suffer multiple concussions may be at risk of developing postconcussive syndrome (PCS) (Macchiocchi et al., 1996). It may appear from a clinical judgement that an athlete has made a good recovery, but the period following a mild head injury may be marked by a particular set of subjective complaints unique to the athlete (Richardson, 1990). These postconcussive symptoms often include reported difficulties in three areas (I) cognitive deficits, (ii) physical symptoms and (iii) emotional sequelae, although not all athletes with mild head injury present problems in all of the above areas (Macchiocchi et al., 1998). Other symptoms that are reported are irritability, fatigue, headaches, difficulty in concentrating; dizziness; anxiety; blurred vision; insomnia; slowed information processing; memory problems; depression (Barth et al., 1989; Binder, 1986; Bohnen, & Joles, 1992).

Gronwall and Wrightson (1975) reported that it is when symptoms persist beyond the normal period of recovery that it then be regarded as indicative of postconcussive syndrome. Richardson (1990) states that while it is normal for an athlete to suffer some postconcussive symptoms in the posttraumatic period following a closed head injury, these subside within a matter of days or, at most, weeks. Should an athlete continue to complain of postconcussive symptoms beyond the posttraumatic period this can then be referred to as postconcussive syndrome. Postconcussive syndrome, however, lacks standardisation and different authors include different symptoms under this heading (Lishman, 1988). Lishman (1988) states that while headaches and dizziness are central to most definitions; additional symptoms such as fatigue, noise intolerance, irritability, emotional instability, and insomnia may be included.

Recovery from postconcussive symptoms may be inconsistent and sometimes contradictory. Lovell et al. (2003) evaluated recovery from memory impairment and subjective self-reported symptoms following MTBI in a group of high school athletes. The control group performed at a similar level of memory function as the athletes throughout the testing process. However, significant discrepancies in memory functioning were evident between athletes with short-lived and those with more prolonged alteration of mental status, with athletes with more enduring on-field symptoms presenting with greater memory impairment postconcussion (Lovell et al., 2003). It was evident from the study that minor concussions may result in marked memory difficulties which may persist several days post-injury, with more severe injuries producing memory impairment which may last for at least seven days following the concussion (Lovell et al., 2003). It is important to note that this study showed a marked discrepancy between objective neuropsychological assessment results and subjective self-reported symptom checklists. As a result of the unreliability and inconsistency of athlete self report-scales, which are the most commonly used methods in return-to-play decisions in schools and many colleges, this study presents strong evidence for the standardization of neuropsychological evaluation for athletes, both preseason and post-injury, in order to assist with return-to-play decisions. (Lovell et al., 2003)

2.3.6 Concussion in contact sport

Cerebral concussion is the most common and pervasive injury among athletes in contact sports at professional, college, and high school levels of play (Bailes, & Hudson, 2001; Collie, Darby, & Maruff, 2001; Echmendia, & Julian, 2001). Athletes who participate in certain sports predispose themselves to multiple concussions and, therefore, possible cumulative cognitive impairment, which highlights the need for proper assessment and management of MTBI (Collie et al., 2001). In contact sports, concussion usually results from trauma to the head, although it may also occur in non-contact sports, often as a result of falls (Randolph, 2001). Acceleration and deceleration energy forces are implicated in the majority of MTBI incurred in football, ice hockey, and boxing (Bailes & Hudson, 2001). Rotational forces, such as in whiplash injuries, can cause concussion without a direct blow to the head (Randolph, 2001). Similarly, boxing head injuries may also result from a hook punch that includes a rotational component (Bailes & Hudson, 2001).

In recent years, research in the area of sport related concussion has provided the medical professions with valuable new knowledge. In the United States of America, recurrent concussions to several high-profile athletes, some of whom were forced into retirement as a result, has increased awareness among sports medicine personnel and the general public. Research and clinical practice is the key to reducing the incidence and severity of sport related concussion and to improve return-to-play decisions.

One of the key developments made by the Prague Group (McCrory et al., 2005) is the understanding that concussion may be categorized for management purposes as either simple or complex concussion. In the case of simple concussion an athlete suffers an injury that progressively resolves without complication over 7-10 days (McCrory et al., 2005). Limiting play or training while the concussion is symptomatic is recommended, and no further intervention is required during the period of recovery. No formal neuropsychological screening will be administered during this time, although a screening of the athlete’s mental state can be done. Simple concussion can be managed by a physician or by certified athletic trainers working under medical supervision.

However, athletes suffering from complex concussion present with persistent symptoms, specific sequelae of convulsions, prolonged loss of consciousness or prolonged cognitive impairment following the injury (McCrory et al., 2005). These athletes may suffer from multiple concussions over time where blows of progressively less impact result in repeated concussions. Formal neuropsychological testing and other investigations should be considered in complex concussions. Complex concussion can be managed in a multidisciplinary manner by physicians with specific expertise, doctors with experience in concussions, sport neurologists or neurosurgeons. The Prague Conference guidelines for distinguishing between simple and complex concussion are vague because they do not specify that the athlete’s history is necessary in order to judge the status of the concussion (McCroy et al., 2005). This can create associated management difficulties.

Decrease in such injuries has been attributed to a variety of factors including: rule changes, such as regulation head helmets for hockey players; player education about rule changes; implementation of equipment standards; availability of alternative assessment techniques; a marked reduction in physical contact time during practice sessions; a heightened awareness among clinicians of the dangers involved in returning an athlete to competition too early; and psycho education with regard to risks associated with concussion as a way of increasing the athlete's awareness.

Having considered various aspects of concussion, the next section will focus on neuropsychological aspect in sport.

2.4 Neuropsychological assessment in sport

Since the mid-1980s, neuropsychological assessment has taken place in the USA sporting arena (Lovell & Collins, 2002). Such assessment has also enhanced the understanding of cerebral structure and pathophysiological processes involved in MTBI and PCS (Collie & Maruff, 2003). Research in this area initially focused on boxing but expanded to cover other contact sports including American Football, Australian Rules rugby, soccer and Rugby Union (Shuttleworth-Edwards, Border, Reid & Radolf, 2004). Pioneering studies on college football players revealed the significance of neuropsychological tests in describing the severity and course of concussion-related neurocognitive dysfunction (Barth et al., 1989; Macciocchi et al., 1996). An overview of objective neuropsychological test findings from this research most frequently revealed impairments in the functions of planning, information processing and memory as a result of repetitive concussion (Iverson, Gaetz, Lovell & Collins, 2002).

In addition to such formal testing, a detailed concussion history is also important (Guskiewcz, Bruce & Cantu, 2004). Case histories will assist in identifying athletes that fit into the "complex" category outlined above. A structured concussion history should include previous symptoms of a concussion, in addition to the number of past concussions (Guskiewicz et al., 2004). In such cases, what the injury characteristics of previous concussions should be taken into account, for example, LOC, amnesia, recovery time, and time lost from participation. For athletes with multiple concussions it is important to clarify any apparent pattern of concussion occurring as a result of lighter impacts, recovery time with successive concussions and a less complete recovery with each injury (Guskiewicz et al., 2004). Documenting a history of attention disorders, learning disability, or other cognitive developmental disorders is critical, especially in interpreting an athlete's baseline and post-injury performance on neuropsychological testing. Reported concussive injuries by team mates or coaches have been demonstrated to be unreliable and thus Aubry et al. (2002) locate neuropsychological assessment as the cornerstone of MTBI evaluation.

Over the past 15 years, neuropsychological assessment for diagnostic purposes in the evaluation of concussion has developed rapidly (Lovell & Collins, 2002). However, the use of this neuropsychological assessment has developed so fast that many questions remain regarding its relevance. Concerns include:

> The sensitivity and specificity of neuropsychological testing in separating concussed from non-concussed athletes. The relationship between neuropsychological test results and other indicators of concussion, for example, clinical signs and symptoms, and neuroimaging results. The value of neuropsychological testing in predicting both acute and more chronic cognitive impairment and disability (Grindel, Lovell, & Collins, 2001, p. 140).

The first large neuropsychological study in sport was conducted by Barth et al., (1989) in the mid-1980s. The primary motive was to learn more about recovery following mild TBI. A baseline study of over 2300 college football athletes from the Ivy League and the Universities of Virginia and Pittsburgh was conducted. The study is important for it demonstrated that neuropsychological test procedures could be adapted for use with large groups of athletes. It also provides a model for evaluating changes in neuropsychological test performance from pre-injury baseline to post-injury. The approach identifies or addresses the problem of subjectivity inherent in many concussion grading and guideline scales, as well as accounting for individual, changeable pre-morbid function and recovery path. The recommendation emerging from this was for individualized return-to-play decisions, based on clinical judgement that the player is asymptomatic and on neuropsychological assessment results that reveal no cognitive deficits (Barth et al., 1989).

The second major step in the development of neuropsychological testing in sports occurred in the early 1990s, with the implications of a clinical protocol within the National Football League (NFL) in the USA (Barth et al., 1989). The diagnosis, treatment and management of sports related concussion has gained widespread attention in recent years in the fields of neuropsychology and sports medicine. This increase in interest is based on the fact that approximately 300 000 sports related MTBI occur each year in the United States of America alone (Barth et al., 1989). At high school level, approximately 62 816 sports related concussions occur yearly, with high school football players acquiring 60% of recorded concussions (Powell & Barber-Foss, 2001). Athletes with a history of concussion have been shown to have cumulative cognitive effects, as well as decreased cognitive performance relative to non-concussed and fully recovered peers, as well as athletes with a history of only one previous concussion (Collins et al., 1999; Collins, 2003; Scolero, Moser & Schatz, 2002).

2.4.1 The role of concussion management

Although few have doubted the general usefulness of neuropsychological testing as a diagnostic tool, the exact role of test results in making return-to-play decisions has been a difficult issue (Grindell, Lovell & Collins, 2001). There are several questions which need to be answered:

i) Does normal neuropsychological testing indicate normal brain functioning?

It should be stressed that findings from a comprehensive concussion programme at the University of Pittsburgh suggest concordance between neuropsychological test results and alterations in brain activity, as measured by functional magnetic resonance imaging (FMRI). The establishment of the validity of neuropsychological testing in sport cannot be doubted as the current studies have made it possible to correlate neuropsychological test results with sophisticated neuroimaging procedures such as functional magnetic resonance imaging (FMRI) (Grindel et al., 2001).

ii) Should athletes with abnormal neuropsychological test results return to play?

Research suggests that any abnormality in neuropsychological testing should be used as grounds or reasons for exclusion. The assumption must be made that abnormal neuropsychological test results indicate abnormal function and, therefore, increase the risk of re-injury and disability (Lovell, Collins, & Iverson, 2004). This approach to concussion management is supported by all the current clinical guidelines and papers in the area (Grindel et al., 2001).

Three ways of grading the concussion at the time of injury are used with regard to the return-to-play decision. The concussion at the time of the injury is graded as mild (1) moderate (2) or severe (3). Instead of delaying the final grading until all the symptoms have disappeared, attention should be rather be focused on the athlete's recovery by checking or observing symptoms, and administrating neurocognitive, and postural-stability tests (Bailes & Hudson, 2001). When a decision is taken to follow the above approach the athlete's trainer or physician should be consistent in its use, regardless of the athlete's sport, or the circumstances surrounding injury (Bailes & Hudson, 2001).

Baseline cognitive testing should be considered for athletes who play sports which carry a high risk of concussion. The time of the initial injury should be recorded and the presence or absence of signs and symptoms of injury should be documented. Vital signs and level of consciousness should be monitored until the athlete's condition improves. Monitoring of the athlete every five minutes after the concussion and observing for delayed signs and symptoms, is important (Lovell et al., 2004).

Concussion severity should be determined by paying close attention to the severity and persistence of all signs and symptoms including the presence of amnesia (retrograde and anterograde) and loss of consciousness, as well as headaches, concentration problems, dizziness, and blurred vision. It is recommended that symptom check lists be used at all times (Lovell et al., 2004).

No test should be used in isolation to determine recovery or return-to-play as concussion presents in many different ways. Once the athlete is symptom free, a thorough assessment should be done to establish that cognition and postural stability has returned to normal (Lovell & Collins, 2002).

The issue of the relationship between symptoms and neuropsychological test scores has provoked some interest, and has at times resulted in the wrong conclusion that neuropsychological testing is not sensitive to concussion (Lovell et al., 2004). It should be noted that cognitive test results and post concussive symptoms should not be expected to correlate highly in all cases, because they may represent two or more neurobehavioral processes that are so fundamentally different that they cannot be compared (Lovell & Collins, 2002).

2.4.2 Paper and pencil tests in the assessment of concussions

Traditional paper and pencil tests have proven to be useful in assessing and monitoring neurocognitive impairments and recovery from MTBI (Wotjyis, 1999). Despite their widespread use, most of these tests however lack sufficient sensitivity to detect mild or subtle deficits that exist following concussion (Grindell et al., 2001). They vary greatly with regard to their stability or reliability over time (Lovell, 2002). Practice effects can sometimes obscure true differences between test results obtained at different times within the recovery process, thus influencing interpretation (Barr, 2003; Collie, & Marruf, 2001; Lovell, 2002).

The interpretation and administration of these tests is time consuming and costly. They require a trained neuropsychologist to administer them and one individual is usually tested at a time (Collie, & Maruff, 2003). The shortage of trained personnel and time constraints in dealing with large numbers of athletes has limited the distribution of traditional paper and pencil tests (Collie & Maruff, 2003). These tests are expensive and limit their use and availability to groups, especially at the high school level. Although most professionals and college teams can afford to fund this type of project, high schools have had difficulty funding this type of venture (Collie & Maruff, 2003). This is also applicable in South Africa, where only high schools that can afford a fee have been able to gain access to these tests.

Athletes receiving postconcussion neurocognitive evaluations have typically completed traditional paper and pencil tests. Traditional neuropsychological tests require a neuropsychologist or psychometrist to administer, score, and interpret each battery (Lovell, & Collins, 2002). This is inconvenient and expensive, and baseline testing can take days and even weeks to complete. In addition, researchers have found that various paper and pencil tests do not have adequate norms or specificity and sensitivity, and are vulnerable to significant practice effects in some athletes, with test scores returning to baseline before their concussion symptoms had resolved (Collie, Darby, & Maruff, 2001; Hinton-Bayre, & Geffen, 1999; Schatz, & Zillmer, 2003).

2.4.3 Computer based neuropsychological testing in the assessment of concussion

Computer based neuropsychological testing procedures have a number of advantages and relatively few disadvantages when compared with more traditional neuropsychological testing procedures (Lovell & Collins 2002). Use of computers allows for the evaluation of large numbers of student athletes with minimal manpower. This has made research less time consuming (Maroon et al., 2000). In the current research, for example, a group of 77 high school boys were evaluated, up to eight boys simultaneously, in a single high school computer laboratory. This promoted the assessment of an entire group within a reasonable time period using minimal human resources. Data acquired through testing can be easily stored in a specific computer or computer network, and can therefore be accessed at a later date. This not only promotes the efficient clinical evaluation of the athlete, it also increases the possibilities for research (Collie, Darby, &, 2001). Computer use promotes the more accurate measurement of cognitive processes such as reaction time and information processing speed. Computerized assessment allows for the evaluation of response times that are accurate to 0,01 of 1 second, whereas traditional testing allows for accuracy to only 1 to 2 seconds (Lovell & Collins, 2004). The increased accuracy will undoubtedly increase the validity of test results in detecting subtle changes in neurocognitive processes. The use of the computer allows for the randomization of test stimuli that should help to improve reliability across multiple administration periods, minimizing the practice effects that naturally occur with multiple exposures to stimuli. Computer-based assessment also allows for the unbiased evaluation of cognitive processes by eliminating error due to scoring reliability issues. It allows for rapid dissemination of clinical information into a coherent clinical report that can be easily interpreted by the clinician (Schnirring, 2001).

Computerized neuropsychological tests have been established as psychometrically equivalent when compared with traditional paper and pencil tests. According to Lovell and Collins (2002), the advantages of computerized neuropsychological screening methods are more important than the disadvantages. There have been a number of studies conducted to establish the sensitivity of computerized tests (Lovell et al., 2004; Erlanger et al., 2003; Collins et al., 2003; Iverson et al. 2003a).

Computerized neuropsychological tests such as Immediate Postconcussion Assessment and Cognitive Testing (ImPACT), developed in the United States, and CogSport, developed in Australia, and Concussion Resolution Index (CRI, Headminder) are all concussion software products marketed to sports professionals who are responsible for management of concussed players (Schnirring, 2001).

2.4.3.1 CogSport

CogSport was developed in 1999 by CogState, a university-affiliated research institute in Melbourne, to monitor mild traumatic brain injury in professional and semi-professional Australian football clubs (Collie & Maruff, 2003). The test battery takes approximately 15-20 minutes to administer and uses playing cards as stimuli, with almost infinite equivalent alternate forms (Makdissi et al., 2001). The CogSport programme generates measures for cognitive domains of simple and complex attention, working memory, short-term memory and new learning, incidental memory, adaptive problem solving, continuous performance, and spatial abilities (Makdissi et al., 2001; Schatz & Zilmer, 2003). Results are submitted to Cogstate in Australia for scoring and assessment, with optional features including "customized reports, custom data for import into popular statistical packages, assistance in interpretation of results for publication and presentation, assistance in the preparation of research protocols or IRB submissions, storage and retrieval of data and results" (Schatz & Zillmer, 2003, p.140).

2.4.3.2 Concussion Resolution Index (CRI)

The Concussion Resolution Index (CRI) was developed by the New York-based HeadMinder Insititute. It is a web-based, computerized test battery which provides online neuropsychological assessment tools for sports professionals responsible for the management of concussion (Erlanger et al., 2001). CRI takes approximately 25 minutes to administer, and consists of a demographic, medical and concussion history questionnaire, a self-report symptom questionnaire, as well as six subtests tapping visual memory, reaction time, decision making and information processing speed (Erlanger et al., 2001; Schatz & Zillmer, 2003). The administration of the CRI takes place pre-season and at various stages after injury. This programme is currently used by professional, semi-professional, college and high school organizations in many countries (Erlanger et al., 2001). The CRI evaluates self-report symptoms after injury and monitors the resolution of these symptoms. Test results from CRI are scored on-line and the results are made available to the on-site test administrator whose responsibility it is to interpret the scores and provide feedback to the athlete.

Both CogSport and the CRI have been established as valid and reliable screening instruments in the assessment of postconcussive sequalae (Erlanger et al., 2001). The differences between the two assessment measures are: i) CRI makes use of traditional neuropsychological tests, whilst CogSport utilizes unusual stimuli in the form of playing cards; and ii) CRI includes a self-report symptom scale while CogSport focuses only on neurocognitive assessment with no symptom checklist (Makdissi et al., 2001). A disadvantage of both of these computerized testing systems is their web-based analysis which may limit in-depth analysis of scores based on demographic details, thereby restricting research possibilities.

2.4.3.3 ImPACT

Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) was designed by the University of Pittsburgh Medical Centre Sports Medicine Concussion programme to resolve some of the limitations of traditional paper and pencil tests (Lovell & Collins, 2002; Schatz & Zillmen, 2003). It was also an attempt to increase the availability of neuropsychological testing within the athletic environment (Lovell, 2004).

ImPACT consists of three main parts: demographic data, neuropsychological tests, and a Postconcussion Symptom Scale (PCSS). The three sections combine to provide data to assist in accurately assessing and managing concussive injuries. The demographic data section supplies all relevant sport, medical, and concussion history information (Lovell & Collins, 2002). The PCSS contains 22 symptoms commonly associated with concussion (Collins et al., 2003). The test battery consists of seven individual modules which cover aspects of cognitive functioning sensitive to brain injury, namely: attention span, reaction time, visual memory, working memory, verbal memory, sustained attention, selective attention and non-verbal problem solving (Maroon et al., 2000).

The battery can be administered to individuals or conducted in large groups in computer laboratories, taking around 25 minutes to complete the entire battery (Lovell & Collins, 2002). It can be administered by a non-psychologist, nurse, physician or psychometrist but it is recommended that interpretation be done by Master's and Doctoral level licensed psychologists only (Collins et al., 2003). Accurate and efficient clinical assessment of individual athletes is promoted through the computer-generated composite indices that allow isolation of particular domains of cognitive impairment (Lovell & Collins, 2002).

The initial version of ImPACT was revised to allow for a composite memory score. In 2003, an updated version of ImPACT (version 3.0) was introduced, in order to distinguish between visual and verbal memory (Iverson et al., 2003a). It is identical in administration to ImPACT 2.0 but percentile scores were added to indicate whether performance falls outside or within reliable change index (RCI) scores. That ImPACT 3.0 distinguishes between visual and verbal memory score sets it apart from CogSport and the Concussion Resolution Index (CRI) test batteries which do not assess verbal memory.

Athletes with concussion typically show performance decrements on computerized neuropsychological tests in the first few days post-injury (Erlanger, Feldman & Barth, 2001). This demonstrates the sensitivity of computerized neuropsychological testing to the acute effects of concussion. Some recent examples of the sensitivity of computerized neuropsychological testing to concussion in athletes include high school athletes with grade 1 (“ding”) concussion showing a decline in memory between one to three days post-injury (Lovell, 2004); some concussed athletes showing a clear increase in simple and choice reaction times at approximately two days post-injury with improvement to approximately six days post-injury (Erlanger et al., 2003); concussed athletes who reported headaches at one week post-injury had slower reaction times and lower memory scores than concussed athletes who did not report headaches (Collins et al., 2003); and, concussed athletes who reported perceived “fogginess” at one-week post-injury had slower reaction times, reduced processing speed, and lower memory scores than athletes who did not report fogginess (Iverson et al., 2002).

The ImPACT battery has been subjected to multiple reliability tests and has repeatedly demonstrated strong reliability and validity (Collins et al., 2003). The test-retest reliability coefficient scores for four of ImPACT’s composite scores (impulse control was excluded) are considered equivalent or better than other traditional neuropsychological tests, including the Wechsler Memory Scale III (WMSIII) (Iverson et al, 2003a). ImPACT is a stable measure with good consistency, even across multiple administrations (Lovell & Collins, 2002). One of the most important aspects of validity has to do with the ability of a test or group of tests to discriminate injured from non-injured subjects (Iverson et al., 2003a). In a study that included memory, reaction time and processing speed composites from ImPACT 1.0, Iverson et al. (2003a) found significant differences between baseline and post-injury performances in a group of high school athletes (Maroon et al., 2000).

There has, however, been limited implementation of these screening methods at high school and college level (Lovell & Collins, 2002). In the United States of America, there is a need for further development of research at the high school level as this has been slower in development, but currently it is an area of intense activity (Lovell & Collins, 2002). Data have been gathered from over 200 concussed high school athletes, all of whom were previously evaluated through baseline testing (Collins et al., 1999).

Computer-based neuropsychological research has focused predominantly upon American soccer players (Lovell & Collins, 2002). In South Africa, the assessment of Rugby Union chronic concussive sequalea using paper and pencil tests have indicated that cognitive impairment is more pronounced in rugby players than in non-contact sports players (Shuttleworth-Edwards, Kemp & Radolff, 2004). Deficits were highlighted in delayed verbal and non-verbal memory, verbal attention, information processing speed and memory. Position of play and previous cognitive difficulties were found to further contribute to postconcussive symptomatology (Shuttleworth-Edwards et al., 2004). Neuropsychological research on concussed amateur athletes using ImPACT, shows most declines being in reaction time, verbal memory and self-reported symptoms, followed by declines in visual memory and processing speed (Iverson et al., 2003a).

In the next section, cultural aspects of neuropsychological or, more generally, cognitive, assessment will be discussed. This is in order to locate ImPACT more clearly within the South African context.

2.5 Culture and neuropsychological assessment tools

It is well recognized that psychometric assessment in cross-cultural settings is innately problematic (Ardila, 1995; Nell, 1999; Manly et al., 1998; Whitefield et al., 2000). Given the role that culture plays in test-taking attitudes and learnt cognitive abilities, the challenge for the researcher is to identify those abilities that are strongly affected by socio-cultural factors, which may happen to characterize a particular ethnic group. Examples of these factors are: cultural beliefs and behaviours, ecological demands, language level and quality of education (Ardila, 1995). It is equally important to identify measures of cognitive function that are relatively culture fair in the sense that they reveal equivalence in performance regardless of socio-cultural and/or ethnic influences (Nell, 1999).

Considerable research has demonstrated that the application of cognitive tests from one ethnic group to another without appropriate standardization is highly problematic for both diagnostic and placement purposes (Ardila, 1995). Furthermore, although people may come from the same ethnic group they may not necessarily share the same socio-cultural characteristics (Shuttleworth-Jordan, 1996). In the current environment of globalization, and the rapid movement of previously disadvantaged individuals to urbanized western surroundings, socio-cultural features may vary for people within the same ethnic group (Ardila, 1995). This may result in varying cognitive test performances.

It has been found that different cultures value different skills and this influences what is learned by its members (Kline, 2002). Thus, each culture determines what is relevant and necessary to learn for their survival. In western cultures, language usage, reading ability, and the level and quality of education are some of the important socio-cultural variables that have an impact on test performance (Ardila, 1995). Also of importance is the testee's testwiseness, including the ability to respond to the test items by paying appropriate attention to them, and specific skills, such as pencil manipulation and copying (Nell, 1999). These entrenched classroom-type skills are described as "the most powerful moderator of test performance" (Nell, 1999, p.13), and hence there is a potential for substantial socio-cultural effects on cognitive test measures in both the verbal and non-verbal areas. Thus, the literature suggests that individual test performance will be affected by socio-cultural factors, which can occur in association with ethnicity. There is always a question of diversity with regard to norms, values, and customs. It is thus clear that wrong conclusions may be reached by using norms from other ethnic groups.

Research conducted by Shuttleworth-Edwards et al. (2004), investigated cross-cultural influences on WAIS-III test performance for a South African sample (age range 19-30), when the test was administered in English. A comparison done between black African first-language and white English first-language speakers indicated a significant effect due to both level and quality of education. For example, black African first language graduates with advantaged education perform better than the black African first language graduates with a disadvantaged education. The above statement serves to support the dynamics of the effect of level or quality of education through acculturation, which is the extent to which an ethnic group adopts the behaviours, language and values of the dominant culture (Edwards et al., 2004).

2.5.1 Effects of education

The quality of education in South Africa was affected by the change of government in 1948 when whites were given privileged preference at the expense of the majority of blacks (Cull, 2001). Black learners had access to the small ratio of the resources relative to those of their white counter parts (Claasen, Krynauw, Paterson & Mathe, 2001b), which had a documented harmful effect on educational achievement amongst these under privileged blacks. Since the dismantling of apartheid, the marked inequality in educationally black and white schools is taking time to remediate especially in the rural impoverished areas (Cull, 2001). Prior to 1994, schools were categorized into sections, including elite private schools, modelled on the British Public schools, Model C government schools, designed for white education, and Department of Education and Training (DET) schools, designed for black education. According to Cull (2001), white schools in South Africa were designed under the model-C system, whilst the DET schools were designed for blacks, which were exceptionally under resourced, especially for the black majority of Eastern Cape schools in the former homelands (Transkei and Ciskei). The school learning pass rate for black people from the historically black schools has always been, and remains, substantially lower than that of the historically white schools (Cull, 2001). This commonly comprises a grade 12 pass rate of less than 50% for blacks compared with pass rates approximating 100% for examinees in the top historically white schools (Cull, 2001).

However, the end of the apartheid regime was accompanied by the termination of enforced racial segregation thus increasing the numbers of black individuals gaining access to better quality education within the former white schools (Cull, 2001). This allows for a comparison to be made between black and white individuals with advantaged education, and between black individuals with advantage education and those with a disadvantaged education who have continued to attend the historically black schools. The current study compares Xhosa-speaking males from a semi-rural population who have relatively advantaged Model C education, with males from the United States of a similar age.

2.5.2 Effects of language

In a comprehensive review of existing concerns in mainstream South African cross-cultural assessment, Retief (1988) concludes that despite its historically racist origins, considerable progress has been made in eradicating regional obstacles to the practice of fair cross-cultural psychometric assessment. More recent research has shown that the most significant factors in cross-cultural assessment are language, exposure or familiarity with testing situations and content or cultural bias (Geinsinger, 1994; Helms-Lorenz & Van de Vijver, 1995). Research by Shuttleworth-Jordan (1996) provides evidence that there are language limitations in the use of neuropsychological tests. Language conveys different meanings for different ethnic groups. For example, different ethnic groups might use the same word but the meaning or interpretation might be different in their respective cultures.

2.6 Statement of intent

To conclude, all normative studies need to take the factors of education and language into consideration in their research designs. Although ImPACT is used extensively, especially in sport, for concussion assessment across a wide variety of settings in South Africa, there are currently few available South African norms for the third version. There is, therefore, a need for studies that aim to establish norms for particular South African populations for this programme. The current project thus focuses on Xhosa-speaking males in the age range 13-18. Both English proficiency and level of education were considered. It thus hopes to make available a relevant normative database for this specific population group.

Furthermore, the study aims to, within limits, determine whether and how norms for this population differ from the existing ImPACT 3.0 United States norms for a similar age group and gender group. Since it will be administered in English, to a population with significant exposure to the use of this language, it also aims to identify and address any administrative and linguistic difficulties that are experienced by individuals during completion of the battery.

The question may now be answered as to why effort should be made in the generation of normative data for a concussion assessment tool in the current assessment context of South Africa. It is evident that sport related concussion has specific short-term effects and potential long-term effects (McCrory et al., 2005). It is also clear that neuropsychological testing has a role to play in the evaluation and management of players who suffer from such injuries (Mueller, & Collins, 2002). Athletic participation is a daily activity for many youths, adolescents, and young adults, especially in South Africa, and this places them at risk of sport related concussion. Multiple sports related concussions have been shown to result in impaired neurocognitive functioning post-injury, and decreased performance on baseline testing, and have placed the athlete at risk for more severe causes of concussion, such as loss of consciousness, amnesia, and confusion (Collins et al., 1999).

Neuropsychological baseline assessment paradigms facilitate the detection and management of mild neurocognitive change in athletes who have sustained a concussion, and a computerized assessment of sport-related concussion offers unique advantages to the athlete, athletic trainer, team physician, and consulting neuropsychologist (Lovell & Collins, 2002). It is also evident that the ImPACT test battery is both a sensitive and specific instrument for the assessment of the neurocognitive and neurobehavioural sequalea of concussion. In addition, ImPACT is clearly a reliable and validated tool for the assessment and management of concussion (Iverson et al., 2003a). It provides post-injury cognitive and symptom data that can assist a practitioner in making safer return-to-play decisions (Iverson et al., 2003a).

The next chapter will discuss the research design and methodology used in this study. Ethical considerations will also be briefly discussed.

Chapter 3

Methodology

3.1 Introduction

This study aims to establish norms for semi-rural Xhosa-speaking schoolboys in the age range 14-18, for the ImPACT 3.0 programme as administered in English. In addition, the aim is to determine whether norms for this population are different from the existing ImPACT 3.0 United States norms for boys of a similar age. Finally, any administrative and linguistic difficulties that are experienced by individuals during completion of the battery will be described .

Here, the following topics will be discussed: The research participants, the measuring instruments used, and data collection procedures. Data analysis will then be discussed followed by ethical considerations which are the most crucial issues when collecting information for research.

3.2 Research Participants

The sample consists of South African Xhosa-speaking schoolboys from a semi-rural Model C school in the Eastern Cape. Model C schools are the previously white government schools that, since the dismantling of apartheid, have been opened to all races. Approximately 116 Xhosa-speaking non-concussed individuals from Grades 8, 10 and 12, age range 14-18, were selected. A list of all the boys from Grades 8, 10 and 12 who are Xhosa-speaking was sent to the researcher by the school secretary for selection. The selection criteria were based on age (14, 16, or 18) and language (Xhosa-speaking) There were 60 Xhosa-speaking Grade 8 boys aged 14 in total. Due to the large number of Grade 8 boys, a random selection was made by selecting every third boy in the class list, who met the criteria for the research. There were 32 Grade 10 boys in the age group of 16, and 24 Grade 12 boys in the age group of 18 who met the age and language research requirements. Due to the low numbers, there was no need to do a random selection process for Grades 10 and 12. The researcher ideally would have liked to target around 40 learners per grade. However, this was not possible due to the limited number of boys in grades 10 and 12 who met the research criteria. The scope of this preliminary norming project did not warrant targeting other schools, to make up for the numbers. Consequently a total of 77 boys were assessed: Grade 8, n = 39; Grade 10, n= 32; Grade 12, n = 24. All the boys included in the study were assessed between September and November 2005.

Participants were excluded on the basis of the following criteria: having suffered two concussions or more, the presence of a neurological disorder, and the diagnosis and continued treatment of psychiatric and related disorders, including substance abuse, learning disorders and ADHD. From Grade 8, two boys were excluded from the study due to one having a concussion history and another a history of substance abuse. From Grade 10, one boy was excluded due to incomplete data, and one Grade 12 boy was excluded due to his concussion history. In addition, three boys were excluded after statistical analysis due to outlying scores of 3 standard deviations or more from the mean (verbal memory, n = 1; impulse control, n = 1 and symptom score, n = 1). Table 3.1 (page 34) illustrates this process. The final sample consisted of N = 70 boys.

Table 3.1 Selection of Sample

Grade	Total number prior to sampling	Total number post random sampling	Total number tested	Total number after pre-statistical exclusion	Total number post statistical exclusion
8	60	39	39	37 n=1:>2 Concussions n=1: Substance abuse	36
10	32	32	20 n=12: Failed to arrive for testing	19 n=1: Incomplete Data	18
12	24	24	18 n=6: Failed to arrive for testing	17 n=1: > 2 Concussions	16
Totals	116	95	77	73	70 (n =3: outliers excluded) (n =1: Verbal Memory) (n =1: Impulse Control) (n =1: Symptom Score)

3.3 Measuring Instruments

Two forms of assessment and a demographic questionnaire were completed in this study. The ImPACT 3.0 programme and an English language test comprised the tests. As discussed in chapter 2, ImPACT is a computer-based neuropsychological screening programme which includes a demographic questionnaire and a symptom checklist. The demographic questionnaire consists of a combination of identity document number (ID), date of birth, first and last names, height and weight, gender, handedness, and concussion history. Computer-based testing allows for simultaneous assessment of a number of athletes at the same time (Lovell, 2002), and can be administered by a trained clinical psychologist, athletic trainers or physician (Iverson, Lovell, & Collins, 2003a).

The test battery consists of seven individual modules that evaluate neurocognitive functions vulnerable to mild traumatic brain injury (MTBI). ImPACT converts these modules into five composite scores: Verbal Memory (made up of a word recognition test, a symbol-number matching task, and a letter memory task), Visual Memory (consisting of an abstract figure memory task and a task requiring the identification of highlighted Xs and Os), Processing Speed (representing the weighted average of three tasks that are done as interference tasks for the memory paradigms), Reaction Time (the average response time on a choice and the symbol matching task), and Impulse Control (Xs and Os and a colour matching task) (Iverson, Lovell, & Collins, 2005). The instructions are clear and uncomplicated which means that the English-speaking test-takers should have no difficulty in understanding what is expected of them (Iverson et al., 2003a). However, given that the test instructions are in American English, some additional difficulties may occur given that the participants are Xhosa first-language speakers.

The ImPACT symptom checklist consists of 22 commonly experienced symptoms which are graded in a continuum (0-6) (Iverson et al., 2003a). The ImPACT clinical report is generated by the computer and provides a summary of relevant biographical information and details pertaining to the athlete's medical and psychiatric history. ImPACT 3.0 consists of a graphic representation of the athlete's performance across various cognitive domains and ensures comparison of performance at different testing intervals (Iverson et al., 2003a). In addition, ImPACT presents the neuropsychological test performance on each of the six composite scores. This is reflected as the correct percentage for the athlete's performance within the associated age related percentile (Iverson et al., 2003a).

The ImPACT battery has been subjected to multiple reliability tests and has repeatedly demonstrated strong reliability and validity (Iverson et al., 2003a). The Impulse Control composite score is still undergoing reliability and validation testing (Iverson, et al., 2003b). ImPACT is a stable measure with good consistency, even across multiple administrations (Lovell, & Collins, 2002).

The second instrument used was a test to gauge English language competence. The research participants completed a questionnaire used by the Human Science Research Council during the development of the standardization of the WAIS III (Claasen, Krynauw, Peterson, & Mathe, 2001b). No norms were offered by the HSRC and, consequently, participants were excluded in the present study if their scores on this test fell 3 or more standard deviations below the mean for the group.

3.4 Data Collection

A letter of application (see Appendix A) for permission to conduct research at a semi-rural, Model C school was sent to the principal. Upon approval, a consent form (see Appendix B) was sent to the principal prior to testing. The testing sessions were facilitated by the researcher in the school computer laboratory. Care was taken to ensure that the testing environment was comfortable. Space was created between the computers that were used for testing, and there was good lighting and minimal distractions such as a high noise levels or interruptions. Each participant was first given the information and consent form (see Appendix C), which was explained to him by the researcher. Once any questions had been answered, and approval given, the participants were required to fill in a demographic questionnaire (see Appendix D) that was developed as part of the research. Consenting participants were asked to complete an English questionnaire (see Appendix E) to gauge their English language competence, and the ImPACT 3.0 programme was then completed. Participants were tested in groups, with a maximum of eight learners in a group.

The questionnaire was completed by each participant and provided demographic information including identifying data, such as first name, surname, school, grade and contact details. Background information was also required, including age, date of birth, height and weight, handedness, country of birth, first and second languages, years spent speaking the second language, level of education, sporting history, and sports played. The medical history included treatment by a speech therapist, occupational therapist or psychiatrist, attendance of special or remedial classes, history of repeated grades, any current diagnosis of a learning disability, ADHD, or substance abuse, and whether there had been any prior admission to a psychiatric hospital.

As indicated in the previous section, English language competence was gauged by using a questionnaire used during the development of the WAIS III by the Human Science Research Council (Claasen et al., 2001b). Any indicated difficulties were noted and addressed. At the end of the session, a debriefing questionnaire (see Appendix F) was distributed as a method of gathering information with regard to the individual experience of the testing session.

3.5 Data Analysis

The scoring is computer generated yielding five composite scores to be used in the overall data analysis. The subtest scores were generated by the ImPACT 3.0 programme. The demographic information and the results were coded and entered into a spreadsheet.

The data were subjected to descriptive analyses, the mean scores and standard deviations for each subtest per grade being determined. The outliers were identified, those with three standard deviations (SD) or more from the mean were removed from the sample. Levene's test for Homogeneity of Variances was used to determine the degree of normal distribution for all indices. Data from the ImPACT 3.0 subtests and English test (except the symptom score) met the assumption of normality of distribution and homogeneity of variances required for parametric tests, so an analysis of variance (ANOVA) was completed to determine if there were significant differences between the group means, followed by post hoc tests. Pearson's correlations were consequently determined for all these subtests.

For the symptom score, the distribution values failed to meet the assumptions of normality. Consequently, these results were investigated using non-parametric statistics (K-W-Kruskal-Wallis), chi-Square and Spearman's rho).

Finally, United States percentile scores were descriptively compared with the South African sample, to determine whether norms for this population were different from the existing ImPACT 3.0 United States norms for boys of a similar age. Formal statistical comparisons between the two sets of normative data were not possible, in that the raw data from the USA which was requested did not arrive in sufficient time to allow for these analyses.

3.6 Ethical Considerations

Psychological testing calls for the highest degree of care from the evaluating psychologist (Smaling, 1992). He suggests that a psychologist should be familiar with the issues to be addressed by the evaluations, and be aware of any medical or psychiatric history of the examinee. A psychologist should be able to justify the choice of the battery of tests for the specific issue being addressed, be able to demonstrate that the test is relevant, and be familiar with the reliability and validity of the tests used.

In the current study consent was requested in writing from the principal and permission was granted telephonically for the research to be conducted at the school's laboratory. The purpose of the study, the data sought, the use that would be made of the scores, as well as assurances of anonymity were indicated on the letter of request and consent form which was signed by the examinee prior to testing. The test results are kept in a safe locked place and only the intern clinical psychologist and her two supervisors have access to the test protocols.

The next chapter will report the results in the form of tables and brief explanations.

Chapter 4

Results

4.1 Introduction

This chapter presents the results of the study, which aims to develop norms for semi-rural Xhosa-speaking boys with an advantaged education.

The descriptive means and standard deviations are shown in Table 4.1. The outliers were identified and those testees with three standard deviations (SD) or more were removed from the sample. Levene's test for homogeneity of variances was used to determine the degree of normal distribution for all the tests and the results are shown in Table 4.2. Verbal Memory, Visual Memory, Visual Motor Speed, Reaction Time and Impulse Control followed a normal distribution and these results are shown in Table 4.5. An Analysis of Variance (ANOVA) was completed for all tests, except the symptom checklist scores, and the results are shown in Table 4.3. Following this Scheffe's Post Hoc tests were completed (Table 4.4) for tests showing significant variation. Pearson correlations were then completed, the results are shown in Table 4.5, followed by non-parametric tests: the Kruskal-Wallis (K-W), (Table 4.6), Chi-square (Table 4.7) and Spearman's rho (Table 4.8) for the symptom checklist scores. Tables 4.9 and 4.10 compare United States percentile scores with those of the South African sample.

Finally, a qualitative analysis is provided. This analysis includes whether they reported difficulties with regard to the tests and self-reports, which tests were reported as having instructions which were difficult to follow or to perform, and whether there were any distractions during testing.

4.2. Means, standard deviations and ranges

In Table 4.1 (p 41), the means, standard deviations and ranges (minimum and maximum) of the English language test and six subtests from ImPACT 3.0 are presented.

The English language, Visual Motor Speed, and Reaction Time show a trend of improvement through Grades 8, 10 and 12, and the symptom score shows a trend of worsening across Grades 8, 9 and 12. The Verbal Memory, Visual Memory and Impulse Control subtests mean scores do not show any consistent upward or downward trends amongst the grades.

Relatively large standard deviations are noted for the Grade 12s in comparison to other grades on the Visual Motor Speed, Reaction Time and Impulse Control, whilst the Grade 8s showed a relatively small standard deviation compared to the other two grades on the Symptom Score measure.

4.3 Parametric statistics

In Table 4.2 (p. 42), Levene's test for homogeneity was completed for the English test, Verbal Memory, Visual Memory, Visual Motor Speed (VMS), Reaction Time and Impulse Control. This indicated acceptable distribution for parametric testing with scores less than the F-score of 3.12 ($p = 0.05$). However, the symptom test score exceeds this score, and thus failed to show acceptable normality, hence non-parametric test procedures were used for this variable.

Table 4.1 Descriptive statistics

Test	Grade	N	Mean	SD	Minimum	Maximum
English Language	8	36	21.17	4.17	14	30
	10	19	23.32	4.05	15	30
	12	15	26.07	3.57	19	32
	Total	70	22.80	4.41	14	32
Verbal Memory	8	36	81.53	9.22	49	99
	10	19	79.58	11.07	54	99
	12	15	82.27	10.72	65	99
	Total	70	81.16	9.97	49	99
Visual Memory	8	36	64.83	14.19	23	91
	10	19	71.89	17.63	31	95
	12	15	68.47	17.61	38	91
	Total	70	67.53	15.98	23	95
VMS	8	36	24.48	5.81	14.98	37.43
	10	19	26.76	6.50	13.88	38.35
	12	15	28.96	9.39	9.68	41.20
	Total	70	26.06	7.02	9.68	41.20
Reaction Time	8	36	0.66	0.13	0.32	0.95
	10	19	0.62	0.07	0.49	0.79
	12	15	0.61	0.99	0.52	0.92
	Total	70	0.64	0.11	0.32	0.92
Impulse Control	8	36	33.78	29.66	2	124
	10	19	21.26	21.16	5	86
	12	15	30.80	41.08	1	117
	Total	70	29.74	30.56	1	124
Symptom Score	8	36	11.42	9.15	0	31
	10	19	18.16	16.66	0	61
	12	15	19.87	15.02	0	45
	Total	70	15.06	13.24	0	61

Table 4.2 Test for homogeneity of variances

	Levene Statistic	df1	df2
English Score	0.384	2	67
Verbal Memory	0.591	2	67
Visual Memory	0.777	2	67
Visual Motor Memory	2.030	2	67
Reaction Time	2.231	2	67
Impulse Control	2.870	2	67
Symptom Score	**4.749**	**2**	**67**

Table 4.3 Analysis of variance

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
English Language	Between Groups	261.61	2	130.581	8.056.	0.001
	Within Groups	1086.039	67	16.210	--------	-------
	Total	1347.200	69	---------	--------	-------
Verbal Memory	Between Groups	70.734	2	35.367	0.349	0.707
	Within Groups	6796.537	67	101.441	-------	------
	Total	6867.271	69	44.764	-------	------
Visual Memory	Between Groups	636.920	2	253.739	------	------
	Within Groups	17000.523	67	---------	1.400	------
	Total	17637.443	69	---------	-------	------
Visual Motor Speed	Between Groups	224.731	2	112.365	2.367	0.102
	Within Groups	3180.250	67	47.466	-------	------
	Total	3404.981	69	--------	-------	------
Reaction Time	Between Groups	0.32	2	0.016	1.215	0.303
	Within Groups	0.884	67	0.013	-------	------
	Total	0.916	69	-------	-------	------
Impulse Control	Between groups	1969.065	2	984.532	1.056	0.354
	Within Groups	62484.306	67	932.602	-------	-------
	Total	64453.371	69	---------	-------	-------
Symptom Score	Between Groups	1006.762	2	503.381	3.039	0.055
	Within Groups	11097.010	67	165.627	-------	-------
	Total	12103.771	69	---------	-------	-------
Age	Between Groups	178.800	2	89.400	0.00	0.00
	Within groups	0.000	67	0.000	0.00	0.00
	Total	178.800	69	--------	0.00	0.00

In Table 4.3 the analysis of variance indicated a significant difference between the groups only for the English proficiency test.

Table 4.4: Scheffe Post Hoc Tests

Dependent Variable	(I)	(J) Grade	Mean Difference (I-J)	Std. Error	Sig.
English language	8	10	-2.149	1.142	0.178
		12	**-4.900**	1.237	0.001
	10	8	2.149	1.142	0.178
		12	-2.751	1.391	0.149
	12	8	**4.900**	1.237	0.001
		10	2.751	1.391	0.149

Table 4.3 reveals a highly significant effect for English Language across groups (p = 0.001). There were no other significant results, with the VMS and Symptom Scores being closest to significance (p = 0.01 and p = 0.055, respectively). The significant Scheffe results for the English Language score analyses are shown in Table 4.4. Post Hoc comparison tests were completed for the English Language scores between Grades 8, 10, and 12 respectively. Completed results show a significant difference in the English test performance between Grade 8 and Grade 12. The mean difference of -4.900 between Grade 8 and 12 is in the direction of negative performance for Grade 8. The mean difference of 4.900 between grade 12 and 8 is in the direction of positive performance for Grade 12. The results of the statistical analyses reveal a significant difference in language proficiency between Grade 8 and Grade 12 in the direction of poorer performance for Grade 8 for this sample. This suggests that English proficiency improves with age and grade for this population. The results approaching significance are also appear to reflect differences between Grades 8 and 12, with Grade 8s tending to perform worse than Grade 12s on VMS, and for Grade 12s to have a higher symptom score than than Grade 8s.

Pearson (parametric) and Spearman's rho (non-parametric) tests were both completed. The size of the correlation coefficient ranges between –1 and +1, where –1 indicates a perfectly linear negative relationship, 0 shows no relationship, and +1 indicates a perfectly linear positive relationship. The English Language, Verbal Memory, Visual Memory, VMS, Reaction Time and Impulse Control were shown to have acceptable distribution, hence parametric test procedures were used for these indices. However, the symptom score failed the test of normality, hence a non-parametric test procedure (Spearman's rho) was used for this variable.

Only correlations significant at 0.01 and 0.05 levels were considered. In Table 4.5, substantial relationships (0.4 - 0.7) were indicated for age and English Language, Verbal Memory and Visual Memory, Verbal Memory and Visual Motor Speed, and Visual Motor Speed and Impulse Control. Thus, increased English proficiency is suggested with increased age, whilst good Visual Memory scores are often accompanied with similarly good Verbal Memory scores. Furthermore, accuracy in processing speed correlates with increased Verbal Memory scores. Finally, acting fast and inaccurately (poor impulse control) correlates negatively with good speed and accuracy (processing speed).

Table 4.5 Pearson Correlations

		Age	English	Verbal Memory	Visual Memory	VMS	Reaction Time	Impulse Control
Age		1	**0.439(**)**	0.066	0.125	**0.257(*)**	-0.173	-0.076
		0.000	0.000	0.961	0.302	0.032	0.151	0.530
	N	70	70	70	70	70	70	70
English Score		**0.439(**)**	1	0.097	0.229	0.173	-0.079	-0.225
		0.000		0.424	0.057	0.152	0.516	0.061
	N	70	70	70	70	70	70	70
Verbal Memory		0.006	0.097	1	**0.519(**)**	**0.499(**)**	0.027	-0.227
		0.961	0.424		0.000	0.000	0.823	0.059
	N	70	70	70	70	70	70	70
Visual Memory		0.125	0.229	**0.519(**)**	1	**0.457(**)**	-0.187	**-0.284(*)**
		0.302	0.057	0.000		0.000	0.121	0.017
	N	70	70	70	70	70	70	70
VMS		**0.257(*)**	0.173	**0.499(**)**	**0.457(**)**	1	**-0.362(**)**	**0.530(**)**
		0.032	0.152	0.000	0.000		0.002	0.000
	N	70	70	70	70	70	70	70
Reaction Time		-0.173	-0.079	0.027	-0.187	**-0.362(**)**	1	-0.108
		0.151	0.516	0.823	0.121	0.002		0.373
	N	70	70	70	70	70	70	70
Impulse Control		-0.076	-0.225	-0.227	**-0.284(*)**	**-0.530(**)**	-0.108	1
		0.530	0.061	0.059	0.017	0.000	0.373	
	N	70	70	70	70	70	70	70

**Correlation is significant at p = 0.01 and *p = 0.05

Small relationships (0.2 - 0.4) were indicated for age and Visual Motor Speed, Visual Memory and Impulse Control, Visual Motor Speed and Reaction Time. This suggests that processing speed improves with an increase in age. Visual Memory and Impulse Control suggests that increased impulsiveness negatively correlates with performance on the visual memory tasks. Finally, good VMS and Reaction Time scores tend to occur together.

4.4 Non-parametric tests

Non-parametric test procedures were used to further examine the reported symptoms scores across the three groups.

Table 4.6 Kruskal-Wallis Tests

Test	Grade	N	Mean Rank
Symptom score	8	36	31.21
	10	19	38.34
	12	15	42.20
	Total	70	-------

Table 4.7 Spearman's rho Correlation

Symptom Score	Age	English Score	Verbal Memory	Visual Memory	VMS	Reaction Time	Impuls e Control	Symptom Score
	0.228	-0.038	-0.138	-0.046	-0.078	-0.035	0.053	1.000
	0.057	.755	0.255	0.707	0.523	0.772	0.664	0.000
N	70	70	70	70	70	70	70	70

Because the symptom score failed to assume a normal distribution, the non-parametric procedure was used. No significant differences or correlations were indicated between the Symptom score and the other variables.

4.5 Comparison of South Africa and United State of America norms

Means and standard deviations for the USA sample were unavailable at the time this study was completed, therefore percentiles are descriptively compared in the following section.

Table 4.9 show percentile scores for the four subtests from the ImPACT 3.0 programme, comparing South African Xhosa-speaking boys for the age group 14 with United States boys for the age group 13-15. Interpretation should proceed with caution, as the age used for the South African sample (14), is not equivalent to the wider United States of American sample age range (13-15).

Xhosa-speaking boys in this age range consistently score lower than the USA sample. This is especially pronounced for the Visual Memory and VMS percentiles with differences of 10 points or more appearing consistently. Large Reaction Time differences are also noted for most of the percentile rankings. Differences are less pronounced for the Verbal Memory scores with a difference of only one point between boys scoring at the 99th percentile.

Table 4.10 shows scores for the four subtests from the ImPACT 3.0 programme, comparing South African Xhosa-speaking boys for the age group 16 and 18 with United States boys for the age group 16-18. Again, comparisons should proceed with caution. South African boys consistently score lower than United Sates boys. The Visual Memory differences here are less pronounced than with the younger boys, though the VMS differences are consistently close to 10 points or more, reaching peaks for the lower percentiles (15.77 and 14.59). Reaction Time differences are pronounced for the mid-range percentiles. Differences are minimal (1 point) at the 99th percentile for both the Visual and Verbal Memory indices.

Table 4.8 Comparison: SA males' age group 14 and USA males' age group 13-15

Country	Percentile	Verbal Memory	Difference	Visual memory	Difference	VMS	Difference	Reaction Time *	Difference
SA	5	64.30	5.70	36.60	18.6	15.87	6.48	0.47	0.00
USA		70.00		55.20		22.35		0.47	
SA	15	72.00	4	50.00	15	17.44	9.95	0.52	0.20
USA		76.00		65.00		27.39		0.50	
SA	25	77.25	2.75	54.50	14.50	19.10	11.13	0.57	0.40
USA		80.00		69.00		30.23		0.53	
SA	35	79.00	3	59.95	12.05	22.50	9.43	0.60	0.50
USA		82.00		72.00		31.93		0.55	
SA	45	81.65	3.35	66.00	8.8	23.24	10.23	0.64	0.80
USA		85.00		74.80		33.47		0.56	
SA	55	84.35	3.65	67.70	11.3	24.81	9.72	0.67	0.10
USA		88.00		79.00		34.53		0.57	
SA	65	85.05	4.95	71.05	10.95	27.16	8.77	0.68	0.90
USA		90.00		82.00		35.93		0.59	
SA	75	87.00	6	74.00	12	29.33	8.45	0.74	0.14
USA		93.00		86.00		37.78		0.60	
SA	85	90.00	4	79.00	12	30.69	10	0.83	0.20
USA		96.00		91.00		40.69		0.63	
SA	99	99.00	1	91.00	7.16	37.43	15.12	0.95	0.26
USA		100.00		98.16		52.55		0.69	

*** Increasing score indicates slower reaction time and thus poorer performance**

Table 4.9 Comparison SA males' age group 16 & 18 and USA males' age group 16-18

Country	Percentiles	Verbal Memory	Difference	Visual Memory	Difference	VMS	Difference	Reaction Time *	Difference
SA	5	62.25	8.75	36.25	16.75	11.83	15.77	0.51	0.10
USA		71.00		53.00		27.60		0.45	
SA	15	67.25	5.75	47.00	19	17.21	14.59	0.55	0.13
USA		76.00		66.00		31.80		0.48	
SA	25	74.50	5.25	58.25	11.75	24.24	9.45	0.55	0.14
USA		79.75		70.00		33.69		0.49	
SA	35	77.00	6.00	69.25	5.75	25.98	9.53	0.58	0.70
USA		83.00		75.00		35.51		0.51	
SA	45	80.75	4.25	72.50	5.5	28.44	8.66	0.59	0.70
USA		85.00		78.00		37.10		0.52	
SA	55	83.00	4.00	75.00	6	29.40	9.33	0.61	0.60
USA		87.00		81.00		38.73		0.55	
SA	65	84.75	6.25	77.50	6.50	30.66	9.47	0.62	0.60
USA		91.00		84.00		40.13		0.56	
S.A	75	88.00	3.75	83.25	5.75	32.78	9.8	0.65	0.70
USA		92.25		89.00		42.58		0.58	
S.A	85	93.75	2.75	89.75	2.25	35.29	10.32	0.71	0.90
USA		96.00		92.00		45.61		0.62	
S.A	95	99.00	1	95.00	1	40.30	9.91	0.82	0.13
USA		100.00		96.00		50.21		0.69	

- **Increasing score indicates slower reaction time and thus poorer performance**

4.6. Experiential reports

It was necessary to document the boys' reports with regard to the testing session, hence the distribution of a debriefing questionnaire as discussed in chapter 3. The questionnaire assisted with evaluation of difficulties experienced with regard to the test, attitudes towards the examination, and whether there were any distractions during testing. In general, all the boys approached the testing session with a positive attitude and co-operated well during the administration of tests. No anxiety was noted during testing. Care was taken to ensure that the testing environment was comfortable. Space was created between the computers that were used for testing and there was good lighting and minimal distractions, such as high noise level or interruptions. The school's computer laboratory is situated away from the rest of the school buildings and 'do not disturb' and 'testing in progress' signs were posted outside the door to minimize any disturbances.

Out of the total sample, 60% of the boys reported that the Visual Memory task, which required the identification of highlighted Xs and Os (that assesses attention, concentration and working memory), was difficult and that they had difficulty in following the instructions. Results on the Visual Motor Speed subtest indicated a generally poor performance compared to the United States of American sample suggesting that the reported lack of understanding may have had an negative impact.

Out of the total sample, 80% of the boys reported that they had suffered from most of the symptoms listed in the demographic questionnaire of the ImPACT 3.0 battery. Many boys did not understand the graded continuum (0-6), and most boys requested clarification regarding this during the early part of the session prior to the testing session. After the completion of the test the researcher had to follow up with regard to reported symptoms because 50% of boys reported admission to psychiatric hospital. On enquiry it was found they meant the general hospital to which they had been admitted for minor illnesses like chicken pox. 40% reported that they had been diagnosed with a learning disability, or had received occupational therapy or attended remedial classes. On enquiry it was discovered that they thought extra

English or mathematics classes meant that they suffered from a learning disability. It was noted in all the grades that were assessed.

The next chapter will discuss the results, possible implications; limitations of the study; and possible future studies.

Chapter 5

Discussion

5.1 Summary

The purpose of this research was to develop norms for Xhosa-speaking schoolboys from a semi-rural population, within the age range 14-18, for the ImPACT 3.0 programme as administered in English. A further intention was to compare the norms for this population to the existing ImPACT 3.0 United States norms for a similar age and gender group. Finally, any administrative and linguistic difficulties that were experienced by individuals during completion of the test battery would be noted. In this chapter the findings will be discussed, implications and limitations of the current study will be identified, and recommendations for future studies will be outlined.

5.2 Synopsis and implications

Findings of the English language test indicated a significant difference between age groups for this sample. Substantial differences were indicated by the Analysis of Variance and the Scheffe Post-Hoc test indicated a significant difference between the Grade 8 and 12 boys for English proficiency. This indicates the need to use the grade specific norms for this test when testing boys from a similar background. Furthermore, boys scoring three standard deviations beyond or below this proficiency test should not be compared in terms of their ImPACT scores to these norms. It is therefore important to use an English proficiency test in addition to the ImPACT battery. No other significant differences were shown in all the other subtests therefore it would appear that the total normative scores could be used across these age and grade groups, although grade specific norms are provided. However, given the small numbers in the sample, it would probably still be better to use the grade specific norms, in that small numbers may have led to significant differences being missed when in fact there are differences (Type II error), that would have become evident with larger samples especially in the Grade 10 and Grade 12 groups. In particular caution should be applied to age differences between Grades 8 and 12 for the two tests approaching significance, being Visual Motor Speed and Symptom Scores.

Only correlations significant at 0.01 and 0.05 levels were considered. Substantial relationships were indicated for age and English language proficiency; Verbal Memory and Visual Memory; Verbal Memory and Visual Motor Speed; and Visual Motor Speed and Impulse Control. Increase in age suggests an increase in English proficiency; good Visual Memory is associated with good Verbal Memory. Accuracy in Processing Speed correlates with increased Verbal Memory performance, whereas increased impulsivity correlates negatively with Visual Motor Speed.

Small relationships were indicated for age and Visual Motor Speed; Visual Memory and Impulse Control and Visual Motor Speed and Reaction Time. This suggests that processing speed improves with increasing age, that impulsiveness is not associated with good Visual Memory performance and that good reaction times are associated with good Visual Motor Speed ability.

A comparison of the United States of America and South African norms for this gender and age group indicates that relevant South African norms should be used for this local population. South African boys generally scored lower than USA boys. There are some points of minimal and maximal differences. The maximum differences are seen between for the Visual Memory, Visual Motor Speed and Reaction Time indices. This may in part be attributed to the increased computer exposure of USA boys and speed being a USA cultural norm. This can also be attributed to a differential quality of education as already outlined in chapters 1 and 2. Furthermore, the struggle to comprehend the Visual Memory instructions reported by the majority of the boys may have had a negative impact on performance on these tasks. The comparison is, however, limited by the small size of the SA sample, the absence of more rigorous comparison due to the unavailability of means and standard deviations for the USA sample, and the comparison of specific age 14, 16 and 18 year age groups for the South African sample to 13-15 and 16-18 age ranges for the United States of America sample.

Finally, given the tendency to misunderstand the symptom report section, it is recommended that the symptoms reported by boys from this population should be followed up and clarified with them verbally after the testing session. The absence of a normal distribution for this index, and the large standard deviations found for this sample, indicates that symptom scores for this population should be treated with extreme caution.

5.3 Limitations of the current study

The sample size was small in this study due to the limited availability of participants. The sample was however carefully controlled with respect to age, grade, gender and Xhosa as a first language. The age and language groups were restricted to 14, 16 and 18 years olds. There were relatively few Xhosa-speaking boys aged 16 and 18 in the specific grades and this resulted in a small sample used for assessment. However, the numbers can be considered sufficient to have provided useful normative indications that can be used clinically with more relevance on this population than the USA norms. Small sample numbers may have been responsible for the failure to find significant differences for the cognitive composite scores between grades, and therefore it would still be advisable to use the scores provided for different grades rather than the total scores for all grades.

Various practical problems were encountered during data collection. Only two computers were set up for the administration of the testing on the first day and there were generally fewer computers in working order than expected. Permission to administer the test was granted on condition that the end of the year examination was given priority. As the administration was done during September and November there was a high rate of absenteeism. However, despite such practical limitations and delays, those tested were able to complete the battery without technical difficulties or interruption.

The use of computers and computer literacy are limited for this population and there are few semi-rural schools with computer laboratories. This restricted the study to a minority of children who had the advantage of attending advantaged schools. This implies that these norms should only be used with boys with substantial secondary school computer exposure.

Other limitations in the current study are that, although a standardized questionnaire was used to collect the information, concussion history and symptom score data were self-reported. It appeared that the majority of boys maximized their self-report of symptoms, as some boys reported admission to a psychiatric hospital although on enquiry they meant the general hospital. Some reported that they had been diagnosed with a learning disorder, had received occupational therapy or attended remedial classes. On enquiry it was discovered that they thought extra English or mathematics classes meant that they suffered from a learning disorder, therefore it is important to be cautious when interpreting this symptom scale.

The current study compared 14, 16 and 18 year-old South African Xhosa-speaking boys to United States norms using boys in the age ranges of 13-15 and 16-18. Interpretations based on the descriptive percentile comparisons should be made with caution, since no United States of American means and standard deviations could be obtained and therefore a more rigorous comparison was not possible.

Finally, due to the restricted scope of this thesis, these normative indications are limited to Xhosa-speaking boys in a semi-rural environment, and may be lower than would be evidenced for Xhosa-speaking boys attending a Model C or English medium private school in an urban environment. It is conceivable that, in contrast to the results of the present study, normative indications for more sophisticated, urbanized Xhosa-speaking boys at urban Model C or private schools, may not differ from the USA norms.

5.4 Future studies

There is a need for replication of this study, with larger samples, across all ages 13 to 18, allowing more effective comparison to USA norms. Furthermore, normative indications should be investigated on Xhosa-speaking learners at advantaged schools in an urban area, as these may differ from the current normative indications for a semi-rural population.

It is recommended that the ImPACT 3.0 programme be translated into the Xhosa language because, as Shuttleworth-Jordan (1996) indicates, language is part of culture and there are language limitations in the use of neuropsychological tests. It appears from the current study that language might have restricted better performance especially in the younger group.

5.5 Conclusion

The results of this study indicate that there is a need for the further development and use of more appropriate South African normative data for semi-rural Xhosa-speaking boys for the ImPACT 3.0 programme. The lower South African percentile scores indicate that the uncritical use of United States of America norms for South African populations is problematic. Various reasons (cultural, educational, experiential) may be responsible for this variation, which requires further investigation.

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APPENDIX A

Application Letter

PROVINCE OF THE EASTERN CAPE

DEPARTMENT OF HEALTH **ISEBE LEZEMPILO**

FORT ENGLAND HOSPITAL
Private Bag / Engxowa Eyodwa X1002
Grahamstown
6140

Enquiries/Imibuzo: Thandi Godlo
Phone: 046-6227003 Ext 260

Date: 04-March-2005
Fax No. 046-6227630

The Principal
Queens Boys College
Queenstown

Dear Sir

Re: Application for Permission to conduct a Master's Research Project on Normative Data

I am a registered Clinical Psychology student with Rhodes University and currently an Intern Psychologist at Fort England Hospital. I kindly request your permission to conduct a Master's research project involving the collection of normative data on the ImPACT (concussion package) in your school. ImPACT is a computer administered neuropsychological screening battery that monitors cognitive recovery following a concussion to assist with scholastic recommendations and return-to-play decisions. My objective is to collect normative data for the ImPACT test on around 30 Xhosa-speaking non-concussed individuals from Grades 8, 10 and 12. A prerequisite for the research is that these learners must be computer literate. I shall be supervised by Professor Ann Edwards and Mr Clifford Van Ommen, who are both neuropsychologists from Rhodes University.

The benefits of this research will be to facilitate the development of the ImPACT programme for Xhosa-speaking school athletes who are at risk for sports-related concussive injury. Several top schools in the country are participating in the ImPACT programme. However, your school will be the first project with the crucial aim of making ImPACT available to our Xhosa-speaking athletes. If any of the research participants are concussed during the 2005 season, we will be prepared to assist in their post-concussion management using ImPACT.

Kindly find an attached copy of the ImPACT concussion information pamphlet.

I am originally from Queenstown and I would find it particularly rewarding to involve a school from my local area to participate in the research. I hope that my request will receive your favourable consideration.

Thandi Godlo	***Professor Ann Edwards***
Intern Psychologist	***Director:***
	National Sports Concussion Initiative (NSCI)

APPENDIX B

Principal Consent Form

RHODES UNIVERSITY
DEPARTMENT OF PSYCHOLOGY

THE PRINCIPAL CONSENT FORM

I,___________________________________, principal of_______________________, have been informed of the nature of the research which will be conducted by Noluthando Salman Godlo, an intern psychologist and registered Rhodes University masters student, to establish normative data on male Xhosa-speaking highschool learners using the ImPACT 3.0 programme.

I understand that:

1. The above-mentioned student is conducting research to establish normative data on male Xhosa-speaking high school learners as a requirement for a MSc (Clinical Psychology) degree at Rhodes University.

2. The research will involve non-concussed highschool learners from Grades 8, 10, and 12, age range 13-19. Testing will take place at the school laboratory. Learners will be assessed using the internationally validated ImPACT 3.0 computer programme. They will be requested to fill out a brief demographic questionare including a medical background questionare and a symptom checklist.

3. Participation in the research is strictly voluntary and the principal will act on behalf of the parents in giving consent.

4. Should any of the assessed learners suffer a concussion during 2005, a follow up assessment will take place within 36 hours of injury and then again at weekly intervals until symptoms have subsided to such an extent as to allow return to play.

   This study does not, however, interfere with or substitute for good medical practice. It is therefore advised that all schoolboys with concussion should be seen as soon as possible by their general practitioner or other medical practitioners and should not return to contact sport for at least 3 weeks from the time of injury and thereafter only on the advice of the medical practitioner.

5. The data collected on individual schoolboys will be treated as strictly confidential and will only be available to the medical practitioner on request. This information may form part of a management decision in individual cases. However, the researcher will not be held accountable

6. for management or medical decisions made by medical practitioners, sports coaches, sports administrators or other relevant parties on the basis of that information.

6. Data arising out of this project will be used only for thesis and publication purposes by the collaborating university.

I hereby give consent for those learners who will be participating in this research project to be assessed by the abovementioned researcher.

SIGNED: __________________________ **DATE: _______________**

APPENDIX E

Learner Consent Form

GENERAL INFORMATION FOR LEARNERS AND LEARNER CONSENT FORM

Please take note of the following information, which will be read to you and explained by the tester.

I am a researcher conducting research on normative data as a requirement for a MSc (Clinical Psychology) degree at Rhodes University.

1. What I am doing here today is obtaining basic information which will assist the school coach and doctors manage a concussion should any of you suffer a concussion whilst playing sport during the year 2005. This is the latest way that sports concussion is being managed in other parts of the world (e.g. United States of America and Australia).

2. I am going to ask questions and ask you to complete a number of small tasks. Two sessions are required for this. Both assessment times will not take longer than a 50-minute period.

3. The information I collect today, and on computers at the next meeting, will be anonymous. Should any of you suffer a concussion during 2005, a follow up assessment will take place within 36 hours of injury and then again at weekly intervals until your symptoms have subsided to such an extent as to allow you to return to play. The researcher only acts in an advisory capacity and does not take responsibility for the final decision about return to play.

4. The information I collect will also be used for research purposes, where your identity will not be of any importance and will not be made known.

5. It is very important to do your best, and to be as accurate and honest as possible when you answer the questions. If at the end of the computer session you believe you have not been able to do your best for any reason, please indicate this at the space provided at the end of the programme. Reasons might be because you have a headache, are worrying about something else, or have felt distracted because there was a noise in the corridor, and so on.

6. Please ask if there is anything that you do not understand or are unhappy about If you are happy to go ahead, please sign the consent paragraph that follows below.

I,____, understand the nature of the research project as specified above. I understand that participation in the research is strictly voluntary and that I have the right to withdraw from the study at any stage.

SIGNED: ___________________________ **DATE:_____________________**

APPENDIX D

Demographic Questionnaire

STRICTLY CONFIDENTIAL

INFORMATION QUESTIONNAIRE

A. IDENTIFYING DATA

1. **First Name:** ________________________________
2. **Surname:** ________________________________
3. **School:** ________________________________
4. **Grade:** ________________________________
5. **Contact No.:** ________________________________

B. BACKGROUND INFORMATION

1. **Age:** _______________________________
2. **Date of Birth:** _______________________________
3. **Height:** _______________________________
4. **Weight:** __________________________
5. **Right Handed:____ Left Handed:___ (Tick one)**
6. **Country of Birth:** _________________
7. **First Language:**_________________
8. **Second Language:**_______________
9. **Years Speaking Second Language:**______________

10. Please indicate YES or NO on the line if you have ever experienced or attended any of the following:

10.1 ____ Speech therapy

10.2 ____ Special or remedial classes

10.3 ____ Occupational therapy

10.4 ____ Repeated any grades at school. If so which?_______________

10.5 ____ Diagnosed with Attention Deficit or Hyperactivity Disorder by a doctor or a psychologist?

10.6 ____ Diagnosed with a Learning Disability?

10.7 ____ Have you abused substances including alcohol?

____ Treated by a psychiatrist?

____ Been admitted to a psychiatric ward or hospital?

11. Name all the sports in which you currently participate?__________________

12. What is your position in each team sport?_____________________________

13. What teams were you in last year?___________________________________

14. How many years have played at this level (not including this year)?_______

15. How many times have you been diagnosed with a concussion?_____________

16. If you have sustained a concussion please complete the following:

	Date of concussion (Approximately e.g. 2000)	**Reason for Concussion** (e.g. playing rugby, motor vehicle accident, falling off a ladder or a tree, stick fighting etc.)
1.		
2.		
3.		
4.		
5.		
6.		

17. From the list above indicate the total number of concussions that resulted in loss of consciousness.

____

18. Indicate the total number of concussions that resulted in confusion.

____

19. Indicate the total number of concussions that resulted in difficulty with memory for events occurring immediately before and after the injury.____

20. Indicate the total number of concussion that resulted in difficulty with memory for events occurring immediately before the injury.____

APPENDIX E

English Language Test

ENGLISH TEST

SURNAME……………………………INITIALS…………DATE…………..

SECTION A

Read the following paragraphs and then circle the number next to the most appropriate word that can be used to complete each sentence:

Example: the principal at Lebohang high School urged his pupils to come to school……… Time

1. **at**
2. **on**
3. **to**
4. **by**

PARAGRAPH:I

The police said the escaped convicted was still……………

1. **in**
2. **at**
3. **by**
4. **to**

Large. But that they hoped to get the gang…………………

1. **to**
2. **after**
3. **behind**
4. **in**

bars before the end of the week. They warned however that the convict was dangerous and would go…………………

1. **to**
2. **in**
3. **from**
4. **at**

any length to avoid being caught. Apparently the prisoner got out by stretching himself out…………..

1. **to**
2. **in**
3. **from**
4. **at**

full length and this reaching the top of the wall. Was then able to hoist himself……

1. **across**
2. **over**
3. **from**
4. **before**

the wall. The other prisoners were………..

1. **in**
2. **out**
3. **with**
4. **by**

on his plans and held

1. **at**
2. **off**
3. **with**
4. **in**

the guards until he was well………..

1. **on**
2. **off**
3. **under**
4. **beyond**

his way. The officer………….

1. **at**
2. **on**
3. **in**
4. **with**

charge promised to look…………… the matter.

1. **at**
2. **about**
3. **into**
4. **for**

PARAGRAPH:II

The old man wanted to set…………….

1. **by**
2. **down**
3. **aside**
4. **for**

an amount of money for a rainy day or perhaps put it…………

1. **towards**
2. **for**
3. **at**
4. **about**

a new car. He and his wife were………

1. **to**
2. **out**
3. **in**
4. **of**

one mind abut this but then they were led………..

1. **by**
2. **through**
3. **with**
4. **along**

their noses by an unscrupulous salesman who talked to them……

1. **into**
2. **over**
3. **from**
4. **to**

buying his car which was more expensive than they could afford. When they realised what they had let themselves…………….

1. **at**
2. **out of**
3. **about**
4. **in for**

they confronted the salesman but he was immediately……………

1. **upon**
2. **up in**
3. **out of**
4. **at**

arms and told them that they had already entered………..

1. **under**
2. **with**
3. **by**
4. **into**

a contract and must abide…………..

1. **through**
2. **with**
3. **by**
4. **in**

its stipulations. The couple decided to take the salesman……….court.

1. **to**
2. **at**
3. **in**
4. **on**

APPENDIX F

Debriefing Questionnaire

DEBRIEFING QUESTIOINNARE

Name: ______________________

Surname: ____________________

1. Were there any destructions in or outside the room during testing?

if Yes, when and how severe?_____________________________

What duration?____

2. Did you experience problems with your computer or computer mouse?
3. Were the instructions clear and easy to understand?

____

if not, which ones?____

4. did you experience difficulties in answering particular or specific Questions?

If so, which ones?____

5. Did you experience any stress shortly before the test?

How long before?____

Day ?____

6. Did you give your best while performing the task?____________________

If No How come?____

7. Did you find any problems with the time limit?______________________
If Yes, What were the problems?____________________________________