A research report

entitled

Exploring neurocognitive sequelae following mild traumatic brain injury and the effects that it has on school readiness.

by

Ashné Courtney Billings

Student Number: 678548

submitted to the Faculty of Humanities as a partial fulfilment of the requirements for the Master of Arts (Social and Psychological Research) degree in the field of Research, University of the Witwatersrand, Johannesburg, <16 August 2018>.

Through sub-classification supervisor: Enid Schutte

Abstract

Literature reveals controversial issues surrounding Mild Traumatic Brain Injury (Mi-TBI) and the possible latent effects that follow and whether it impacts on the cognitive profile required for effective scholastic performance. Mi-TBI Test and Neurotypical contrast participants, aged 6-10 years, were recruited from Chris Hani Baragwanath Academic Hospital (CHBAH). The Aptitudes Test for School Beginners (ASB) was used to elicit participant's cognitive profile. Across the cognitive profile, the performances delivered by the combined Mi-TBI sample were weaker than that delivered by the neurotypical comparison group, specifically on memory and verbal comprehension subtests. Further interrogation of the realized data was attempted through sub-classification of Mi-TBI participants who were dependent on whether or not CT scans were conducted and what the results of those were. However, results of this interrogation proved to be inconclusive. Other analysis such as correlation and regression tests reveal that age, grade and grade repetition were significantly correlated to the cognitive profile for school readiness, while only grade and preschool attendance significantly predicted the cognitive profile for school readiness. Furthermore research is needed in this field to validate these results and add to the body of literature.

Key words: Mild Traumatic Brain Injury, School readiness, Chris Hani Baragwanath Academic Hospital, Neurotypical contrast group

.

Declaration

I declare that this research project is my own, unaided work. It has not been submitted before for any other degree or examination at this or any other university.

Ashné Billings 15-03-2018

A.c. Billings

Dedication

In dedication to my late grandfather, Alfred Dennis Cook, who always believed in my aspirations, continuously motivated me and took pride in my hard work. May your lovely soul rest in peace.

Finally this report is dedicated to my daughter, Giovanna Billings, who had become a reason for whom to do my best.

Acknowledgements

I would like to use this platform to thank the following people:

- Foremost this research would not have been possible if not for Jesus Christ who graced me with life and strength to carry through.
- Secondly, I would like to thank my Supervisor, Enid Schutte, for timeously sitting up with me in the morning hours, attempting to edit and correct my work, as well as offering invaluable research critiques in order to improve my work. I have indeed learnt a lot from her wisdom.
- I too would like to thank this study's principal researcher, Dr. Vered Lack, for taking me under her wing and facilitating the research process, making available a multidisciplinary team to help where needed. Additional thanks to Professor Jerome Lovemore and the Department of Paediatric Surgery at the CHBAH for paying for, hosting and allowing use of patient data.
- A special thanks to the research administrator, Mr. Samuel Moeketsi, who willingly helped to recruit and screen participants needed for this study.
- I would also like to thank the study sample, who agreed to participate in this study and faithfully commit to the prearranged testing times, arrive on time and enthusiastically completed the psychometric test. Additional thanks to their parents, who brought the participants to CHBAH and patiently waited for the testing to be complete before they left.
- Lastly, I would like to thank my friends and family for the countless and invaluable support and exhortation in times where I thought I could not make it through.

Table of Contents

List of Tables

List of Figures

Chapter One: Introduction

The present study aimed to explore the neurocognitive effects that mild traumatic brain injury (Mi-TBI) may have on scholastic ability and the cognitive profile needed for school readiness. To date, no thorough investigation with respect to the impact of mild traumatic brain injuries sustained by participants admitted to Chris Hani Baragwanath Academic Hospital (CHBAH) has been undertaken and the possible impact of Mi-TBI on school-readiness is unknown. Much controversy exists in the literature relative to the published literature, with researchers such as Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001; Belanger et al., 2004; Catale, Marique, Closset, & Meulemans, 2009; Eisenberg, Meehan,&Mannix, 2014; Van Zyl, 2011; Wrightson, McGinn, &Gronwall, 1995) evidencing latent effects following Mi-TBI whilst others contradict this and evidence no, or inconsequential effects following Mi-TBI (Babikian et al., 2011; Cassidy et al., 2004; Emery et al., 2016; Gronwall & Wrightson, 1974; Rees, 2003; Schretlen & Shapiro, 2003). Moreover, there is insufficient evidence that Mi-TBI effects scholastic ability and furthermore the cognitive profile needed for school readiness.

CHBAH, situated in Soweto, Johannesburg, is one of the main tertiary level teaching hospitals. As the largest medical facility in the country, CHBAH not only serves the community in which it is located but is also the referral center for other medical facilities in the broader cluster. The Department of Paedatric Surgery admits and cares for approximately 1200 trauma related cases per year. About 50% of these cases involve Traumatic Brain Injuries (TBI). The vast majority of TBIs is mild and discharged within 24 hours with no apparent residual effect. A multidisciplinary team in a dedicated “Head Injury Clinic” follow up only more serious TBIs (moderate- severe), leaving Mi-TBIs without further consultation (Lack, 2016). This study aimed to explore the latter, questioning whether in-fact the Mi-TBI patients should, or should not be involved in the hospital follow-up.

South Africa is populated by unique demographics that might induce uniquely differential brain architecture and plasticity as this might have implications for the effects of Mi-TBI, if any do exist. It becomes important to investigate the possible differential impact that trauma might have within this society as this impact is unknown. Latent effects, if any, could have an impact on cognitive function, with effects lasting into scholastic years. Such knowledge has implications for multiple spheres, such as the health sector, political sector (schooling policies), psychometric domains as well as research.

Rationale

Due to the number of demographic variables (i.e. Language, Socioeconomic status(SES) etc.) that are specific to this group of young South Africans, it is possible that the combination of demographic variables unique to this population may impact on neurodevelopment and cyto-architecture rendering the applicability of the international literature less than appropriate for the population. Given the pressures of high patient load and limited facility in many areas of the country, it is important that best practice be driven by appropriate knowledge, respond to issues found to pertaining to Mi-TBI in a South African context and extend their practice towards transformation in a society with limited resources. This study aims to contribute to this knowledge base and explore the applicability of the published research through an examination of the cognitive profile that supports scholastic performance in a cohort of CHBAH patients who have sustained Mi-TBI and a comparison group of neurotypical representatives of the same population group. The presence of clinical or sub-clinical sequelae might potentially impact on the individual's ability to cope with the demands of formal education. This study becomes relevant because it is not known whether sequelae have prevailed since the time they were discharged. No thorough investigation has been conducted on this subject on participants admitted to CHBAH and the possible impact of Mi-TBI on school-readiness on this sample is unknown.

Chapter Two: Literature Review

Mild Traumatic Brain Injury

Traumatic Brain Injuries (TBIs) are resultant from an acute insult to the brain from an external mechanical source which may produce structural or functional physiological pathology/ies (Silver, McAllister, & Yudofsky, 2011; Management of Concussion/mTBI Working Group, 2009). TBIs exist on a continuum of injury varying from mild to severe (Silver et al., 2011).

A vast majority of the literature equates Mi-TBIs with the term "Concussion". However, they do not share the same definition (Hamilton & Keller, 2010). The term "Concussion" suggests a specific event of an injury that might or might not have lasting symptoms and also the idea that there could be possible positive recovery (Ponsford et al., 2002; Suhr &Gunstad, 2002). However, according to Hamilton and Keller (2010), the term Mi-TBI implies greater impact of the injury and concludes that the two terms cannot be equated on the grounds that concussions often result in functional disturbances and not structural disturbance as seen in many Mi-TBIs. Concussions should be a subtype of Mi-TBI and not equated to it.

Gordon (2006) describes that it is much more difficult to outline pediatric diagnostic criteria as opposed to that for adults. Gordon (2006) doubts the validity of any criteria delineating pediatric Mi-TBI as the injury occurs to an undeveloped brain. The writer thus prefers to define Mi-TBI or the misnomer, "*Concussion*", according to the abridged American Academy of Neurological definition, "*a trauma induced alteration in mental status*" (p. 246). Hamilton and Keller (2010) state that most diagnosis prominently focuses on the Glasgow coma scale and the components thereof, in addition to, but secondarily focus on other criteria for diagnosis. While research by Gordon (2006) and Hamilton and Keller (2010) may emphasize different criteria, generally the diagnosis of Mi-TBI is made according to the most frequently employed diagnostic criteria. This consists of:

> "*1. any period of loss of consciousness;*
>
> *2. any loss of memory for events immediately before or after the accident;*

> *3. any alteration in mental state at the time of the accident (eg, feeling dazed, disoriented, or confused); and*
>
> *4. focal neurological deficit(s) that may or may not be transient; but where the severity of the injury does not exceed the following:*
>
> *loss of consciousness of approximately 30 minutes or less;*
> *after 30 minutes, an initial Glasgow Coma Scale (GCS) of 13–15;*
> *and posttraumatic amnesia (PTA) not greater than 24 hours."(*Head, 1993, p.86).

Additionally on this continuum are moderate TBIs (Mo-TBIs) to severe TBI (STBIs) and they are unanimously agreed upon to be defined as brain injuries with increasing periods of loss of consciousness and posttraumatic amnesia and extended recovery periods, as well as greater neurological sequelae (i.e, psychological, behavioural and cognitive) (Babikian et al., 2011; Wrightson et al., 1995). On the continuum of injuries, Mi-TBIs meeting the above criteria are further classified into 2 groups (Hamilton & Keller, 2010). These groups consist of Mi-TBI with positive and those with negative CT scans. The Mi-TBI positive CT scans would show alterations to the brain or skull such as bleeding, swelling or fractures and the negative CT scans would show no alterations to the brain or skull. Those with negative CT scans, reveal to have less severe injuries compared to those with positive CT Scans (Hamilton & Keller, 2010). While different scans show differences in the injuries between positive and negative scans, McCauley, Boake, Levin, Contant and Song (2001) suggest that there is no difference between positive and negative scanned groups with regard to the post-concussional effects that they may display. Hofman, Verhey, Wilmink, Rozendaal and Jolles (2002) agree with McCauley et al. (2001) in that positive CT scanned groups are not predictive of worse outcomes than participants with different scans (i.e. Negative scans). CT brain imaging can detect differences in the types of Mi-TBI, however is not sensitive enough to detect small differences in the central nervous system. It thus cannot dictate anything pertaining to the long-term effects of Mi-TBI (Farrer, 2010).McAllister, Sparling, Flashman, and Saykin (2001) suggest that functional imaging is better at detecting "*pathophysiology, symptom genesis, and mechanisms of recovery*" (p. 775)post-injury and thus might be of better use than CT imaging is. In this study, irrespective of the type of CT scans, none of the two groups were followed up on; at most those with positive CT scans are reviewed by neurosurgeons and treated with antiepileptics for approximately a month with no additional therapy (Lack, 2016). This study thus aimed to explore whether differences exist between sub-ordinate Mi-TBI groups and whether long term effects exist within the Mi-TBI group. This will have implications of the health sector.

Research emanating from both American (Bazarian et al., 2005; Meehan &Mannix, 2010) and African (Adesunkanmi, Oginni, Oyelami, & Badru, 2000; Udoh & Adeyemo, 2013) studies suggests an increase in the prevalence of Mi-TBI across the spectrum of societies. In South Africa, Mi-TBI being the most frequently reported traumatic incident (Lack, 2016).

As previously stated, when comparing Mi-TBI to non-TBI injured controls evidence suggests that, in children and adolescents, no or inconsequential cognitive, behavioural, and/or psychological/psychiatric problems persist beyond the acute and sub-acute period following a Mi-TBI (Emery et al., 2016). However, contrary to this, research has found that there are significant latent effects that persist beyond the acute and sub-acute period following a Mi-TBI (Anderson et al., 2001; Belanger et al., 2004; Catale et al., 2009; Wrightson et al., 1995; Van Zyl, 2011, Eisenberg et al., 2014).

Functional sequelae following mild traumatic brain injury.

While researchers such as Maillard-Wermelinger et al. (2009) and Babikian et al. (2011) say that Mi-TBIs do not adversely impact on scholastic ability, others such as Wrightson et al. (1995), Van Zyl (2011), Anderson et al. (2001) and Catale et al. (2009) and most recently Prasad, Swank, & Ewing-Cobbs (2017) dispute this finding. Anderson and Colleagues (2001) specifically explored the long term effects of Mi-TBI and found deficits in children aged 3-7 when studied longitudinally. Deficits that were present 6 months post-injury were still existent 30 months post-injury. These results and results alike were claimed to be inconclusive by many researchers who were on the opposite end of the argument, however Anderson et al. (2001) proved for these results to be significant. These cognitive deficits include shortfalls in intellectual ability, everyday memory and spatial memory and receptive language. Anderson et al. (2001) also found that children with Mi-TBI had deficits specifically related to story recall and verbal fluency and were not recovering overtime. Previous work done by Wrightson et al. (1995) as well as a recent work done by Prasad et al. (2017) demonstrates that latent effects follow a few years after the Mi-TBI, possibly delaying their milestones and affecting how school ready they are. Prasad et al. (2017)

revealed that approximately 10 years post-injury children with Mi-TBIhad delayed scholastic milestones, which include abilities such as counting, reading, writing etc. and increasingly made use of school service use (remedial classes, smaller classes with additional instruction etc). Konrad et al. (2011) are in consensus with the authors mentioned above, in that Mi-TBI does indeed impact on cognitive functionality and profile. They found that participants who had sustained a Mi-TBI 6 years earlier revealed significant impairment on all cognitive domains, including attention, working memory, learning, recall and executive function. This study done by Konrad et al. (2011) summates all work mentioned previously and most importantly aligns with in.

Structural sequelae following mild traumatic brain injury.

Most studies assess the acute effects of Mi-TBI and when the long term effects are studied, the focus is on the functional effect of Mi-TBI. The conception that there might be long-term neurological/ structural effects associated with Mi-TBI is neglected. A study done by Iverson, Gaetz, Lovell and Collins, 2004) show that most athletes return to normal cognitive functioning after at least 3 months after the brain injury however have revealed a significant amount of data that shows that a Mi-TBI not only infers the risk of additional Mi-TBIs but also future brain deficits. The research discussed previously by Vanderploeg, Curtiss, Luis and Salazar (2007) also speaks to not only functional deficits as a result of Mi-TBI but also structural deficits. Vanderploeg and Colleagues (2007) have identified that those Mi-TBI injured participants had neurological deficits which include peripheral visual imperceptions and poor tandem gait. The authors mentioned above evidence that cognitive functions are not the only deficits but that there are structural impairments that result from a Mi-TBI as well.

The conation of individuals with mild traumatic brain injuries.

Reitan and Wolfson (2000b) did a follow up study on brain injured and control participants, in which they focused on conation in the event of it linking and predicting the relationship between the constructs of cognitive ability and performance capabilities. According to these authors, conation is one’s ability to apply oneself productively or industriously to a task or instruction until reaching the completion thereof. Results revealed that brain injured participants had a lower sense of Conation than did the control participants. This means that participants with brain injury (irrespective of the variation in the injury) might potentially have the cognitive abilities needed for the task or instruction, however might not possess the ability to carry the task or instruction to completion and if they do it is in a languid manner. This then influences these injured participants performance capabilities. Work done by Vanderploeg, Curtiss and Belanger (2005) concur with the work done by Reitan and Wolfson (2000b), as participants in their study had displayed a lower rate in continuation to complete attention tasks.

The error in findings.

Farrer (2010) suggest that the above (whether positive or negative) results could potentially be as a result of the neuropsychological testing and the error margins that these tests attract. Reitan and Wolfson (2000a) agrees with Farrer (2010), indicating that the neuropsychological test used in their study has shown that Mi-TBI and more severe traumatic injured participants had scored similarly on the Halstead-Reitan Battery which measures Neuropsychological deficit. These results indicate that there is no significant difference between the injuries on the TBI spectrum and suggest that other tests, that can detect broad range deficits, should be used to investigate this difference. Vanderploeg et al. (2005) also found long-term deficits resulting from a MiTBI in their study. Long-term deficits were primarily associated with s*ubtle* aspects of attention and working memory but found no significant neuropsychological differences across groups. Farrer (2010) reveals that tests such the one done by Vanderploeg et al. (2005) fail to report that most tests done by participants with Mi-TBI were incomplete due to low conation and analysis was done on tests of those who had completed. This resulted in their conclusion of no significant difference across groups; however this result was based on incorrect reports of their study analysis. As pointed out by Geary, Kraus, Pliskin and Little (2010), it becomes pivotal to be weary of results that are found as it could be because of the effects of the specific tests used and also the Vanderploeg et al. (2005) study revealed that sometimes incorrect conclusions it might be drawn as a result of test evaluations. This might be the reason for the inconsistencies and controversies within literature (Farrer, 2010).

Cognitive Optimization

Literature shows that neurodevelopment is in direct correlation with age. That means that as age increases so does the child’s neurodevelopment (Knezevic, Kostovic, Wisniewski, & Spilich, 2012). Literature also shows that at the school-going age, this is when there is an increase of cognitive capacity in order to equip the child for school. The sample in this study is significant because the age that school readiness begins at is concurrently the age at which cognitive optimization occurs.

According to Epstein (1974), phrenoblysis is a phenomenon defined by physical growth spurts that correlate with qualitative improvement in cognitive ability. There is a consensus within literature that the critical periods in which spurts occur are within age bands, 6-8, 10-12 and 14-17 years. The sample age in the current study is pertinent to the critical periods and is the reason for the 6-10 years age of inclusion in this study instead of limiting the samples age to the age of school readiness (6-7 years). This study uses the Aptitudes test for School Readiness (ASB) as a measure that elicits the cognitive profile of the samples age and uses that cognitive profile to compare across contrast groups.

Neurodevelopment is not the most robust development process; there are factors affect it. Research shows evidence of it. These include bilingualism (Bialystok, Craik, & Luk, 2012), social class (i.e. employment status, poverty and nutrition etc.)(Halle et al., 2009), family structure (i.e. Parent-child relationships), peer relationships, stress (Kolb & Gibb, 2011), stimulation (Australian Early Childhood Mental Health Institute, 2014), age, general health, intelligence and previous head injuries (Binder, 1986). Most of these factors directly affect participants in this study. Neurodevelopment is directly linked to performance, as poor neurodevelopment can highly impacts on a child’s performance. Research done by Vohr and Coll (1985), show that children with low birth-weight children did not achieve the IQ level that their normal counterparts had achieved as these physiological defects had consequences for their neurological performance. Additionally, they had poorer Visio-Motor integration and reading ability for their age, which caused them to require special education. The study done by Vohr and Coll (1985) reveals how poor neurodevelopment can potentially affect performance. Other variables that affect both neurodevelopment and performance are revealed in the study done by Mezzacappa (2004). He presented findings in which alert, orientation and executive function of urban children was investigated. Results show that older children from a high SES performed better on speed and accuracy, while younger children from high SES respond better to alerting cues. Here, it is clear that gender, SES and age affects how children develop and how they perform cognitively.

Many studies explore the effect of the environment on academic performance. Most of this literature speaks to the notion that the home environment indeed plays a bigger role on academic performance than does the school environment. Another factor that affects a child's neurodevelopment is the child's parental involvement. The more involved the parent is in the child's school life, the better the child performs academically. However, these results became non-significant when low SES was added to the study as a covariate. This indicates that no matter how involved a parent is in the child's life, if the home environment is not as stimulating and enriching, it might just affect how effective the parental involvement is on the child's academic performance (Jeynes, 2005). In the study by Jeynes (2005), low SES is particularly a dictating factor in this sample hence parental involvement, if any, might have differing effects on the child's academic performance. Additionally factors such as family attitudes, parental schooled cognitions, parenting behaviours, parent's experiences and academic socialization all influences the child's neurodevelopment and academic performance (Taylor, Clayton, & Rowley, 2004). A child's school environment or preschool environment too is a factor that determines a child's neurodevelopment and thus their academic performance. Macneil, Prater and Busch (2009) compared 3 types of schools, recognized, acceptable and exemplary type schools and found that schools with healthier environments (Exemplary schools) produce better academic performance. Research also shows that preschools with a Family and Child Education programmes, in which families are involved in their child's education, influences their child's academic performance more than preschools who do not have this programme active (Nugent, Kunz, Sheridan, Glover & Knoche, 2016).

Neurodevelopment occurs continually from the prenatal, postnatal, preschool and onwards. Before birth, whilst still in the mother womb, the child brain had begun to develop. When the child enters his/her home environment, they receive continual stimulation from their surroundings and that increases brain development. As mention previously, the amount of stimulation received, determines the amount of brain development the child acquires. The age at which a child starts preschool is when a certain level of brain development had occurred and cognitive abilities should have developed. According to the Australian Early Childhood Mental Health Institute (2014), at the age of 4/5 years a well-developed child would have increasing development of the brain's language areas and the sophistication thereof. Other areas developed are the interconnection of the language areas to other areas, increasing integration of sensory and motor abilities that orchestrate fine motor skills, management of emotions, and increasing skills associated with reasoning and understanding of complexity. These developmental skills are relevant because these are the skills needed before schooling and school readiness can occur and are considered to developmental milestones for a child of this age group. However, this might or might not be the case for a child with Mi-TBI.

Norms Relative to Schooling

Some norms relating to schooling apparent in South Africa are relatively pre-apartheid, however since then very much has changed. These evolving societal practices (i.e. schooling policies, nutrition, social grants, SES, etc.) indirectly affect a child's neurodevelopment. All of the above is relevant in a country such as South Africa as they can translate to the specific vulnerability of this population that is not present in the international literature.

The ASB is a relatively old measure and although the norms of school readiness were revised post –apartheid, many of the norms have further evolved since then. This study aimed to see if the norms pertaining to this measure retained its consistency across pre and post-apartheid periods.

South African Schooling System

In the present South African school system, preschool is not compulsory, however the developmental skills mentioned above relevant to this age group are needed before children are school ready and if not developed at this age this will impact on scholastic ability (Van Zyl, 2011).

According to the South African Basic Education Laws Amended Act of 2011, "schooling is compulsory for all South Africans from the age of 6-7 (grade 1) to the age of 15 or the completion of grade 9". The compulsory school going age is also the age that encompasses school readiness.

School Readiness

School readiness is defined as the child's total readiness to benefit from education in a group setting (Prinsloo, Vorster & Sibaya, 1996). School readiness is also seen as the child's intellectual, physical, emotional and social development that is important to classify the child as school ready (du Plooy, 2003). The definition for school readiness used in this study is "School readiness is the child's preparation to succeed or how competent the child is when they enter school when referring to their cognitive abilities (Van Zyl, 2011).

School readiness depends on many factors; language, stimulation, intelligence, health, physical and cognitive development (de Jager, 2012), nutrition, stress, maturation, peer and parent relationships (Australian Early Childhood Mental Health, 2014), SES, quality of education and interpersonal factors (Van Zyl, 2011). This study acknowledges this; however, it only focuses on those factors important to this study.

Prinsloo et al. (1996) disagrees with previously mentioned authors and implies that age has little to do with how school ready an individual is, it all depends on which level of development the child is at. This study agrees acknowledges that age and the cognitive developmental stage both inform how school ready a child is. This study is cognizant that children with Mi-TBI face a possibility of not being school ready at the compulsory school going age. Thus this research aims to explore when exactly the mild traumatic brain injured child becomes school ready.

The abilities needed for school "*refers to cognitive, physical, emotional, social adjustment and self-regulating skills like distractibility, adaptability, paying attention, following instruction and inhibiting inappropriate actions*" (Van Zyl, 2011, p.36). Intellectual development is a primary factor needed for schooling which encapsulates language and speech. Other abilities such as perception, categorizing, logic, problem solving and memory (which are the primary focus of this study) are also needed for schooling (de Jager, 2013). This study acknowledges other abilities, all of which are beyond the scope of the study. The ASB is a non-verbal test, hence does not directly measure speech and acknowledges that at this age language might still be slightly under-developed and makes it more appropriate to measure in a polyglot society. Instead of verbal ability, the test measures the reception of instruction in the comprehension tests, which is a sub-measure of both language and speech. What will aid the reception of instruction is that the school readiness test is administered in the participant's home languagesand the understanding of all test instruction is monitored through practice items.

The above abilities delineated by Van Zyl (2001) and de Jager (2013) are determined by some of the factors that will be outlined. The National Institute of Child Health and Human Development (NICHD) Early Child Care Research Network (2002) had established in (1993), the importance of early childcare as a factor that impacts on a child's neurodevelopment, performance and ultimately school readiness. Fontaine, Torre and Grafwallner (2006) also acknowledge that early childcare at home is not always possible, especially with decreasing dual incomes and increasing single parenting. The authors thus refer parents to early childcare programmes that focus on; health, physical, emotional and social development. Additionally, focusing on approaches to learning, communication and cognitive skills and increasing general knowledge. These focus areas are all pertinent to a child progressing in becoming school ready. It is also is important for parents to be cognizant of the developmental challenges their children might be facing and counteract those challenges with professional and appropriate childcare if they are not able to provide that for their child. In this article by Fontaine et al. (2006) it is suggested that parent enroll their children in early childcare programmes that are comprehensive of the needs children might have considering that they might be physically or cognitively challenged, economically disadvantaged or linguistically inadequate. All of these factors might impact on the child's school readiness. Family and social environments were also highlighted as factors that could affect school readiness. Research shows that the amount of risk exposure the child has had in early development impacts on the child's cognitive abilities and performance when the child reaches a school-going age. Children with greater exposure to social risk during infancy and toddlerhood are less prone to have obtained cognitive and academic achievement, and self-regulatory skills (Mistry, Benner, Biesanz, Clark, Howes, 2010). Ramey and Ramey (2004) elaborate on the effectiveness of early learning as predictors for school readiness. Early learning as a factor along with the other factors (mentioned above) that determines school readiness influences neurodevelopment (as discussed previously), cognitive performance and now school readiness.

Participants who do not possess the above-mentioned abilities when starting school are set up for a delay and are unprepared for the tasks they are required to do in school. Ultimately they fall behind with their reading, writing, learning etc. and proceed to higher grades with these deficits (Halle et al., 2009). The ASB manual specifically addresses how the cognitive abilities measured speak to the scholastic abilities required at school. Based on the above literature on Mi-TBI, the sample might display some of these deficits and to prevent a long-term problem of deficits, this study will attempt to highlight the implications for school policies and health departments in order that better action be taken in remediating the abilities at deficit and also prevent this from happening in the future.

Chapter Three: Methodology

Research Aim

This study primarily aims to:

- Explore scholastic-specific neurocognitive sequelae following Mi-TBI and the effects that they have on school readiness.
- To explore if differences exist between Mi-TBI groups to a neurotypically contrasted group.
- Explore (if any) the delay in functionality pertaining to scholastic abilities after sustaining Mi-TBI.
- Test the psychometric properties to see if the ASB still is reliable 24 years post-apartheid.

This study plans to pursue study aims, by answering the following questions:

1. Are there any scholastic-specific neurocognitive sequelae that follow Mi-TBI and how does it affect school readiness?
2. Does performance across the cognitive domains/profile measured in a school readiness profile differ for Mi-TBI (with positive CT scans) when contrasted to the performance of participants with Mi-TBI (with negative CT scans), and participants of a similar demographic who have not suffered mild TBI?
3. Are there any delayed functions that can be observed in the Mi-TBI groups?

This study secondarily aims to answer the following question:

4. Have the norms relative to school readiness retained consistency between pre and post-apartheid education?

Design

Research description.

This study adopted a quantitative and cross-sectional approach as all participants were only tested at one respective point in time. Additionally, this design made use of a non-probability, volunteer convenience sampling technique depending on the availability, convenience and the participant's willingness to respond. It is classified within the positivist paradigm and is a non-experimental, ex-post facto design, because the study's independent variable (Mi-TBI) could/cannot be contrasted or manipulated as the manifestations of such an event had already occurred. This research was designed to compare groups that were assumed to be equivalent in terms of age, nurturance, SES, and their choice of primary health care facility for incidents normally considered to be minor ailments. This design thus aimed at answering the questions set out in the study aims listed above.

Procedure

Data collection was conducted at prearranged suitable locale at Chris Hani Baragwanath Academic Hospital (CHBAH) over several days per week for approximately 12 weeks, in the Head Injury Clinic. On a given day, participants were given information about the research study, invited to partake in the study and a signed informed consent form was obtained from the parent/primary caregiver and an assent form was given to the child to initial. When signed consent was obtained, hardcopy test booklets were distributed, which participants used to answer the questions on the eight domains of the ASB. The tasks were administered to one language group at a time, in one room; while participant's parents were simultaneously filling out the demographic questionnaire in the adjacent room. The researcher will facilitate the process, however where necessary, a multilingual co-researcher who was involved in the same umbrella project administered the test in vernacular languages or assisted the parents. The test administrator gave instructions as prescribed in the Aptitude for School beginners test manual. The test allows for 10-15 participants in one group session at a time. However, it was acknowledged and anticipated that there were not going to be many participants of the same language group that would volunteer on a given day. The number of participants the ASB was administered to depended on the number of participants available and the demographics of the participants. Upon completion, tasks and questionnaires from both the participant and the caregiver were collected by the researcher and stored in a sealed box which was kept in a secure location. On pre-arranged days, the participant ASB profiles were scored by the researcher with the aid of the test manual. Once all ASB questionnaires were scored, it was entered, cleaned and coded using an excel spreadsheet which was used later for analysis.

Participants

Study population was the pediatric department database of Mild traumatic Brain Injuries. The test sample was randomly drawn from the pediatric department database of Mild traumatic Brain Injuries in accordance with the inclusion criteria of the THINK study clinic trial. The THINK study focused on examining neurocognitive, psychosocial and psychiatric sequelae following Mild Traumatic Brain Injury, in a low socio-economic population. This study had obtained Ethics Clearance M1611113.

Test groups.

In this follow-up study, the caregivers of those participants who had been included in the study, were then telephonically contacted by the Head Injury Clinic's administrator and were invited to volunteer as participants in this research project. A time and date which was primarily suitable for the participant was arranged.

This study investigated cognitive sequelae of head injury in 3 distinct head injury subgroups; Mi-TBI (with positive scans), Mi-TBI (with negative scans) and Mi-TBI (with no scans). The Mi-TBI group (with positive scans) consisted of participants who had sustained a head injury with CT scans evidencing fractures/brain swelling/visible bleeds. The Mi-TBI group (with negative scans) consisted of participants who had sustained a head injury with CT scans evidencing no fractures/brain swelling/visible bleeds, i.e. the brain looks normal on the CT scan even after the head injury. The Mi-TBI group (with no scans) consisted of participants who had sustained a head injury and may or may not have fractures/brain swelling/visible bleeds, but have symptoms that are not as severe as the above-mentioned groups and hence, did not qualify to undergo CT scans.

At CHBAH, there were approximately 40 Mi-TBI admissions per month. All information relating to admissions was stored in a locked cupboard and kept on a password protected database to ensure confidentiality. Hospital admissions who had met the study's inclusion criteria were thus invited to partake in the study. Over the period of data collections only children aged 6-10 were psychometrically assessed.

Contrast group.

Participants in this group were hospital patients of the Pediatric Outpatient Department (POPD) Clinic and were recruited whilst awaiting consultation for for reasons that neither required surgery nor medication or ailments that might potentially impact on cognitive functioning. Participants included in this group were classified as neurotypical.

It is important to note that in accordance with their hospital records history, the demographic questionnaire further screened participants, revealed and included only those who were neurotypically contrasted based on age, language proficiency, socioeconomic status, and educational background, medical and social history. In addition to the above information elicited from the hospital records, participants completed a demographic questionnaire to elicit further information relative to age, language proficiency, socioeconomic status, educational background, medical and social history. All of which was used to ensure direct comparability of the tests and contrast groups.

Inclusion Criteria.

For test participants.

1) A minimum recovery period of at least 1 year post-injury to eliminate the possibility of factors relating to the acute event presenting as a confounding variable

2) Clinical records supporting the classification of miTBI

3) Participants must have been between the ages 6-10 years at the time of testing.

For neurotypical contrast participants.

4) Participants must have been comparable relative to age, language proficiency, socioeconomic status, stimulation and educational background.

Participants must have been neurologically uncompromised with no history of TBI or medical conditions that might impact on neurological functioning.

Exclusion Criteria.

1) Participants with other traumatic injuries (i.e. injuries aside from Mi-TBI) requiring hospitalization were excluded. This also excludes any injuries that suggest infliction of violence or abuse.
2) Participants who had previously presented or are presenting with signs of epilepsy and meningitis were excluded.
3) Participants with any form of concomitant illnesses, psychological (i.e. anxiety, mood, personality, psychotic disorders etc.) Or physiological sequelae (i.e. neurological disease processes, head trauma, immune diseases etc.) were excluded.
4) Participants with a history of medication with potential to alter one's state of consciousness or cause disruption in cognitive functioning were excluded.
5) Participants with neuro-developmental issues (e.g. Anencephaly, hydrocephalus, spina bifida, etc.) were excluded.

Sample Size.

The realized sample size of 70 was made up of the following:

1) Contrast group (n=31)
2) Mi-TBI group (n= 39)

Ethics

This study is embedded within the Traumatic Head Injury: Neurocognitive and Behavioural Assessment and Management in Kids (THINK) study (M1611113) led by the principal investigator who has already obtained:

- Permission from the management of CHBAH to access patient records.
- Permission from the Head of the Department of the Paediatric Surgery to access patient data from department database.
- Ethics approval from the Human Research Ethics Committee (Medical) (M1611113).

Although this umbrella research project had obtained Medical Ethics approval, additional Non-Medical Ethics Clearance was obtained for the current study (MASPR/17/001/IH).

In this nested present study:

Participation was said to be voluntary. Parental/caregiver's informed consent allowed for their child's participation in this study. All participants initialled an informed assent form to indicate their agreement to partake in this study. Participants were informed of their right to withdraw from the study at any time without prejudice, as well as given an opportunity to ask questions pertaining to the research. Confidentiality of information was ensured, relative to the research report and any publications that might emanate from this; summary reports will be made available to each participant's hospital file with participants informed that they were welcomed to consult with the lead research paediatrician relative to these findings. Where indicated a clinical referral was made via the hospital network. Participant numbers ensured anonymity as the data sheet only identifies the participant where follow-up is necessary. The researcher and the supervisor's contact details were given to the parents to further consultation about the purpose and nature of research.

Lastly, for the participants' convenience, the majority of the data collection was scheduled for the mid-year school break.

Data Collection

Tasks were estimated to take approximately 2 hours to complete. However, a pilot study evidenced that testing takes at most 45 minutes to complete. This was time efficient; hence fatigue can be ruled out as a rival hypothesis.

Measuring instruments.

Demographic questionnaire.

This contains questions on collateral information relevant to developmental history pre and post injury, medical history, socio-economic status (SES), language proficiency, gender, current age, and age at injury, as well as educational/scholastic background of both child and caregiver.

The demographic questionnaire was completed by the caregiver and that information was supplemented with the available hospital records.

The Aptitudes test for School Beginners (ASB).

This is a group test, which was developed by Olivier, Swart & Coetzee in 1974 and revised again in 1994. This test is generally administered to participants aged 6-8 years of age.

Reliability and validity were tested and confirmed for this test and were both interpreted by the test developers as generally satisfactory, with all subscales obtaining a reliability of ≥0.74 (Olivier & Swart, 1974). There are 8 domains tested; Visual Perception, Spatial Orientation, Reasoning, Numerical, Gestalt, Coordination, Memory, Verbal Comprehension which consist of 91 items overall (Olivier & Swart, 1974). The ASB norms are standardized on a 5 point stave ranging from 1-5, where low scores a lower score represent a less favourable comparison to peers while a higher score suggests that the individual's performance is more competent than the comparable peers. The ASB is/was available in the following languages: English, Afrikaans, isiXhosa, isiZulu, Sepedi, Setswana, and Sesotho. At least one member of the research team was proficient in each of these languages.

Data Analysis

All data were entered, cleaned and coded on an Excel spreadsheet. Results and documents were analyzed for descriptive statistics such as the mean, standard deviation, range, and those were documented on an anonymous Excel sheet.

Examination of the data sheet revealed many missing values reducing case numbers per variable. This made case numbers per variable less than expected. Missing values patterned analysis reveals that across all variables at least 1 value is missing, this means that 0 of 22 variables have complete data. Further analysis reveals that 88 values of approximately 1266 values data are missing.

According to Field (2009), fewer case numbers increase the probability of getting a significant finding even when there is no significant difference between cases. The classic and traditional way to deal with missing values would be by deleting cases that had more than 2 values missing on the dependent variable. However, rather than deleting cases with more than 2 missing values and reduce the sample size, multiple imputations were employed. According to Acock (2005), multiple imputation is one of the best ways to deal with missing data. This author suggests that multiple imputation offers a substantial improvement over traditional methods. In comparison with other methods such as single imputation, *"Multiple imputation improves on this approach by using the consistency (or inconsistency) of estimations derived from multiple imputations as additional information, and it can estimate standard errors that are unbiased"* (p. 1018). It also allows for the imputation of missing values even when the missing values are missing systematically.

After multiple imputation, statistical analysis was conducted on the data to explore correlations and comparisons of means and that will be appropriately interpreted.

The ASB measures 8 cognitive domains which are considered necessary for scholastic performance. The ASB produces raw scores per subscale for each participant and theses scores are primarily represented on an interval scale of measure. Furthermore, the maximum raw scores per subscale are not equivalent across the test, however the test manual make provision for the conversion to standardized norm scores (staves), which makes it possible for comparability between subscales. An exploration of available literature on the ASB does not identify any studies in which composite scores had been used as an outcome variable, neither were various independent variables used to predict the cognitive profile needed for school readiness; in order to do this the ASB subscales composite scores of the ASB were needed. To address these gaps in knowledge, the present study uses an overall composite ASB measure within regression techniques, as well as for various statistical techniques in order to meet some of the aims mentioned above.

Chapter Four: Results

Statistical Analysis was conducted by the researcher in which data analysis interrogated a comparison of the brain injured test group and a neurotypical comparison. In addition it aimed to assess the relationships that exist between the demographic variables such as gender, age at the time of the injury, age at the time of psychometric testing, Home Language, number of spoken languages, preschool attendance, grade repetition and school readiness. This study looked at whether any of these variables are predictive of cognitive profile needed for school readiness and which of these possibly act as covariates to the school readiness measure. It also investigated the psychometric properties of the ASB by using frequencies and cross-tabulations to investigate whether the school readiness norms still apply since the last revision thereof.

Demographic Description

The above aims were tested on 4 groups, 3 of which were classified as neurologically compromised Mi-TBI groups and 1 that was a neurotypical contrast group. These groups are presented below. After sample exclusion, the final sample consisted of 70 participants. Table 1 describes the sample as 60% male, with females in the minority. As can be seen in Table 1, more males had experienced head injuries compared to females in the test group. The 60/40 gender split clearly demarcates an uneven gender distribution. However, an independent samples t-test indicates non-significance (p= 0.439), which suggests there is no significant difference of gender means across the neurotypical contrast and test group (See Table 3). This means that the number of males and females were distributed relatively even across groups. The initial gender imbalance was proven to have no effect on results as correlations show that gender is positively but yet very weakly related to the overall ASB scores and this relationship is statistically non-significant, where (r =0.034) and (p=0.782). This means that the ASB scores are not gender dependent. This finding that gender has no significant influence of school readiness was agreed upon by Milander, Kingwill, Wolmerans and Venter (2014).

Table 1 - Demographic descriptive statistics for contrast and test groups (categorical variables)

	Neurotypical Contrast (*N*=31)	Test Group (*N*=39)	Overall Sample (*N*=70)
			n (%)
Gender			
Male	17	25	42 (60%)
Female	14	14	28 (40%)
School Grade			
Not in School	3	1	4 (5.6%)
Grade R	3	2	5 (7.1%)
Grade 1	7	11	18 (25.7%)
Grade 2	9	5	14 (20%)
Grade 3	4	13	17 (24.3%)
Grade 4	4	5	9 (12.9%)
Grade 5	1	2	3 (4.3%)
Grade Repetition			
No	15	22	37 (5.2.9%)
Yes	16	17	33 (47.1%)
Preschool Attendance			
No	5	5	10 (14.3%)
Yes	26	34	60 (85.7%)
Home Language			
English	2	1	3 (4.3%)
Other Indigenous African Languages	29	38	67 (95.7%)

Table 1 also shows that 70% of the study participants were within the first 3 years of formal primary school, with approximately 47.1 % of all participants having previously repeated a grade. The above results also reveal that 85.7% of all participants had attended preschool before formal schooling. A large percentage, 95.7%, of participants spoke Home Languages other than English.

Group Differences

Table 2 - Demographic descriptive statistics for contrast and test groups (interval variables)

	Neurotypical contrast group (*N*=31)		Test group (*N*=39)	
	M (SD)	Range	M (SD)	Range
Age at testing (in months)	97.8 (15.9)	73-131	95.56 (13.2)	72-116
Age at injury (in months)	--	--	62.85 (15.8)	35-93
Time since injury	--	--	32.69 (8.2)	17-45
No. of languages	3.06 (1.8)	1-6	2.92 (1.41)	1-6

*Note: *=p<0.05, Blank spaces are representative of a mean and standard deviation that could not be generated for that variable because it is not relevant for the group. All age related data presented as total months*.

Table 2 describes the differences between the contrast and test group, identifying independent samples t-test conducted to outline differences or the lack thereof.

Table 2 indicates that the average age for both the neurotypical contrast group and test group was approximately 8 years. The test group was approximately 5 years old (on average) at the time of injury, with at least 2 to 3 years period since their Mi-TBI which rules out acute sequelae as a rival hypothesis. Additional information about the sample is that all participants on average spoke at least 3 languages, meaning that all participants were bi/multilingual.

Table 3 - Independent Samples T test to investigate differences between groups

	T-test		ANOVA	
	T	P	F	P

Gender	-0.778	0.439	0.276	0.843
Age at testing	-0.643	0.522	0.259	0.855
Age at injury	-0.053	0.958	0.028	0.972
Time since injury	0.188	0.851	1.436	0.240
School Grade	1.424	0.159	1.157	0.333
Grade Repetition	-0.660	0.511	2.619	0.058
Preschool Attendance	0.388	0.699	0.272	0.845
Home Language	0.790	0.432	0.493	0.688
No. of languages	0.093	0.926	1.217	0.311

The above T-tests in Table 3 compares the Mi-TBI group to the neurotypical contrast group indicate that there are essentially no differences between 2 groups ($p < 0.05$). Similarly, when conducting an ANOVA to compare the means of all 4 groups across the variables, there are no significant differences. This means that the analysis was suitable for conducting inferential tests, as groups are homogenous.

Test assumptions

The test assumptions are important to explore as this dictates the power of the inferential tests used in the study. This study's assumptions are displayed below.

Normality.

In order to test the assumption of normality this study made use of the normality bell curve as well as the variable skewness coefficient. The bell curve should be approximately perfectly bell shaped and skewness coefficient needs to be within the -1 to 1 range in order for data to be normally distributed. Results in Table 4 show that all variables and test subscales are normally distributed except the first ASB subscale, Perception. Figure 1 illustrates the slight skewing of this subscale.

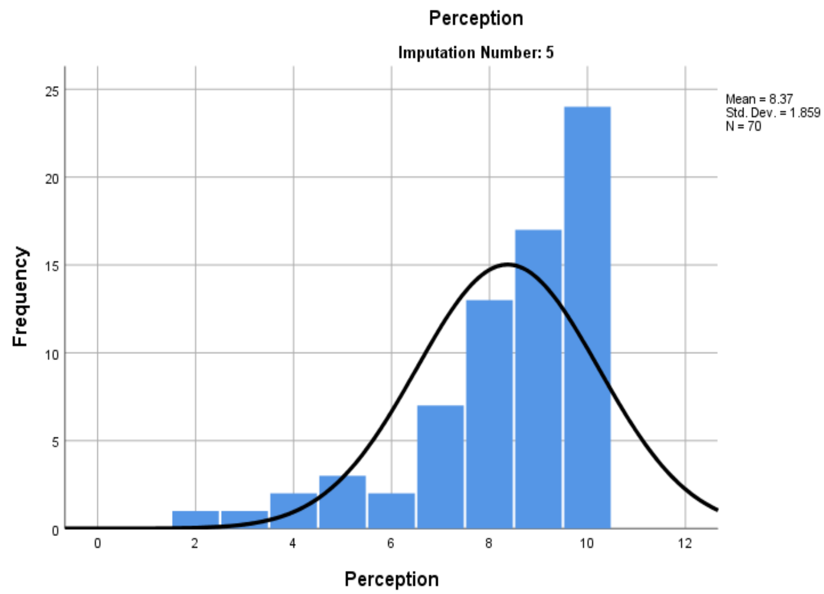

Figure 1: Normality distribution for skewed subscale

Table 4 - Skewness Coefficients for all variables

Variable	Skewness Coefficient
Age in months at accident	-0.207
Age in months at test date	-0.174
Time since injury	-0.325
School Grade	-0.100
Number of language	0.812
Perception	-1.471
Spatial Orientation	-0.029
Reasoning	-0.779
Numeracy	0.443
Gestalt	-1.083
Co-ordination	-0.925
Memory	-0.862
Verbal Comprehension	0.369

Overall ASB	-0.736

Homogeneity of variances.

Homogeneity of variances were checked using Levene's Test of homogeneity. Levene's test revealed that all variables were homogenous across all 4 groups however only subtest 7, Memory, was found to be heterogeneous and therefore routed the study to use a non-parametric test wherever this subtest was tested and/or compared.

Independent Observations.

All measuring instruments not only allowed for, but researchers' instructions reinforced that both demographic questionnaires and the psychometric test be completed independently, hence this assumption were met from early on in the test operationalization.

Outliers, linearity and scale of measure.

There were no outliers found revealed by the studentized residual vs. standardized predicted graph, additionally studentized residual values fell within the -3 < SRE_1 > 3 range. Linearity was established by data points all congregating around the in the linear line on the P-P plot. The assumption of Multi-collinearity was met when the correlation matrix that revealed that no correlation was > 0.8 and VIF values were all less than 10. Lastly, the Scale of Measure, depending on the type of scale needed to conduct a certain test, were all met. In most cases, the scale of measure for the dependent variable needed to be interval, in this instance the assumption was met.

Homoscedasticity.

Upon inspecting the studentized residuals vs. the standardized predicted graph, the observation was made that the graph forms rectangle shape and not an oval shape or a triangle, which clusters data points together. A rectangle shaped graph indicates that the error term is evenly distributed across all independent variables.

Power analysis

In order to do a power analysis of the study, the descriptives for the overall ASB score was used to calculate the effect sizes for the inferential tests used. The effect size of the independent samples t-test testing the mean overall ASB differences between the Mi-TBI groups and the neurotypical contrast group was revealed to be d= 0.482787. This is interpreted to be approximately a medium effect size and that 48% of the variance seen in the cognitive profile can be attributed to the differences between the 2 groups. After the effect size was calculated, a statistical programme called G-Power was used to calculate the power using the effect size and descriptives (mean and standard deviation and the sample size). The power revealed to be $(1-\alpha) = 0.779785$. This means that there is a 78% probability of correctly rejecting H_0 when H_0 is indeed false.

Instrument Reliability

In this study, additional reliability tests were conducted (See Table 5). This was done in order to evaluate if the test still is efficiently reliable and valid to use 24 years later than when it was first established.

Table 5- Reliability Statistics of the Overall ASB psychometric measure

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.597	0.824	8

According to Reliability Statistics α= 0.824. This means that the overall reliability is good because it exceeds 0.80 which infers the ASB's capacity to consistently measure cognitive profile for school readiness. In simple terms, the scores obtained by the ASB is accurate, reliable and reproducible on another testing occasion.

Table 6 shows that when deleted, no scale would exceed 0.824 hence all scales should be kept in the ASB. The corrected item-total correlation for all subscales should all be ≥ 0.30 however as can be seen in table 6, Verbal Comprehension has a value of .149 which is below .30. However, when deleted it does not increase the Cronbach Alpha value to a value > 0.824. In addition, when looking at the inter-item correlations, Verbal Comprehension poorly correlates with the other subscales and should perhaps be revised in future. Furthermore, none of the correlations exceeds 0.8 that indicates that there is no multicollinearity on the ASB measure. This means that no two subscales are measuring the same construct; each subscale measures an individual construct.

Table 6- Item-Total Statistics of all ASB subscales

ASB Subscales	Scale Mean if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Perception	136.24	0.655	0.570
Spatial Orientation	139.25	0.532	0.565
Reasoning	137.08	0.550	0.566
Numeracy	138.27	0.608	0.560
Gestalt	66.13	0.683	0.668
Co-ordination	123.71	0.555	0.490
Memory	137.55	0.474	0.563
Verbal Comprehension	134.05	0.149	0.599

The Aptitude test for School Beginners and Mild Traumatic Brain Injury

As mentioned above, this study aimed to compare the mean ASB scores across the different groups. Common parametric tests that are designed to do this are 2 samples t-tests and ANOVA’s.

Mean comparison between test and neurotypical group.

An Independent Samples T-test was conducted to see whether there were differences in the ASB means across the 2 groups except for where there were significant differences across the 4 groups on Co-ordination (see page 43).

Table 7 - Independent Samples T-test to compare the means for the 2 final groups

		Levene's Test for Equality of Variances			
		F-statistic	Significance	*t*-statistic	Significance (2-tailed)
Perception	Equal variances assumed	0.212	0.647	-1.233	0.222
Spatial Orientation	Equal variances assumed	0.420	0.519	-1.353	0.180
Reasoning	Equal variances assumed	1.015	0.317	-1.031	0.306
Numeracy	Equal variances assumed	2.290	0.135	-1.770	0.081
Gestalt	Equal variances assumed	0.037	0.849	-0.220	0.827
Memory	Equal variances not assumed			-2.417	0.018*
Verbal Comprehension	Equal variances assumed	0.549	0.461	-2.028	0.046*
Overall ASB	Equal variances assumed	2.787	0.100	-1.974	0.052

Inferential statistics from the above Independent Samples T-test show there is insignificant differences between the test and neurotypical contrast group when comparing groups on the overall ASB, where t (68)= -1.974 and (p= 0.052). These results are indicative and in agreement with the larger body of knowledge on mild brain injury that suggest Mi-TBI has negligible effects on one's cognitive profile.

Independent Samples T-test comparing the mean ASB measures across the 2 groups' show that compared to the other subtests, only subtests 7 and 8, Memory and Verbal Comprehension, were statistically significantly different. Statistics show this with t (68) = -2.417 and (p = 0.018*) when assuming unequal variances for Memory (subtest 7) and t (68) = -2.028 and (p = 0.046*) for verbal comprehension (subtest 8).

Results show that in memory, the neurotypical contrast group (8.04 ± 2.606) performed better than the test group (6.29 ± 3.442). Table 13 shows that even though the other subscales are not significant across groups, there is a trend across all subscales. The neurotypical contrast group performs better across all subscales in comparison to the test group, even though these statistics seems to be insignificant.

Table 8 **-** Descriptive statistics for neurotypical and test group for the performance on all subscales

Subscale	Test Group (*N*=39)		Contrast (*N*=31)	
	Mean	SD	Mean	SD
Perception	8.13	1.963	8.68	1.701
Spatial Orientation	4.97	2.748	5.84	2.531
Reasoning	7.26	2.533	7.87	2.391
Numeracy	5.87	2.823	6.94	1.999
Gestalt	77.99	20.679	79.10	21.404
Co-ordination	20.20	7.226	21.79	7.934
Memory	6.29	3.442	8.04	2.606
Verbal Comprehension	9.71	4.034	11.63	3.834
Overall ASB	23.87	7.027	26.87	5.277

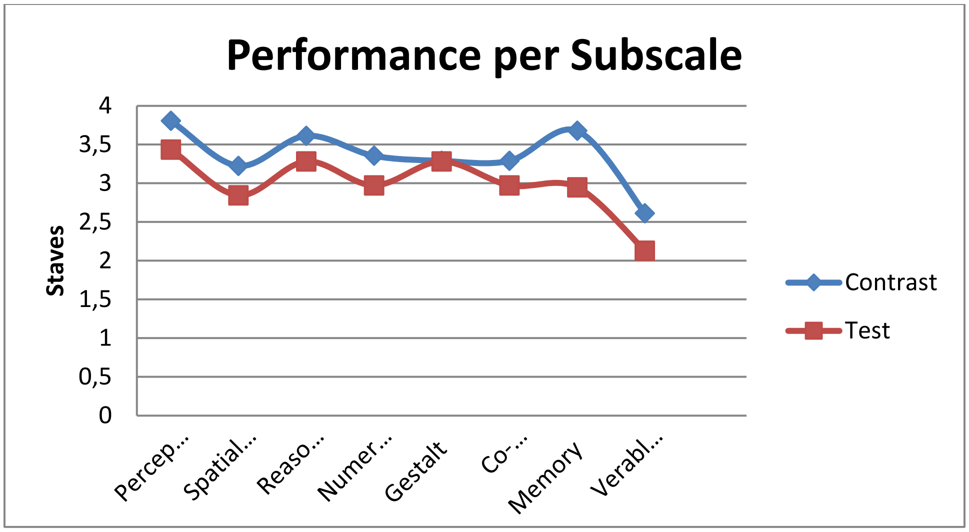

Figure 2: Line graph illustrating the performance on all subscales per group

Table 8 and figure 2 reveals a trend throughout all subscales and the overall ASB. These results show that irrespective of the fact that only the Memory and Verbal Comprehension subscales are statistically significant, all subscales indicate that the Mi-TBI test group had performed poorer than the Contrast group.

Mean comparison between subordinate test groups and the neurotypical group.

To further interrogate these results, the Mi-TBI group was broken down into 3 groups and compared to the neurotypical contrast group. A one way ANOVA was conducted to compare the overall ASB means across 4 contrast groups (Mi-TBI with no scan done, Mi-TBI with negative scan, Mi-TBI with positive scan, and the Neurotypical contrast groups).Levene's test of homogeneity suggested that the variances across the groups were homogenous, with $p > 0.05$. Only subtest 7, Memory, revealed Levene's test of homogeneity as significant with $p < 0.05$, which indicated heterogeneity across the groups.

According to Moder (2010), one of the increasingly used ANOVA's are the Welch's ANOVA, which is used when variances are heterogeneous. Normality, unequal variances and unequal samples sizes are requirements in order to carry out the Welch's ANOVA. Apart from this test accounting for unequal variances it also has the highest power and the lowest type 1 error rate and thus under these heterogenic circumstances is the best test to use as opposed to the classic ANOVA or Non-parametric Kruskal Wallis test.

Normality statistics too suggest slight negative skewing on the subtest Perception, with the skewness co-efficient = -1.471 with the rest of the ASB measures ranging between 1and -1, however according to the Andy Fields (2009), ANOVA's are generally robust to even slight violations of the normality assumption.

A Classic ANOVA was used for the 7 subtests that revealed homogeneity and a Welch's ANOVA on the subtest, Memory, which revealed heterogeneity.

Table 9 - Levene's test for homogeneity

	Levene Statistic	Significance
Perception	0.524	0.667
Spatial Orientation	0.444	0.722
Reasoning	0.033	0.992
Numeracy	1.543	0.212
Gestalt	0.402	0.752
Co-ordination	2.074	0.112
Memory	3.121	0.032*
Verbal Comprehension	0.922	0.435
Overall ASB	0.976	0.409

Table 9 shows that the parametric assumption of homogeneity of variance that was met for all subtests except subtest 7, Memory, with $F(3, 66) = 3.121$ and ($p = 0.032$), $p < 0.05$ indicating that the 4 groups have heterogeneous variances when comparing the ASB means on Memory.

Table 10 - ANOVA results of mean comparisons between the 4 groups

		Sum of Squares	Mean Square	*F*-statistic	Significance
Perception	Between Groups	7.800	2.600	0.744	0.529
	Within Groups	230.542	3.493		
	Total	238.343			
Spatial Orientation	Between Groups	18.348	6.116	0.852	0.470
	Within Groups	473.723	7.178		
	Total	492.071			
Reasoning	Between Groups	35.247	11.749	2.006	0.122
	Within Groups	386.588	5.857		
	Total	421.836			
Numeracy	Between Groups	27.552	9.184	1.462	0.233
	Within Groups	414.716	6.284		
	Total	442.268			
Gestalt	Between Groups	139.335	46.445	0.103	0.958
	Within Groups	29876.061	452.668		
	Total	30015.396			
Co-ordination	Between Groups	482.683	160.894	3.093	0.033*
	Within Groups	3433.374	52.021		
	Total	3916.057			
Verbal Comprehension	Between Groups	84.682	28.227	1.794	0.157
	Within Groups	1038.555	15.736		
	Total	1123.237			
Overall ASB	Between Groups	164.448	54.816	1.339	0.269
	Within Groups	2702.752	40.951		
	Total	2867.200			

Notes. * *indicates that* $p < 0.05$

Table 10 reveals the ANOVA statistics when comparing the ASB means across the 4 groups. Subtests 1, 2, 3, 4, 5 and 8, that is Perception, Spatial Orientation, Reasoning, Numeracy, Gestalt and Verbal comprehension were shown to be non-significantly different when comparing the ASB means across the 4 groups. Subtest 6, Co-ordination, was shown to be significant with F (3, 66) = 3.903 and($p = 0.033^{*}$), which means that $p< 0.05$, and thus showed sufficient evidence to believe that there is significant difference between the 4 groups when comparing ASB mean scores on Co-ordination.

This could possibly mean that the Mi-TBI had caused significant difference on participant's scholastic co-ordinating ability. Power analysis could not be conducted as group sizes were not equal, however $N^2= 0.05$ (for the overall ASB) was a small-medium effect size.

Table 11 **-** Tukey HSD post-hoc comparison of multiple groups

Dependent Variable	Type of CT brain abnormalities	Comparison CT brain abnormalities	Mean Difference	Significance
Coordination	None	Negative	-7.917^{*}	0.040^{*}
		Positive	-7.346	0.083
		Contrast	-7.291^{*}	0.035^{*}
	Negative	None	7.917^{*}	0.040^{*}
		Positive	0.571	0.997
		Contrast	0.627	0.992
	Positive	None	7.346	0.083
		Negative	-0.571	0.997
		Contrast	0.055	1.000
	Contrast	None	7.291^{*}	0.035^{*}
		Negative	-0.627	0.992
		Positive	-0.055	1.000

Notes. * *indicates that* $p< 0.05$.

Table 12 - Tukey HSD Mean comparison for coordination

	Subset means for alpha = 0.05	
CT brain abnormalities	1	2
None	14.50	
Contrast		21.79
Positive		21.85
Negative		22.42

Table 11 shows where exactly differences in co-ordination between Mi-TBI and contrast groups lie. The table shows that there are differences between the Mi-TBI group with no scans done and the Mi-TBI group with negative scans. As well as differences between the Mi-TBI group with no scans done and the Contrast groups. Table 12 reveal subtest means when comparing test and contrast groups on coordination. It shows that are indeed means differences on the co-ordinating ability between the Mi-TBI group with no scans in comparison to those Mi-TBI groups with scans (Positive or Negative), as well as a difference in comparison to the contrast group. This will be discussed later on in this paper.

Due to Homogeneity of variance violations on subtest 7, a Welch's ANOVA was conducted on one subtest. Table 13 indicates no significant difference across groups on Memory with (p = 0.157). Ultimately concluding that there are no significant differences across groups on ASB means.

Table 13 - Welch's ANOVA to compare the ASB means across 4 groups

		Statistic	Significance
Memory	Welch	1.892	0.157

Table 10 suggests that there are no significant differences across the 4 groups regarding the cognitive profiles that are needed for school. The 3 Mi-TBI groups were thus collapsed into one test group since there were no significant differences on the test measure, this however was not done where there were significant differences i.e. Co-ordination subtest. These 4 groups were then reduced to only 2 groups, the test and neurotypical contrast groups.

Table 6 reveals the skewness co-efficients for the dependent variables. These descriptive statistics that on subtest 1 the skewness is below -1 and this hints towards slight negative skewing of the distribution on this subtest. However, this was corrected by using reverse log transformation and then log transforming it especially, because t-tests are proven to be biased when normality is not met (Fields, 2009). In terms of homogeneity of variances, the Independent samples T-test gives an option to assume unequal variances and thus in this way heterogeneity was taken into account.

Correlations With and Predicting of the Cognitive Profile

The following analysis was not originally aimed to explore, however is aligned with the work done in this study.

According to Olivier, Swart and Coetzee's (1974 ASB manual, the ASB should correlate with both age and grade. Sophisticated cognitive abilities should emerge as the pediatric brain develops and the child ages. There is expected to be positive and moderate to strong correlation between the child's ASB performance and age. This is known to be a biologically expectant development. With a higher grade should come increased acquired cognitive abilities as the pediatric brain is accommodating and adjusting to all that is learnt in school. There is expected to be positive and moderate to strong correlation between the child's ASB performance and grade. This is known to be an environmentally dependent development.

In this study, correlations including data on all participants reveal that the overall ASB was significantly correlated with Age where ($r = .403$, $p = .000$**), Grade where($r = 0.393$, $p = .001$**), all of the ASB subscales and whether they repeated a year where ($r = -.262$, $p = 0.028$*). As previously mentioned, age and grade were expected to be significant.

Table 14 - Independent Samples T-test comparing group means on ASB subscales across participants who did and did not repeat a grade

		Levene's Test for Equality of Variances			
		F-statistic	Significance	*T*-statistic	Significance (2-tailed)
Perception	Equal variances assumed	11.268	0.001	2.291	0.025*
Spatial Orientation	Equal variances assumed	0.221	0.640	1.803	0.076
Reasoning	Equal variances not assumed			2.836	0.006**
Numeracy	Equal variances assumed	1.676	0.200	.597	0.552
Gestalt	Equal variances assumed	0.744	0.392	1.796	0.077
Coordination	Equal variances assumed	1.580	0.213	2.356	0.021*
Memory	Equal variances not assumed			2.707	0.009**
Verbal Comprehension	Equal variances assumed	0.845	0.361	-0.122	0.903
Overall ASB	Equal variances assumed	0.143	0.706	2.239	0.028*

Table 14 show significant differences on ASB subtests 1, 3, 6, 7 (i.e. Perception, Reasoning, Co-ordination, Memory) and the overall ASB scores, with those who repeated grades scoring less on those subtests. This therefore reinforces what is suggested by literature that those who have repeated a year are not as school ready as those who did not. Table 15 shows the means on Perception, Reasoning, Co-ordination, Memory, and the overall ASB scores revealing that those who have not failed have higher means on those subscales, than those who did fail. This suggests that children with Mi-TBI are at greater risk of repeating a grade because their cognitive profile might be underdeveloped in comparison to their non-injured counterparts.

Table 15 - Group statistics for grade repetition

	Repeated year?	N	Mean
Perception	No	37	8.84
	Yes	33	7.85

Spatial Orientation	No	37	5.89
	Yes	33	4.76
Reasoning	No	37	8.30
	Yes	33	6.67
Numeracy	No	37	6.52
	Yes	33	6.15
Gestalt	No	37	82.65
	Yes	33	73.82
Co-Ordination	No	37	22.84
	Yes	33	18.73
Memory	No	37	8.01
	Yes	33	6.00
Verbal Comprehension	No	37	10.50
	Yes	33	10.62
Overall ASB	No	37	26.78
	Yes	33	23.42

A multiple regression was conducted on SPSS to find the predictors of the cognitive profile needed for school. Upon wanting to conduct this test, the assumptions were checked and met before proceeding with the multiple regression.

Table 16 - Summary Statistics of the model

Model	R	R^2	Adjusted R^2
1	.716	.512	.314

This model summary indicates whether the model is successful in predicting school readiness. This output in table 15 reveals (r = 0.716) which is indicative of a strong relationship between the predictors and the predicted. This model obtained a (r2 = 0.512) which means that 51.2 % of the variance seen in school readiness can be explained by the regression model for the sample.

The adjusted r2= 0.314 means that 31.4% of the variance seen in the cognitive profile needed school readiness can be accounted for by the regression model had the model been derived from the population. Ideally, the two r-squared values are expected to be relatively close to one another; however, in this study there appears to be a 17.7% shrinkage. This shrinkage means that if the model had been derived from the population as opposed to the sample then it would account for 17.7% less variance seen in the cognitive profile needed school readiness that is explained by the predictors.

Table 17 - ANOVA statistics for regression model

Imputation Number	Model		Sum of Squares	Mean Square	*F*-statistic	Significance
Original data	1	Regression	688.396	62.581	1.183	.416
		Residual	423.354	52.919		
		Total	1111.750			
5	1	Regression	961.440	87.404	2.579	0.022*
		Residual	914.919	33.886		
		Total	1876.359			

Note. * *indicates that p< 0.05*

Table 17 reveals a p-value of 0.416 for the original data (with missing values), this means that in using the original un-imputed data that no predictors were successful in predicting school readiness. After the last imputation table 16 shows a p value of 0.022, which shows that at least one of the predictors significantly, predict school readiness.

Table 18 - Coefficients table revealing predictors of school readiness

Imputation Number	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients *Beta*	T	Significance
Original data	1	(Constant)	-59.352	84.416		-0.703	0.502
		Gender	2.133	3.878	0.136	0.550	0.597
		Age in months at accident	-0.072	0.193	-0.156	-.371	0.720
		Days hospitalized	0.274	1.018	0.074	0.269	0.795

		Mechanism of injury	0.081	2.002	0.011	0.041	0.969
		OA: GCS	3.803	5.242	0.221	0.725	0.489
		Time since injury	-0.040	0.353	-0.036	-.113	0.913
		Home Language	2.866	2.184	0.693	1.312	0.226
		No. languages	-0.221	2.386	-0.209	-0.512	0.623
		Preschool Attendance	0.195	9.375	0.006	0.021	0.984
		Grade	4.244	2.225	0.718	1.907	0.093
		Grade Repetition	6.001	5.205	0.369	1.153	0.282
5	1	(Constant)	-48.408	44.615		-1.085	0.288
		Gender	2.055	2.030	0.142	1.012	0.320
		Days hospitalized	0.240	0.613	0.058	0.392	0.698
		Mechanism of injury	1.061	1.214	0.134	0.874	0.390
		OA: GCS	1.886	2.620	0.115	0.720	0.478
		Time since injury	0.026	0.139	0.030	0.186	0.854
		Home Language	1.095	0.623	0.358	1.758	0.090
		No. languages	-0.688	1.017	-0.138	-0.677	0.504
		Preschool Attendance	9.269	3.409	0.447	2.719	0.011*
		Grade	2.177	0.913	0.438	2.384	0.024*
		Grade Repetition	-0.446	2.384	-0.032	-0.187	0.853
		Age in months at test date	0.122	0.104	0.229	1.177	0.249

*Note. * indicates that $p < 0.05$.*

Table 19 - Part and Partial value tables

Imputation Number	Model		Correlations	
		Variables	Partial	Part
5	1	(Constant)		
		Gender	0.191	0.136
		Days hospitalized	0.075	0.053
		Mechanism of injury	0.166	0.117

OA: GCS	0.137	0.097
Time since injury	0.036	0.025
Home Language	0.320	0.236
No. languages	-0.129	-0.091
Preschool Attendance	0.464	0.365
Grade	0.417	0.320
Grade Repetition	-0.036	-0.025
Age in months at test date	0.221	0.158

Partial values for preschool attendance is the unique contribution of preschool attendance to the overall school readiness while keeping other variables constant. The part value for preschool attendance is 0.365 and this is treated as a Pearson's R correlation coefficient, thus when squared is 0.1332 and converted to a percentage is 13.32%, this means that if preschool attendance as a predictor is removed from the model then the model variance decreases by 13.32%. Furthermore, 13.32% of the variance seen in school readiness is explained by preschool attendance and is thus worth keeping in the model.

Partial values for grade is the unique contribution of grade to the cognitive profile needed for overall school readiness. The part value for grade is .320 and this is treated as a Pearson's R correlation coefficient, thus when squared is 0.1024 and converted to a percentage is 10.24%. This means that if grade as a predictor is removed from the model then the model variance decreases by 10.24%.

Furthermore, 10.24% of the variance seen in school readiness is explained by grade and is thus worth keeping in the model. In comparison with the original un-imputed data, the original un-imputed part values reveal a lower percentage decrease for preschool attendance, and a higher percentage decrease for grade, this shows that one should be a careful, for doing analysis with missing values, these results should be interpreted with caution.

Both preschool attendance and grade together explain approximately 23.56% of the variance seen in the cognitive profile needed for school readiness. The unaccounted for 76.44% of variance seen in school readiness is as a result of external variables (that haven't been included in the regression model) that can better explain or account for the variance seen in school readiness.

Mild Traumatic Brain Injury Specifically as a Predictor

A simple linear regression was done to see if the experience of a Mi-TBI (or not) can predict the cognitive profile needed for school readiness. Model summary shows a poor model fit with ($r = .229$ and $r2 = .052$). ANOVA statistics reveal ($p = .057$), which means that no predictor in the model significantly predicts school readiness. Coefficient tables reveal $b = .229$, $t\ (68) = 1.937$ and ($p = 0.057$), which indicates that Mi-TBI specifically does not predict school readiness.

The Aptitude test for School Beginners Norms

According to Oliver and Swart (1974), the ASB manual states that the ASB scores are raw scores and can be used as raw scores however for the purpose of standardization, the raws are converted to a standard score on a standardized scale. These standardized scores are called Norms. The Norms are standardized on a 5-point stave ranging from 1-5 depending on normal distribution (See Figure 1). Each scale represents a certain percentage of school beginners (See Figure 2).

Table 20- ASB Norms conversion table

	Raw scores for tests							
Standard score	1	2	3	4	5	6	7	8
	Perception	Spatial	Reasoning	Numerical	Gestalt	Coordination	Memory	English Verbal Comprehension
1	0-5	0-1	0-2	0-2	0-35	0-8	0-1	0-7
2	6-7	2-3	3-6	3-4	36-62	9-17	2-7	8-11
3	8	4-6	7-8	5-7	63-86	18-24	8	12-14
4	9	7-9	9	8-9	87-98	25-28	9	15-17
5	10	10	10	10	99-100	29-30	10	18-20

Note: the above table is a duplication of the table by Olivier, N. M., & Swart, D. J. (1974, p.48). Manual for the aptitude tests for school beginners. Pretoria: Human Science Research Council

Table 21- ASB Norm Percentages and Grade conversion table

Standard score	Percentage of testees	Grading
1	Lowest 7%	Very weak
2	Next 24%	Weak
3	Middle 38%	Average
4	Next 24%	Good
5	Highest 7%	Very good

Note: the above table is a duplication of the table by Olivier, N. M., & Swart, D. J. (1974, p.48). Manual for the aptitude tests for school beginners. Pretoria: Human Science Research Council

One of the aims of this study was to explore whether the norms, percentages and test performance were the same for this sample and temporality. Frequencies and distributions reveal slight skewing to the left, meaning that majority of the scores are distributed on the right hand side of the bell curve. However, this is to be expected as the original sample were school beginners in comparison to the sample in this study who have ranging grades. The slightly deviation from the norm could be as a result of the deviant sample age, this new sample had performed slightly better that from then norm found in 1994. Table 22 displays the average norm scores and their deviations.

Table 22- Descriptives of the ASB norm scores

	Perception	Spatial Orientation	Reasoning	Nume-racy	Gestalt	Coordination	Memory	Verbal Comprehension
Mean	3.60	3.01	3.43	3.14	3.29	3.12	3.27	2.34
SD	1.345	1.042	1.213	1.219	1.139	1.086	1.519	1.203

According to Table 22, the average norm scores ranges 2.34-3.60 which clearly is not as consistent as the norms were when the test was established. The standard deviation according to the manual is supposed to be equal to 1; however as can be seem in table 20 it exceeds 1 maximally by 0.5. Even though it has not increased by very much it has exceeded 3 as a mean and 1 as a standard deviation, when looking at the inter-item correlations, Verbal Comprehension poorly correlates with the other subscales and this impacts of the scales construct validity. This test should perhaps be revised in future.

Chapter Five: Discussion

The primary aim of this research was to explore the neurocognitive sequelae that follow Mi-TBI; exploring whether the cognitive profiles elicited by the ASB were impacted upon as a sequelae of Mi-TBI. The study began with an analysis of whether there were differences between respective group means across the Aptitude for School Beginners' test scores. The first statistical analyses to be done were first, a classic analysis of variance (ANOVA) (for subtests with homogeneity of variance) and second, a Welsh's ANOVA (for subtests with heterogeneous variance) to test the differences between the three Mi-TBI groups and the neurotypical contrast group.

The Aptitude test for School Beginners and Mild Traumatic Brain Injury

Mild traumatic brain injury's influence on memory and verbal comprehension.

In order to explore differences in the cognitive profile, the Mi-TBI test group was compared with the non-injured neurotypical contrast group. An independent samples T-test (Table 7) revealed that only the Memory and Verbal Comprehension subscales were found to have significantly different means across the two groups, with the contrast group performing significantly better than the test group.

Studies in misalignment with the results found in this present study are such of those done by Bijur, Haslum and Jean, who in 1990 conducted a study on Mi-TBI in children. Their sample consisted of children of which 114 suffered head injuries, 601 with limb fractures, 605 with lacerations, 136 with burns, and 1726 without injury. All participants were matched only on age, 5-10 years. Intelligence, sex, socioeconomic status, behaviour and six other factors were assessed. Results show that there was no significant difference between the contrast and test groups. Participants with Mi-TBI had slightly more hyperactive behaviours compared to other groups. Participants with lacerations were evidenced to perform poorer on intelligence, scholastic skills and aggression compared to participants with Mi-TBI. A study by Light et al. (1998) also aligns itself with the results reported on by Bijur et al. (1990), showing that there is no difference between those who have Mi-TBI and those who do not. This study by Bijur et al. (1990) is in direct conflict with the results found in the present study as it reveals that children with Mi-TBI should be classed together with those that do not have Mi-TBIs. The present study contradicts with the preceding studies and reveals that there is indeed neurocognitive differences between the two groups.

The study by Catroppa and Anderson (2002), who conducted memory tests on children with various TBIs, confirm the findings in this study. Their tests assessed immediate and short term memory, intermittent memory, delayed memory and other complex multi-trial memory tasks. Results revealed that participants with severe TBI performed worse than those with Mi-TBI and Mo-TBI, however, concluded that those with Mi-TBI and Mo-TBI still performed poorer than controls 6 to 12 months post injury. The time since injury is of a smaller duration in Catroppa and Anderson’s 2002 study in comparison to the duration in the present study, which might account for why they have found more neurocognitive deficits opposed to the neurocognitive deficits found in the present study.

Results from this current study show that the neurotypical contrast group (8.04±2.606) performed better than the test group (6.29±3.442) on incidental visual recognition memory. Kinsella et al. (2009) did a study in comparing 24 TBI participants to 24 control participants on their memory functionality. The study suggested that TBI participants revealed difficulties in evaluating their memory functioning in comparison to control participants, thus confirming the finding in the present study. This study by Kinsella et al. (2009) however randomly assigned participants with Mi-TBI to either a memory rehabilitation group as a form of intervention, or to a control group without intervention. Those in the intervention group had better everyday memory performance. This evidences that the memory rehabilitation is indeed effective, but it also indicates that Mi-TBI does indeed have latent memory effects. Similar to the Catroppa and Anderson (2002) study, the time since injury is of a much shorter duration than the duration in this present study. This highlights the strength of the current study with regard to it recruiting participants at least one year post injury, which rules out acute effects as an extraneous variable. This finding is also in alignment with the work of Chen, Kareken, Fastenau, Trexler and Hutchins (2003) on memory in pediatrics with Mi-TBI, who found that participants with Mi-TBI had a smaller increase in cerebral blood flow in the right prefrontal cortex, which resulted in lower spatial memory ability. According to these authors, this is one of the symptoms of Post-Concussion Syndrome, but is also possibly a long-term effect of a Mi-TBI. Vanderploeg et al. (2007) compared 3 groups, an un-injured group, an accidental injured group and a Mi-TBI injured group. They found that when examining the long-term psychosocial effects of Mi-TBI, the Mi-TBI group had the most increased likelihood of having Post-Concussion Syndrome. Post-Concussion Syndrome symptoms include the persistence of headaches, dizziness and cognitive problems such as the lack of concentration, attention, and memory amongst others. Hofman et al. (2002) suggest that participants with Post-Concussion Syndrome have displayed less white matter, meaning that they had less myelination in comparison to controls, irrespective of whether they had a negative or positive scan, indicating that participants with Mi-TBI are less able to apply themselves to certain tasks, which ultimately decreases the individuals' cognitive performance capabilities. That might explain why, in the current study, Mi-TBI participants performed poorer on all ASB subscales than the neurotypical contrast group (see Table 8).

Results from the independent samples T-test also show that participants in the Mi-TBI group in the present study performed poorer than the contrast group on both the verbal comprehension and memory subscales. Walker, Greenwood, Hart and Carta (1994) suggest socio-economic status (SES) acts as a predictor variable for verbal ability - both reception and spoken language. This could be because a low SES creates conditions of decreased stimulation. One reason could be that in low SES conditions, parents are often working long hours or double occupations to meet the needs of the household and thus are seldom home to induce or provide lingual stimulation to their still developing children. Parents in low SES environments have often themselves not completed their education or have not even attended school and therefore, sometimes they themselves are illiterate with poor linguistic abilities. Families from a low SES background often cannot afford to send their children to kindergarten, thus perpetuating the inability in these children to develop their language skills. In the current study specifically, the possibility of having a Mi-TBI in low SES conditions could aggravate the effects that Mi-TBI has on verbal comprehension. Further research is needed to clarify that low SES does indeed moderate the effect that Mi-TBI has on verbal comprehension and potentially, other aspects of the cognitive profile.

It also is important to note, as outlined in Table 13 (see Results), that even though the other subscales are shown to be non-significant, there is nonetheless a trend across all subscales showing the test group to be the poorer performing group. This shows the test group as having a poorer cognitive profile in comparison to the neurotypical contrast group. Although the results in Table 12 show subscales other than Memory and Verbal Comprehension as non-significant, they still reveal a pattern which potentially shows that Mi-TBI does impact on the cognitive profile elicited by the ASB measure. However, this pattern. may be due to a small sample size, which could show insignificant differences when there could potentially be differences. There is scope for this concept to be considered in detail in a future study.

Mild traumatic brain injury's influence on coordination.

Further interrogation of data allowed for the Mi-TBI group to be broken down into three Mi-TBI groups in order to explore mean differences on the cognitive profile not only between the Mi-TBI group and the non-injured group, but also within the Mi-TBI group. When comparing the three Mi-TBI groups against the neurotypical group, results revealed that the only statistically significant difference that existed was on the Coordination subtest. As mentioned before, this can be due to anomalies caused by group sizes. Prior to the current study however, this finding was reported and corroborated by the work done by Wheateroft, Malley and Morris (2016) at the Headway Clinic, who reported that poor fine motor coordination is a common symptom post-injury and which is often coupled with motor contrast, dizziness and balance deficits. Wheateroft et al. (2016) suggested that the fine motor coordination and balance organs in the ear are disrupted by the Mi-TBI especially if the Mi-TBI resulted because of a fall or caused the individual to fall. The author further states that usually this may be an experience of patients shortly after suffering from a Mi-TBI, however these symptoms can possibly persist, which seems to be the case in the current study.

The sub-sample of the Mi-TBI test group who did not have any record of CT scanning demonstrated significantly poorer fine motor coordination than both the sub-sample who had negative CT scan results and the uninjured contrast group. Not much work has been done on the sub-samples of the Mi-TBI test group, however work done by Hanlon, Demery, Martinovich and Kelly (1999) revealed no differences between negative and positive scans when measuring participants on vocational outcome and neuropsychological status. McCauley et al. (2001) also show that there is no difference between negatively and positively scanned groups' performance, moreover, just because positive scans reveal more serious injury than negative scans, it does not mean that positive scans have more extreme long-term effects. This is prevalent in the results found in the present study, in which negative and positive scans indeed show differences on the CT scan and structural injuries have no differences in their performance across the ASB scale or, more specifically, on the coordination subscale. The results seen in the current study is echoed by work done by Wheateroft, et al. (2016) where Mi-TBI participants are compared to a contrast group, with the contrast group scoring higher on coordination than the no-CT scan group. This finding reveals that the Mi-TBI participants with no CT scans perform poorer on coordination as opposed to the Mi-TBI group with negative CT scans. More research is required in this field to substantiate why this difference might exist. Additionally, the sample sizes between the four groups are unequal and the Mi-TBI groups are quite small in comparison to the contrast group, which might be producing significant differences when those differences, in fact, do not exist. Nevertheless, irrespective of the small sample size there is a possibility of this difference existing. Slomine and Locascio (2009) do evidence that younger children (aged similarly to those in the current study) with a TBI are at greater risk of frontal lobe impairment, meaning that this might affect the executive functioning of the paediatric brain. Coordination too requires executive functioning in order to plan and carry out goal-oriented tasks. In the current study, the coordination task in the ASB consisted of drawing a smooth line from the dot to the star, which were at opposite poles. Participants found it difficult to stay within the lines and drawing smooth lines while keeping the pencil on the paper. This task might have been difficult because of the effect that the Mi-TBI had on their frontal lobes, irrespective of the type of scans they had. Chou, Kaufman, Walker-Rabatin, Brey and Basford (2004) similarly did a study on gait and posture after TBI, and reported that participants found it difficult to remain stable throughout obstacle crossing and complained of imbalance and instability while walking and walked with slower gait speed and took smaller steps in comparison to controls, irrespective of normal gait scores. Vanderploeg and colleagues (2007) also suggest that Mi-TBI participants amongst other uninjured participants had peripheral visual imperceptions and poor tandem gait, both of which are needed for coordination in movement. This indicates that TBI can potentially influence an individual's fine motor coordinating abilities. However, this leaves room for prospective studies to grow the body of knowledge in this subject area. It would also be worth exploring whether poor coordination could be an existing causative factor of Mi-TBI instead of Mi-TBI producing poor coordination as a sequelae post-facto.

Mild Traumatic Brain Injury and Socio-economic Status

SES also impacts on a child's cognitive profile, possibly inhibiting their school readiness. Van Zyl (2011) did a study testing school readiness in Grade 1 and suggested that children who possess the cognitive profile needed for school readiness in Grade 1 do better in school in Grade 4 and onwards and are more school ready as opposed to children who were not yet school ready in Grade 1. Furthermore, this suggests that combatting low SES could aid in combatting many scholastic problems, including grade repetition, caused by not having the cognitive profile for being school ready. However, in the case of the current study, the combination of low SES and Mi-TBI instigate greater detriments than either one of those variables in isolation. Thus, combatting low SES might lessen the effect that Mi-TBI might have on the child's cognitive profile but solely reducing low SES might not entirely make the child school ready, as Mi-TBI still independently influences the child's cognitive profile. This study shows that participants with Mi-TBI from low SES conditions performed poorer on all ASB subscales in comparison to contrast participants who were also from low SES conditions.

Predicting the Cognitive Profile Needed for School Readiness

This study had not originally aimed to explore predictors of the cognitive profile needed for school readiness, however this aspect is still important to acknowledge when doing a study of this nature. In the current study, results revealed that only 23.56% of the variance seen in this cognitive profile can be explained by grade and preschool attendance. Other studies suggest that there are other variables that could help explain the cognitive profile needed for school readiness. Language proficiency was a variable specific to the current study and was included in the regression model, but the results indicated that it did not significantly predict the cognitive profile needed for school readiness. Diamond (2010) suggests that people with language proficiency have an increased ability to focus their attention selectively and switch their attention from one language to another, from one stimulus to another, and that this is indicative of greater specialization of the prefrontal cortex's executive function capacity. Executive function is a capacity required for school readiness. This shows how language proficiency can predict one's school readiness, even though this was not an explicitly articulated finding in this study. Marian and Shook (2012) agree with this finding, adding that bilinguals/multilinguals have better inhibition abilities as they inhibit the use of one language and switch over to the other language required for reading, communicating and understanding in comparison to monolinguals. This clearly shows how language proficiency could add to the skills required in cognitive profile needed for school readiness as inhibition is a very important skill to have within ones' scholastic career. In this study, however, if participants had no presence of Mi-TBI, then perhaps they might have performed equivalently to the contrast group, since both groups are language proficient and come from low SES conditions. But this is not the case - participants with Mi-TBI performed poorly on every subscale (see Table 13), indicating that even though language proficiency could potentially predict the cognitive profile needed for school readiness, it cannot do so in the presence of Mi-TBI.

Being bi- or multi-lingual requires that one switches between ones' home language and the other language/s. As Chen et al. (2003) suggest, perhaps participants with Mi-TBI have weaker functioning prefrontal lobes compared to the neurotypical contrast group due to decreased cerebral blood flow to this area. This could possibly explain why there was significantly weaker performances in the Mi-TBI group on the coordination, memory and verbal comprehension subtests, as all these components of the cognitive profile make use of the prefrontal cortex for the execution of these cognitive abilities.

Previously, executive functioning (Mann, Hund, Hesson-McInnis, & Roman, 2017; Gooch, Thompson, Nash, Snowling, and Hulme, 2016), adversity through the mediated effect of inhibitory contrast (Brown, Ackerman & Moore, 2013), child care experience, family structure and parenting, home environment, learning-related skills, social behaviour and health and socioeconomic status (Linder, Ramey & Zambak, 2013) have predicted school readiness. In this study, the tables above show that only preschool attendance and grade provide statistically significant results that predict school readiness.

Nugent et al. (2016) did a study in which rural children were placed in a Family and Child Education (FACE) preschool that coordinated a FACE programme that children were partaking in. Results showed that children on the FACE programme in preschool predicted the cognitive profile that is needed for school readiness in comparison to the non-FACE preschool-going counterparts. These results may have low ecological and population validity, hence one needs to be cautious when generalizing from it, however in that group, these results prove that those children who had FACE preschool education were much more school ready than those who did not go to a FACE preschool. This is because in such a programme, the child's family is much more involved in the child's mental stimulation and development. As mentioned above in the work done by Taylor et al. (2004), they suggest that family attitudes, parental schooled cognitions, parenting behaviours, parents' experiences and academic socialization all factor into and affect a child's mental stimulation. The greater the parent schooled cognitions, family attitudes towards school and the better the parents' experiences, parenting behaviours and academic socialization, the greater the child's mental stimulation, and along with preschool education, their school readiness and school performance also improves. Magnuson, Ruhm and Waldfogel (2004), reveal in their results that preschool does in fact increase cognitive skills, however for children from a higher SES, their skills dissipate during their first grade and behavioural problems increase instead. This is the opposite for children from low SES, as their skills remain constant. This might be applicable to the current study as the sample is from low socioeconomic conditions and do display that those who had attended preschool had, in fact, increased cognitive skills and thus a higher degree of school readiness.

Grade also predicted school readiness - this was not surprising as Olivier and Swart (1974) had theorized that children who are school ready proceed to higher grades, increasing their school readiness and would thus be predictive of how school-ready a child is and how well they perform at school. This is corroborated by Van Zyl (2011) as well as historically by Buttram, Covert and Hayes (1979). Even though age and grade repetition positively correlated with the cognitive profile needed for school readiness, it did not predict it as was expected. The Australian Early Childhood Mental Health Institute (2014) suggests that at ages 4 to 5years, children's cognitive abilities increase and as they grow older their cognitive skill becomes a lot more sophisticated in preparation for school, developing all the cognitive skills needed for successful schooling. South Africa's Basic Education Laws Amended Act (2011) is also in agreement with this as they decided on a "school-going" age for children - the age in which the average child is approximately ready to endeavor attending school. Van Zyl (2011) also suggests that if children start school at the wrong age, there is a possibility that the cognitive profile required for school attendance might be underdeveloped and the child might not be school ready yet.

The work done by Alexander, Entwisle and Dauber (2003) emphasizes the importance of acknowledging grade repetition in school readiness, as this variable might display that a child is not school ready when repeating grades early on in formal schooling, grade retention then also might have further detrimental effects on the child's scholastic career.

Another expected, yet not predictor variable was Mi-TBI - several studies have shown how Mi-TBI can affect school performance, cognitive skills, capacity and school ability. Anderson et al. (2001) describe how Mi-TBI affects pediatric memory, attention, language, story recall and verbal fluency (Catale et al., 2009). Prasad et al. (2017) discuss how Mi-TBI might affect and delay developmental milestones such as writing, reading and counting, all of which are needed for school readiness and successful scholastic performance. This study's results have, however, not indicated that Mi-TBI predicts school readiness. This might be due to a small sample size and future research is required in order to make claims regarding these results.

The Aptitude test for School Beginners

Correlates of the Aptitude test for School Beginners.

Age and grade.

Results show, specifically in this study, that age, grade and grade repetition were significantly correlated with the cognitive profile needed for school readiness. Age and grade were expected to correlate with the cognitive profile needed for school readiness as this was found to significantly correlate when the ASB was designed by Olivier and Swart (1974). This then essentially formed the basis of their theory, i.e. that school readiness increases as age and grade increases. Wattie, Cobley and Baker (2008) refer to this as the Relative Age Effect (RAE), this is a phenomenon known to take place as children grow older and increase in maturation, they generally also start performing better academically. Wattie et al. (2008) conducted a study to explore which variables influence academic performance. Their results revealed that RAE, SES and the type of institution the child attends affects academic performance. Additionally, SES is weighted more on the impact on academic performance, however, RAE significantly affects academic performance. Musch and Grondin (2001) corroborate these results.

Like age, grade also increased as school readiness increased. Van Zyl (2011) provided evidence that students who were administered the ASB measure in Grade 4 had performed better than when they were tested on school readiness in Grade 1. This finding directly aligns with the findings in the current study relating to grade, age and school readiness.

Grade repetition.

Grade repetition was too negatively and weakly, but still significantly correlated with the overall ASB. This means that the higher the overall ASB score, the lower the probability of the participant having repeated a year. This was another expected correlation because the more cognitive skills available for school, the fewer difficulties the child is expected to encounter in their scholastic career as they then have the foundational cognitive profile and skillful abilities to overcome any new challenges at school. This is in conjunction with Piaget's theory of cognitive development (1971), which states that as the child explores and is exposed to the environment, they experientially learn and obtain all the skills required for their cognitive capacity and age. When in a new environment like school where new things are being learnt, the child then assimilates and accommodates their cognitive capacity according to the environment.

According to Alexander et al. (2003) children who repeat grades, especially earlier on in their scholastic career (i.e. Gr. R - Gr. 2), are not yet school ready and should have their cognitive, social and psychological abilities assessed and remediated before moving on to a new grade. Failing in preschool and/or Grades 1 and 2 are indicative that the child is not ready to move onto the next grade. These authors reckon that children who repeat a year are retained in that grade and move on with children that are much younger, brighter and smaller than what they are. Despite them being older, they continue the year with a stigma and judgment of failing from teachers and other children who view the child as then being "off-time" (p.1) for the rest of the year, with there being a decline in the future of the child's academic performance and school readiness. The paper by Alexander et al. (2003) questions if grade retention is really the best solution for children as it could have them possibly falling further behind. It thus makes sense that grade retention would predict how school ready a child is. An independent samples t-test conducted in Table 14 above also shows significance between the performance on mean ASB scores of those who repeated grades and those who do not.

Table 14 shows the means on the subscales of perception, reasoning, coordination and memory, as well as the overall ASB scores, which reveal that those who did not fail have higher means on those subscales than those who did fail. The ASB subscales too were expected to correlate with the overall ASB as this is indicative of convergent construct validity.

The ASB norms in this study were found to be deviant from the norms that were originally outlined by Olivier and Swart (1974). The ASB norms were originally tested on a sample of approximately 2000 participants from various areas, however not in Gauteng, and perhaps because this study had a much smaller sample size, the mean and standard deviation deviates from the established norms. Additionally, if these norms had to be reformulated in 2018 in those same areas and under similar conditions as they were in 1994, perhaps the same norms would be found as per the current study. Another reason for why the norms could be different could be language differences - according to the South African census (2011), Gauteng is the most multilingual province in SA. In the years pre-Apartheid and even the immediate years after Apartheid had ended (i.e. 1994), vernacular language was not as encouraged as it is in now (Figone, 2012). For this reason, it becomes possible to see why the English verbal comprehension test has decreased by 0.66 from the norm. In 2017, parents encourage their children to speak more vernacular languages as opposed to just English and Afrikaans which were spoken in previous years (Taylor and Coetzee, 2013), an important factor to consider, given that most psychological and educational tests were previously only conducted in English.

Another reason could be that times have changed and schooling stimulation has increased. According to Singer and Singer (2001), educational stimulation comes in many forms such as television programmes that foster imagination, technological applications (Roschelle et al., 2000), upgraded school facilities at crèche and preschool, and even more so at formal schooling (Young et al., 2003). The idea of parenting has also changed. Previously, pre- and post-Apartheid, parents used to move close to the city for occupational purposes and leave their children to be raised by their grandparents (Walker et al., 1994). Today, employment and transportation has increased to an extent where parents can now presently raise their own children and further add to the stimulation that they receive from their environment. According to Bailey, Haynes and Letiecq (2013), grandparents do still raise their grandchildren, but more so in rural areas as compared to urban areas.

When looking at the percentages in the ASB manual in Figure 3 for school beginners, the table shows that higher percentages lie on the lower scaled norms of the ASB i.e. Norms 1-3, indicating that, even though overall children are school ready, they still perform low to average on most subtests. This might only be true for the current study's sample, but the ASB too has not been recently revised. Additionally, social factors have changed such the ASB was last revised - dynamics around language too have changed. As said previously, the fact that the verbal comprehension subscale does not correlate with all other subscales compromises the overall ASB scales' construct validity and calls for a revision of at least the subscale.

Study Limitations

As repeated previously, this study's biggest limitation can be attributed to sample size. It would be ignorant as a researcher to claim, in light of the limitation of sample size, that none of the above results are applicable. Irrespective of the small sample size, the sample size was sufficient to assume normality according to the central limit theorem, thus the research remains credible. Another limitation was language as a barrier when collecting data, the study needed translators and thus some translated explanations and participant understanding could have been lost in translation, especially on the verbal comprehension task. However, not many participants needed translation.

Another limitation was that many values were missing from the data, however, that was as a result of hospital operationalization, and e.g. contrast participants saw the doctor and never returned for continued testing. Some of the contrast participant's parents would refuse to wait until testing was complete, and thus, due to research ethics, participants rightfully stopped the testing procedure. Parents also passed over some of the demographic questions in the questionnaire which increased the amount of missing values in the data. Contingently, the multiple imputation technique had to be implemented, and this was time consuming.

Recommendations

As a result of these findings, it is recommended that patients with Mi-TBI be followed up by hospital staff, as this research suggests that there are differences in the cognitive profile required for school readiness across the Mi-TBI and Contrast group. With the Mi-TBI group performing poorer than the neurotypical group on all domains of the cognitive profile. Follow up assessments will need to be conducted longitudinally, in order to adequately assess where developmental shortfalls are. The earlier deficits are detected by experts, the earlier the child can receive remedial interventions. Medical experts need to become acquainted with literature, and the controversies surrounding Mi-TBI. This can be a helpful exercise in order to reduce the perception that Mi-TBI has no detrimental effects on children. Additionally, assessing Psychologists should also take cognizance of the medical history of their clients before making any psychological diagnoses as their clients could potentially have psychological sequelae resultant from a head injury and that will determine the type of treatment/therapy the client receives.

Additionally, it would be in the best interests of the school and the child, that schools start using the ASB measure before children enter formal schooling. This test (after revision thereof) would produce the cognitive profile that is needed for school readiness. Once this school profile is met, this would then mean that the child is school ready and can proceed into formal schooling. This could possibly avoid many challenges surrounding grade repetition.

If or before grade repetition does occur, considering that the child has previously had a Mi-TBI, schools should not let the child proceed to the next grade and should instead recommend to the child's parents that the child be enrolled in remedial school. This will allow the child sufficient time and space to develop the cognitive profile needed for school readiness. This too will be done on a pace that the individual is comfortable at, instead of the child being paced at that of mainstream class. Once the child's cognitive ability has been remedially addressed, the ASB can then be re-administered and when the child is school ready to then be classed in mainstream schooling.

Concerning the ASB psychometric measure, the psychometric properties of the test would need to be re-evaluated on the basis of its construct validity being compromised. The ASB can also be correlated with other longer and time consuming batteries. If the ASB subscales strongly correlate with the constructs measured in other school readiness or psychometric measures that test the child's neurocognitive abilities, then the ASB can be used in place of longer batteries. However, this will require various adaptations of the current ASB measure.

Within research, the Mi-TBI field is quite under-developed. Many old controversies are still controversies. With the growing body of literature, more resources should be allocated to understanding and conceptualizing basic terminology, theory, relationships etc. in this field before building up literature around that. Many of the controversies in this field exist because of the misunderstanding of certain concepts. Hence, encouraging sophistication of research in this, valid and reliable research too not only to rectify previous research, but also to inform future practices and research.

Chapter Six: Conclusion

This study aimed (i) to explore whether differences exist between children who have Mild Traumatic Brain Injury (Mi-TBI) and those who do not. It furthermore aimed to explore how those differences, if any exist, impact on school readiness. The Mi-TBI test group was compared to the neurotypical contrast group and results revealed that there were significant differences between the 2 groups on the Memory and Verbal Comprehension subscales, with the Mi-TBI group once more performing poorer as opposed to the neurotypical counterparts. The Mi-TBI group had revealed to perform poorer on all subscales, even though the subscales other than Memory and Verbal Comprehension were not statistically significant, however the mean results still show a trending pattern across all subscales.

Further interrogation of data allowed for the Mi-TBI group to be divided into 3 Mi-TBI groups. The 4 groups compared were; Mi-TBI with positive CT scans, Mi-TBI with negative CT scans, Mi-TBI with no CT scans and lastly a neurotypical contrast group. These groups were tested on the cognitive profile needed for school readiness using the Aptitudes test for School Beginners (ASB). When comparing all 4 groups, results show that there are no significant ASB mean differences across groups except on Co-ordination. Further post-hoc tests reveal that significant differences lie between the Mi-TBI with no scans and the neurotypical contrast group while the largest differences lie between the Mi-TBI with no scans and Mi-TBI with negative scans. Moreover, while some results are comprehensible, others are not, and require further research to help understand and unpack it.

Another aim of this study was (ii) to explore the socio-economic correlations and predictors of the cognitive profile needed for school readiness. Results revealed that age, grade and grade repetitions were significantly correlated to the cognitive profile. Additionally, only grade and preschool attendance significantly predicted the cognitive profile needed for school readiness.

The last aim carried out was (iii) to investigate whether the ASB norms are reliable post-apartheid. Norms described in this study showed means that were different compared to the original mean norm (3) and with greater standard deviation compared to the original standard deviation for the norms. This means that the norms are not consistent. Norm percentages in this study show that most subtests were averaged on the lower norms thus meaning that even though participants appear to be school ready; their results are nonetheless skewing the distribution. The norms might no longer be normally distributed as when the ASB was originally developed, and thus the ASB cannot be reused; it needs adaptations and revising to accommodate the shift in South Africa's environment.

The above results require replication and a larger body of knowledge to contribute to this subject area, to clarify and answer the unanswered questions highlighted above, in order to set straight controversies and correct research. This research acknowledges shortfalls in its own attempt to contribute to research; however, this subject area leaves room for further research to exhaust itself in its endeavours to fill gaps in literature.

References

Acock, A. C. (2005). Working with missing values. *Journal of Marriage and family*, *67*(4), 1012-1028.

Adesunkanmi, A. R., Oginni, L., Oyelami, O., Badru, O. (2000) Road traffic accidents to

African participants: assessment of severity using the Injury Severity Score (ISS). *Injury*.31(4), 225–8.

Alexander, K. L., Entwisle, D. R., & Dauber, S. L. (2003). *On the success of failure: A reassessment of the effects of retention in the primary school grades*. Cambridge University Press.

Anderson, V., Catroppa, C., Morse, S., Haritou, F., Rosenfeld, J. (2001). Outcome from mild head injury in young participants: A prospective study. *Journal of Clinical and Experimental Neuro-psychology*, 23(6), 705–17.

African American youth. *The Journal of Negro Education*, 260-274.

Australian Early Childhood Mental Health Initiative. (2014). Early childhood neurodevelopment[Online pdf].Retrieved from https://www.kidsmatter.edu.au/sites/default/files/public/KidsMatter-Early-Childhood-mental-health-an-introduction-web.pdf.

Babikian, T.,Satz, P.,Zaucha, K., Light, R., Lewis, R.S., & Asarnow, R.F. (2011). The UCLA Longitudinal Study of Neurocognitive Outcomes Following Mild Pediatric Traumatic Brain Injury. *Journal of the International Neuropsychological Society*, 17, 886-9.

Bailey, S. J., Haynes, D. C., & Letiecq, B. L. (2013). “How can you retire when you still got a kid in school?”: Economics of raising grandchildren in rural areas. *Marriage & Family Review*, *49*(8), 671-693.

Basic Education Laws Amendment Act. (2011). Act No.15 of 2011. *Government Gazette 34620*, 555(775), 1-14.

Bazarian, J. J., Mcclung, J., Shah, M. N., Ting Cheng, Y., Flesher, W., & Kraus, J. (2005).Mild traumatic brain injury in the United States, 1998–2000.*Brain injury*, 19(2), 85-91.

Belanger, H. G., Curtiss, G., Demery, J. A., Lebowitz, B. K., & Vanderploeg, R. D. (2005). Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. *Journal of the International Neuropsychological Society*, 11(03), 215-27.

Bialystok, E., Craik, F. I., & Luk, G. (2012). Bilingualism: consequences for mind and brain. *Trends in cognitive sciences*, 16(4), 240-50.

Bijur, P. E., Haslum, M., & Golding, J. (1990). Cognitive and behavioral sequelae of mild head injury in children. *Pediatrics*, *86*(3), 337-344.

Binder, L. M. (1986).Persisting symptoms after mild head injury: a review of the postconcussive syndrome. *Journal of Clinical and Experimental Neuropsychology*, 8(4), 32-346.

Brown, E. D., Ackerman, B. P., & Moore, C. A. (2013). Family adversity and inhibitory control for economically disadvantaged children: Preschool relations and associations with school readiness. *Journal of Family Psychology*, *27*(3), 443.

Buttram, J., Covert, R. W., & Hayes, M. Prediction of school readiness and early grade achievement by classroom teachers. Educational and Psychological Measurement, 1976, 36, 543–546.

Cassidy, J. D., Carroll, L., Peloso, P., Borg, J., Von Holst, H., Holm, L., ...& Coronado, V. (2004). Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of rehabilitation medicine*, 36, 28-60

Catale, C., Marique, P., Closset, A., Meulemans, T. (2009).Attentional and executive functioning following mild traumatic brain injury in participants using the Test for Attentional Performance (TAP) battery. *Journal of Clinical and Experimental Neuropsychology*, 31(3), 331–8.

Catroppa, C., & Anderson, V. (2002). Recovery in memory function in the first year following TBI in children. *Brain Injury*, *16*(5), 369-384.

Census (2011)

Chen, S. A., Kareken, D. A., Fastenau, P. S., Trexler, L. E., & Hutchins, G. D. (2003). A study of persistent post-concussion symptoms in mild head trauma using positron emission tomography. *Journal of Neurology, Neurosurgery & Psychiatry*, *74*(3), 326-332.

Chou, L. S., Kaufman, K. R., Walker-Rabatin, A. E., Brey, R. H., & Basford, J. R. (2004). Dynamic instability during obstacle crossing following traumatic brain injury. *Gait & posture*, *20*(3), 245-254.

De Jager, M. (2012).*Mind Moves ADVANCED INSTRUCTOR Training Manual*. Linden: Mind Moves Institute.

Diamond, L. C., & Jacobs, E. A. (2010). Let's not contribute to disparities: the best methods for teaching clinicians how to overcome language barriers to health care. *Journal of general internal medicine*, *25*(2), 189-193.

Du Plooy, J. (2003). *Brainline*. Pretoria: Brainline- Breinlyn.

Eisenberg, M. A., Meehan, W. P., & Mannix, R. (2014). Duration and course of post-concussive symptoms. *Pediatrics*, 133(6), 999-1006.

Emery, C. A., Barlow, K. M., Brooks, B. L., Max, J. E., Villavicencio-Requis, A., Gnanakumar, V., ... &Yeates, K. O. (2016). A systematic review of psychiatric, psychological, and behavioural outcomes following mild traumatic brain injury in children and adolescents. *The Canadian Journal of Psychiatry*, 61(5), 259-69.

Epstein, H. T. (1974). Phrenoblysis: Special brain and mind growth periods. II. Human mental development. *Developmental Psychobiology*, 7(3), 217-24.

Farrer, T. J. (2010). Positive Versus Negative Neuroimaging in Mild Traumatic Brain Injury Outcome: A Meta-Analysis.

Field, A. (2009). *Discovering statistics using SPSS*. Sage publications.

Figone, K. E. (2012). The hegemony of English in South African education.

Fontaine, N. S., Torre, D. L., & Grafwallner, R. (2006). Effects of quality early care on school readiness skills of children at risk. *Early Child Development and Care*, *176*(1), 99-109.

Geary, E. K., Kraus, M. F., Pliskin, N. H., & Little, D. M. (2010). Verbal learning differences in chronic mild traumatic brain injury. *Journal of the International Neuropsychological Society*, *16*(3), 506-516.

Gooch, D., Thompson, P., Nash, H. M., Snowling, M. J., & Hulme, C. (2016). The development of executive function and language skills in the early school years. *Journal of Child Psychology and Psychiatry*, *57*(2), 180-187.

Gordon, K.E. (2006). Pediatric Minor Traumatic Brain Injury. *SeminPediatrNeurol*, 13, 243-55.

Gronwall, D., &Wrightson, P. (1974).Delayed recovery of intellectual function after minor head injury. *The Lancet*, 304(7881), 605-9.

Halle, T., Forry, N., Hair, E., Perper, K., Wandner, L., Wessel, J., & Vick, J. (2009). Disparities in early learning and development: lessons from the Early Childhood Longitudinal Study–Birth Cohort (ECLS-B). *Washington, DC: Child Trends*, 1-7.

Hamilton, N.A.,& Keller, M.S. (2010).Mild traumatic brain injury in participants. *Seminars in Pediatric Surgery*, 19, 271-8.

Hanlon, Jason A. Demery, Zoran Martinovich, James P. Kelly, R. E. (1999). Effects of acute injury characteristics on neuropsychological status and vocational outcome following mild traumatic brain injury. *Brain Injury*, *13*(11), 873-887.

Head, J. (1993). Definition of mild traumatic brain injury. *J Head Trauma Rehabil*, 8(3), 86-7.

Hofman, P. A., Verhey, F. R., Wilmink, J. T., Rozendaal, N., & Jolles, J. (2002). Brain lesions in patients visiting a memory clinic with postconcussional sequelae after mild to moderate brain injury. *The Journal of neuropsychiatry and clinical neurosciences*, *14*(2), 176-184.

Iverson, G. L., Gaetz, M., Lovell, M. R., & Collins, M. W. (2004). Cumulative effects of concussion in amateur athletes. *Brain injury*, *18*(5), 433-443.

Jeynes, W. H. (2005). The effects of parental involvement on the academic achievement of

Kinsella, G. J., Mullaly, E., Rand, E., Ong, B., Burton, C., Price, S., ... & Storey, E. (2009). Early intervention for mild cognitive impairment: a randomised controlled trial. *Journal of Neurology, Neurosurgery & Psychiatry*, *80*(7), 730-736.

Knezevic, S., Kostovic, I., Wisniewski, H., & Spilich, G. (2012) *Neurodevelopment, aging and cognition*. Boston: Birkhauser.

Kolb, B., & Gibb, R. (2011).Brain plasticity and behaviour in the developing brain. *Journal of the Canadian Academy of Child & Adolescent Psychiatry*, 20(4), 265-77.

Konrad, C., Geburek, A. J., Rist, F., Blumenroth, H., Fischer, B., Husstedt, I., ... & Lohmann, H. (2011). Long-term cognitive and emotional consequences of mild traumatic brain injury. *Psychological medicine*, *41*(6), 1197-1211.

Lack, V. (2016).*Examining neurocognitive, psychosocial and psychiatric sequelae following Mild Traumatic Brain Injury: A potentially significant impact in a Low socio-economic population*. Unpublished doctoral dissertation. The University of the Witwatersrand. Johannesburg.

Landsberg, E., Krüger, D., & Nel, N. (Eds.). (2005). *Addressing barriers to learning: A South African perspective*. Van Schaik Publishers.

Light, R., Asarnow, R., Satz, P., Zaucha, K., McCleary, C., & Lewis, R. (1998). Mild closed-head injury in children and adolescents: Behavior problems and academic outcomes. *Journal of Consulting and Clinical Psychology*, *66*(6), 1023.

Linder, S. M., Ramey, M. D., & Zambak, S. (2013). Predictors of School Readiness in Literacy and Mathematics: A Selective Review of the Literature. *Early childhood research & practice*, *15*(1), n1.

MacNeil, A. J., Prater, D. L., & Busch, S. (2009). The effects of school culture and climate on student achievement. *International Journal of Leadership in Education*, *12*(1), 73-84.

Magnuson, K. A., Meyers, M. K., Ruhm, C. J., & Waldfogel, J. (2004). Inequality in preschool education and school readiness. *American educational research journal*, *41*(1), 115-157.

Maillard-Wermelinger, A., Yeates, K.O., Taylor, H.G., Rusin, J., Bangert, B., Dietrich, A., & Wright, M. (2009).Mild traumatic brain injury and executive functions in school-aged participants. *Developmental Neurorehabilitation*, 12(5), 330–41.

Management of Concussion/mTBI Working Group.(2009). VA/DoD Clinical Practice Guideline for Management of Concussion/Mild Traumatic Brain Injury. *Journal of rehabilitation research and development*, 46(6), CP1.

Mann, T. D., Hund, A. M., Hesson-McInnis, M. S., & Roman, Z. J. (2017). Pathways to School Readiness: Executive Functioning Predicts Academic and Social–Emotional Aspects of School Readiness. *Mind, Brain, and Education*, *11*(1), 21-31.

Marian, V., & Shook, A. (2012). The Cognitive Benefits of Being Bilingual. *Cerebrum: The Dana Forum on Brain Science*, *2012*, 13.

McAllister, T.W., Sparling, M.B., Flashman, L.A., & Saykin, A.J. (2001). Neuroimaging findings in mild traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *23*(6), 775-791.

McCauley, S. R., Boake, C., Levin, H. S., Contant, C. F., & Song, J. X. (2001). Postconcussional disorder following mild to moderate traumatic brain injury: anxiety, depression, and social support as risk factors and comorbidities. *Journal of Clinical and Experimental Neuropsychology*, *23*(6), 792-808.

Meehan, W.P., & Mannix, R. (2010).Pediatric concussions in United States emergency Following Mild Pediatric Traumatic Brain Injury. *Journal of the International Neuropsychological Society*, 17, 886-95.

Mezzacappa, E. (2004). Alerting, orienting, and executive attention: Developmental properties and sociodemographic correlates in an epidemiological sample of young, urban children. *Child development*, *75*(5), 1373-1386.

Mistry, R. S., Benner, A. D., Biesanz, J. C., Clark, S. L., & Howes, C. (2010). Family and social risk, and parental investments during the early childhood years as predictors of low-income children's school readiness outcomes. *Early Childhood Research Quarterly*, *25*(4), 432-449.

Moder, K. (2010). Alternatives to F-test in one way ANOVA in case of heterogeneity of variances (a simulation study). *Psychological Test and Assessment Modeling*, *52*(4), 343-353.

Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental review*, *21*(2), 147-167.

NICHD Early Child Care Research Network. (2002). Early child care and children's development prior to school entry: Results from the NICHD Study of Early Child Care. *American educational research journal*, *39*(1), 133-164

Nugent, G. C., Kunz, G. M., Sheridan, S. M., Glover, T. A., & Knoche, L. L. (Eds.). (2016). *Rural Education Research in the United States: State of the Science and Emerging Directions*. Springer.

Olivier, N. M., & Swart, D. J. (1974).*Manual for the aptitude tests for school beginners*. Pretoria: Human Science Research Council.

Piaget, J. (1971). The theory of stages in cognitive development. Mcgraw-Hill.

Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Kelly, A. M., Nelms, R., & Curran, C. (2002).Impact of early intervention on outcome following mild head injury in adults. *Journal of Neurology, Neurosurgery & Psychiatry*, 73(3), 330-2.

Prasad, M. R., Swank, P. R., & Ewing-Cobbs, L. (2017). Long-term school outcomes of children and adolescents with traumatic brain injury. *The Journal of head trauma rehabilitation*, *32*(1), E24.

Prinsloo, E., Vorster, P. J., & Sibaya, P. T. (1996).*Teaching with confidence*. Pretoria: Kagiso Publishers.

Ramey, C. T., & Ramey, S. L. (2004). Early learning and school readiness: Can early intervention make a difference?. *Merrill-Palmer Quarterly*, *50*(4), 471-491.

Rees, P. M. (2003). Contemporary issues in mild traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 84(12), 1885-94.

Reitan, R. M., & Wolfson, D. (2000). Conation: A Neglected Aspect of Neuropsychological Functioning. *Archives of Clinical Neuropsychology*, 15(5), 443–453.

Reitan, R. M., & Wolfson, D. (2000). The neuropsychological similarities of mild and more severe head injury. *Archives of clinical neuropsychology*, *15*(5), 433-442.

(Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *The future of children*, 76-101.

Schretlen, D. J., & Shapiro, A. M. (2003). A quantitative review of the effects of traumatic brain injury on cognitive functioning. *International Review of Psychiatry*, 15(4), 341-9.

severe head injury. *Archives of clinical neuropsychology*, *15*(5), 433-442.

Silver, J. M., McAllister, T. W., & Yudofsky, S. C. (2011).*Textbook of traumatic brain injury*. American Psychiatric Pub.

Singer, D. G., & Singer, J. L. (2001). Introduction: Why a handbook on children and the media. *Handbook of children and the media*.

Slomine, B., & Locascio, G. (2009). Cognitive rehabilitation for children with acquired brain injury. *Developmental Disabilities Research Reviews*, *15*(2), 133-143.

Statistics South Africa (2012). Census 2011 Statistical release – P0301.4. https://www.statssa.gov.za/publications/P03014/P030142011.pdf

Suhr, J. A., & Gunstad, J. (2002). "Diagnosis threat": The effect of negative expectations on cognitive performance in head injury. *Journal of Clinical and Experimental Neuropsychology*, 24(4), 448-57.

Taylor, L. C., Clayton, J. D., & Rowley, S. J. (2004). Academic socialization: Understanding parental influences on children's school-related development in the early years. *Review of general psychology*, *8*(3), 163.

Taylor, S., & Coetzee, M. (2013). *Estimating the impact of language of instruction in South African primary schools: A fixed effects approach (No. 19/2013)*. Working Papers. Stellenbosch University, Department of Economics.

Udoh, D., & Adeyemo, A. (2013). Traumatic brain injuries in participants: A hospital-based study in Nigeria. *African J Paediatr Surg*, 10(2), 154–9.

Van Eck, S. (2015). What is school readiness?.[Online pdf].Retrieved from https://www.mindmoves.co.za/articles/article/StephaneVanEck_WhatIsSchoolreadiness.pdf.

Van Zyl, E. (2011). The relation between school readiness and school performance in Grade 1 and Grade 7.*SA-Educ Journal*, 8(2), 34-42.

Vanderploeg, R. D., Curtiss, G., & Belanger, H. G. (2005). Long-term neuropsychological outcomes following mild traumatic brain injury. *Journal of the International Neuropsychological Society*, *11*(3), 228-236.

Vanderploeg, R. D., Curtiss, G., Luis, C. A., & Salazar, A. M. (2007). Long-term morbidities following self-reported mild traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *29*(6), 585-598.

Vohr, B. R., & Coll, C. T. G. (1985). Neurodevelopmental and school performance of very low-birth-weight infants: a seven-year longitudinal study. *Pediatrics*, *76*(3), 345-350.

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child development*, *65*(2), 606-621.

Wattie, N., Cobley, S., & Baker, J. (2008). Towards a unified understanding of relative age effects. *Journal of sports sciences*, *26*(13), 1403-1409.

Wheateroft, J., Malley, D., & Morris, R. (2016). Managing Fatigue after brain injury. Headway- The brain injury association: Russell Press Ltd. Nottingham. [Online pdf]. Retrieved from http://www.crftc.org/images/articles/managing-fatigue-after-brain-injury-e-booklet.pdf.

Wrightson, P., McGinn, V., & Gronwall, D. (1995). Mild head injury in preschool participants: evidence that it can be associated with a persisting cognitive defect. *Journal of Neurology, Neurosurgery & Psychiatry*, 59(4), 375-80.

Young, E., Green, H. A., Roehrich-Patrick, L., Joseph, L., & Gibson, T. (2003). Do K-12 School Facilities Affect Education Outcomes? Staff Information Report.

Appendices

APPENDIX A: LETTER OF PROPOSAL APPROVAL

University of the Witwatersrand, Johannesburg

Faculty of Humanities – Postgraduate Office

Private Bag 3, Wits 2050, South Africa • **Tel:** +27 11 717 4007• **Fax:** +27 11 717 4037• **Email:** madile.moeketsi@wits.ac.za

Student Number: 678548

Miss Ashne Courtney Billings
75 Delaware Avenue
Extension 7
Eldorado Park
Johannesburg
1812
Gauteng South Africa

22 June 2017

Dear Miss Billings

APPROVAL OF PROPOSAL FOR THE DEGREE OF MASTER OF ARTS BY COURSEWORK AND RESEARCH IN SOCIAL AND PSYCHOLOGICAL RESEARCH

I am pleased to be able to advise you that the readers of the Graduate Studies Committee have approved your proposal entitled "***Exploring neurocognitive sequelae following mild traumatic brain injury and the effects that it has on school readiness***". I confirm that Ms Enid Schutte has been appointed as your supervisor in the SHCD.

The research report is normally submitted to the Faculty Office by 15 February, if you have started the beginning of the year, and for mid-year the deadline is 31 July. All students are required to RE-REGISTER at the beginning of each year.

You are required to submit 2 bound copies and one unbound copy plus 1 CD in pdf (Adobe) format of your research report to the Faculty Office. The 2 bound copies go to the examiners and are retained by them and the unbound copy is retained by the Faculty Office as back up.

Please note that should you miss the deadline of 15 February or 31 July you will be required to submit an application for extension of time and register for the research report extension. Any candidate who misses the deadline of 15 February will be charged fees for the research report extension.

Kindly keep us informed of any changes of address during the year.

Note: All MA and PhD candidates who intend graduating shortly must meet your ETD requirements at least 6 weeks after your supervisor has received the examiners reports. **A student must remain registered at the Faculty Office until graduation.**

Yours Sincerely

MM Moeketsi

Madile Moeketsi (Ms)
Postgraduate Division
Faculty of Humanities
Private Bag X 3
Wits, 2050

APPENDIX B: DEMOGRAPHIC QUESTIONNAIRE

Principal Investigator- Dr. Vered Lack

Supervisor- Enid Schutte

Researcher- Ashné Billings and Mamakole Alfred Makobe

Part A: Demographics

1. Parent/ Caregiver's date of Birth

Yyyy/ mm/ dd	____/ __/ ___

2. Parent/ Caregiver's Gender

M	F

3. Parent/ Caregiver's Race

Black	
Coloured	
Indian	
White	
Other	

4. Parent/ Caregiver's Home Language

Afrikaans	
English	

Ndebele	
Sepedi	
Sesotho	
Swati	
Tsonga	
Tswana	
Venda	
Xhosa	
Zulu	
Other	

5. Number of Languages Parent/ Caregiver Speaks

Afrikaans	
English	
Ndebele	
Sepedi	
Sesotho	
Swati	
Tsonga	
Tswana	
Venda	
Xhosa	

Zulu	
Other	

6. Parent/ Caregiver's Employment Status

Employed full time (40 or more hours per week)	
Employed part time (less than 40 hours per week)	
Unemployed	
Student	
Retired	
Self-employed	
Home-maker	
Unable to Work	

If employed, what is the name of the company at which you are employed at and what is your occupation?

7. Parent/ Caregiver's Marital Status

Single	
Married	

Divorced	
Widow/ widower	
Separated	

8. Child's Date of Birth

Yyyy/ mm/ dd	____/ __/ ___

9. Child's Gender

M	F

10. Child's Race

Black	
Coloured	
Indian	
White	
Other	

11. Child's Home Language

Afrikaans	
English	
Ndebele	
Sepedi	
Sesotho	

Swati	
Tsonga	
Tswana	
Venda	
Xhosa	
Zulu	
Other	

12. Number of Languages Spoken by the Child

Afrikaans	
English	
Ndebele	
Sepedi	
Sesotho	
Swati	
Tsonga	
Tswana	
Venda	
Xhosa	
Zulu	
Other	

13.1 Who taught the child to speak those language/languages?

13. Child's Preferred Language

Afrikaans	
English	
Ndebele	
Sepedi	
Sesotho	
Swati	
Tsonga	
Tswana	
Venda	
Xhosa	
Zulu	
Other	

Part B: Educational Background

1. Parent/ Caregiver's Highest Level of Education

Less than Grade 7	
Primary School	
High-School (excluding matric)	
Matric	
Certificate	
Diploma	
Technical Qualification	
Degree	
Masters	
PhD	
Other (please specify)	

2. Child's Current Level of Education

2.1 Did the child do to crèche or pre-school before?

2.2 For how long did the child attend crèche, after-care or pre-school?

2.3 Is the child currently enrolled in a school? If not why?

2.4 Did the child ever repeat a grade?

Medical History

1. Were there ever complications when the mother was pregnant with the child?

2. Is there any history of problems at birth or after the birth of the child?

3. Has the child ever needed to be admitted to hospital as a baby or toddler apart from the head injury?

4. How old was the child when he\she had a Mild Traumatic Brain Injury? (in years)

5. Is there any history of surgery that the child has undergone?

6. Is there any history of disease or illnesses for the child (psychological or physiological)?

7. If yes, which? (please tick)

Physiological	

Anxiety	
Diabetes	
Thyroid Disease: Hyper/Hypo	
Arthritis	
Hepatitis,	
Radiation Treatment	
Asthma	
Hypertension (high blood pressure)	
Seizures	
Cancer	
Other (please specify)	
Neurological disease processes	
Previous head trauma	
Immune diseases	
None	

Psychological	
Anxiety disorders (Phobias, General Anxiety Disorder, Panic Disorder, Social Anxiety Disorder, etc.)	

Mood disorders (ie. Depression, Mania, Bipolar 1or 2 etc.)	
Psychotic disorders (ie. Schizophrenia, Delusional Disorder etc.)	
Personality disorders (ie. Borderline personality disorder, Antisocial Personality Disorder, Obsessive Compulsive Personality Disorder etc.)	
Behavioural disorders (ADHD, Conduct disorder, Autism, Learning Disorder etc.)	

8. Is there any history of allergies? (Please specify)

9. Is the child on any form of medication? (Please specify)

10. Cognitive Sequalae

11. Glasgow Coma Scale (GCS)

12. Pre-existing Emotional Disorders

13. Pre-existing Personality Disorders

14. Pre-existing Mental Disorders

15. Pre-existing Behavioural Disorders

Additional Information

1. Do you live with the child?

2. How many people live with the child?

3. How many siblings does the child have?

4. What is the position of the child in the family?

First Born	
Second Born	
Close to Middle Born	
Middle Born	
Last Born	

5. Who looks after the child during the day?

Reference Sheet

This page contains the names and reference numbers of the patients in the investigation. It may not be distributed to anyone without the consent of the researchers and invigilator.

This is an example of how the data will be managed.

	Date (yyyy/mm/dd)	Name and Surname	Reference Number
1			
2			
3			
4			
5			
6			
n			

APPENDIX C: PARENTAL INFORMATION SHEET

Psychology

School of Human & Community Development

University of the Witwatersrand

Private Bag 3, Wits, 2050

Tel: 011 717 4503 Fax: 011 717 4559

Principal Investigator- Dr. Vered Lack

Supervisor- Enid Schutte

Researcher- Ashné Billings

Name of Organization- University of the Witwatersrand

Information Sheet for caregiver

Introduction

I am Ashné Billings, studying at the University of the Witwatersrand. We are doing research on mild traumatic brain injury, which is very common in this country. I am going to give you information about this research and invite you to be part of this research. Before you decide, you can talk to anyone you feel comfortable with about the research.

There may be some words that you do not understand. Please ask me to stop as we go through the information and I will take my time to explain to you in whatever language you speak, if that makes you feel more comfortable. If you have questions later, you can ask them of me, the doctor or the Head Injury Clinic staff.

What is the purpose of the research?

Mild brain injury is becoming one of the most common injuries in this region. The after effects of these types of injury are unknown and this research wants to find out whether patients of mild traumatic brain injury have after effects from the injury or not. We also want to see how it affects how school ready the children who have had mild traumatic brain injury are.

Who are the participants invited to this study?

We are inviting all parents whose children were admitted into the Baragawanth Paediatric Surgery Unit and the children themselves to participate in the research on mild traumatic brain injury and the effects it has on school readiness.

Are you forced to participate in this study?

You and your child's participation in this research are entirely voluntary. It is your choice whether to participate or not. Whether you choose to participate or not, all the services you receive at this clinic will continue and nothing will change. You may change your mind later and stop participating even if you agreed earlier.

What will be done in this study?

We will start off by informing you on the study thereafter you will be given an informed consent forms to sign, the consent form will be for you, the parent/caregiver to consent to participate in the research and also to consent for your child to participate in this research. An assent form will be given to your child as well. Once both forms are signed, we will then proceed with specific tasks that will be administered.

The tasks will be administered to your child, one language group at a time in one room while simultaneously you will be filling out the demographic questionnaire in the next room. The test will be administered by multilingual research colleague who is involved in the same umbrella project; however the researcher will facilitate the process. Multilingual clinic staff will also be present in both rooms to help in cases of illiteracy or simply misunderstanding the task. The test administrator will give instructions from the Aptitude for School beginners test manual. At completion, tasks and questionnaires from both you and your child will be collected by myself and stored in a sealed box which will later be kept in a secure location.

How long will this study take?

The research takes place over 12 months in total. During that time, it will be necessary for you to come to the Head Injury Clinic for only 1 scheduled Friday, for approximately 2 hours.

Will I be reimbursed?

We will give you the amount of money to pay for your travel to the Head Injury Clinic. You will not be given any other money or gifts to take part in this study.

Will the research protect the confidentiality and anonymity?

Participants will be made aware that all data will be kept confidential, in a secure location. Anonymity can be guaranteed because the data sheet will only be identified by a participant number in cases where follow up is necessary.

Who will have access to the data?

Summary Reports will be made available to the Hospital for the participants file and parents are welcome to consult with Dr. Lack with regards to the results on the participants tasks. Any problematic cases will be highlighted for Dr Lack for her attention as their medical practitioner in charge of the case

The Hospital too will have access to a data report and a copy of my thesis to be used by management at any point to further research.

Who to Contact

Who can I contact regarding this research?

Enid Schutte: (011)-717-4521 or enid.schutte@wits.ac.za

Ashne Billings: (061 730 2835) or ashnebillings7@gmail.com

Dr. Lack: veredlack@yahoo.com

Please contact us with further questions regarding this research

APPENDIX D: PARENTAL INFORMED CONSENT FORM

Psychology

School of Human & Community Development

University of the Witwatersrand

Private Bag 3, Wits, 2050

Tel: 011 717 4503 Fax: 011 717 4559

Exploring neurocognitive sequelae following Mild Traumatic Brain Injury and the effect it has on school readiness.

This is Informed Consent form for parents of children who were admitted into the Paediatric Surgery Unit and the child. We would like to take this opportunity to invite you to participate in the research on mild traumatic brain injury.

Principal Investigator- Dr. Vered Lack

Supervisor- Enid Schutte

Researcher- Ashné Billings

Name of Organization- University of the Witwatersrand

I ______________________________ have read the foregoing information on the research project "exploring neurocognitive sequelae following Mild Traumatic Brain Injury and the effects that it has on school readiness", or it was read to me. I have asked all questions about the research and have been answered satisfactorily. I voluntarily give my consent to participate in this research.

I ______________________________ have been invited to have my child participate in the research project exploring neurocognitive sequelae following Mild Traumatic Brain Injury and the effects that it has on school readiness". I voluntarily give my consent to the participation of my child in this research.

Participant's signature ____________________

Date ____________________________

Researcher name __Ashné Billings______________________

Researcher /person signature___________________________

Date ____________________________

APPENDIX E: CHILD INFORMATION SHEET

Psychology

School of Human & Community Development

University of the Witwatersrand

Private Bag 3, Wits, 2050

Tel: 011 717 4503   Fax: 011 717 4559

Principal Investigator- Dr. Vered Lack

Supervisor- Enid Schutte

Researcher- Ashné Billings

Name of Organization- University of the Witwatersrand

<u>Information Sheet for child</u>

Introduction

I am Ashné Billings, I am studying at the University of the Witwatersrand. We are doing research work on head injury, which is very common in this country. I am going to tell you about this and ask you to be part of this research. Before you decide, you can talk to anyone you want to talk with about the research.

There may be some words that you do not understand. Please ask me to stop as we go through the information and I will take my time to explain to you in whatever language you speak, if you want me to. If you have questions later, you can ask them of me, the doctor or the people that work at the clinic.

What is the purpose of the research?

Head injury is becoming one of the most common injuries in this region. We do not know much about the effects of it and this research wants to find out whether children with head injuries have effects after the injury or not. We also want to see if it affects your schooling.

Who are the participants invited to this study?

We are asking all those children who had head injuries and were admitted into the Baragawanth Hospital to take part in this research on head injury and the effects it has on schooling.

Are you forced to participate in this study?

You must want to take part in this research. It is your choice. Whether you choose to take part or not, all the services you get at this clinic will still be given to you and nothing will change. You may change your mind later and stop taking part even if you wanted to earlier.

What will be done in this study?

We will start off by telling you about the study. We will give you an assent form for you sign. Once the form is signed, we will then give you a fun activity to do.

The activity will be explained to you in your home language and you will be told what to do in the activity. There will be people to help you if you do not understand. When you are done with the activity it will be collected by me and closed up in a box and later on put in a locked cupboard.

How long will this study take?

The research is 12 months long. You will be asked to come to the Head Injury Clinic for only 2 hours on 1 Friday.

What will I get in return?

We will give you back the money that you used to come to the Head Injury Clinic. You will not be given any other money or gifts to take part in this study.

Who will know what I wrote and who I am?

No-one will know who you are only me and the doctor so no-one will know what you wrote in the activity because when you are done with it I will close it up in a box and put it in a locked cupboard.

Who to Contact

Who can I contact regarding this research?

Enid Schutte: (011)-717-4521 or enid.schutte@wits.ac.za

Ashne Billings: (061 730 2835) or ashnebillings7@gmail.com

Dr. Lack: veredlack@yahoo.com

Please contact us with further questions regarding this research

APPENDIX F: ASSENT FORM FOR CHILD

Psychology

School of Human & Community Development

University of the Witwatersrand

Private Bag 3, Wits, 2050

Tel: 011 717 4503 Fax: 011 717 4559

ASSENT FORM FOR CHILD

I understand the research is about Mild Traumatic Brain Injury and a test on school readiness will be given to me to complete under the instruction of a co-researcher.

I had the information regarding the research read to me. I have asked all questions about the research and have been answered satisfactorily and any other questions can be asked later.

I assent to participate in this research.

Child's name___________________

Child's signature: ____________________

Date:_______________

Researcher's name_________________

Researcher's signature___________________

Date___________________

Has the participant received a copy of from? Yes / No

Has the Caregiver/Parent signed the informed consent form? Yes / No

Researcher's initial_______________

APPENDIX G: UMBRELLA PROJECT'S ETHICS CLEARANCE

Dr. Lacks' Ethics Clearance

Human Research Ethics Committee (Medical)

Research Office Secretariat: Faculty of Health Sciences, Tel +27 (0)11-717-1234

Phillip Tobias Building, 3rd Floor, Office 304 Tel +27 (0)11-717-2700

Corner York and 29 Princess of Wales Terrace, Parktown, 2193 Tel +27 (0)11-717-2656

Private Bag 3, Wits 2050, Fax +27 (0)11-717-1265 Email: Rhulani.Mkansi@wits.ac.za

Office Email: HREC-Medical.ResearchOffice@wits.ac.za

Website: www.wits.ac.za/research/about-our-research/ethics-and-research-integrity/

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Office of the Deputy Vice-Chancellor Research & Post Graduate Affairs

MEMORANDUM

TO: Dr Vered Lack et al

Department of General Surgery

E-mail: veredlack@yahoo.com

FROM: Mr Rhulani Mkansi

Administrative Officer: Human Research Ethics Committee (Medical)

Tel: 011 717-1234

E-mail: Rhulani.Mkansi@wits.ac.za

DATE: 22 December 2016

REF: ***R14/49***

PROTOCOL NO: M1611113 *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

The protocol below was considered at a meeting of the Human Research Ethics Committee (Medical**)** **on Friday 25 November 2016.** The Committee requires the following amendments/corrections/information from you before your application can be approved.

Project Title: Examining Neurocognitive, Psychosocial and Psychiatric Sequelae Following Mild TBI (Traumatic Brain Injury): A Potentially Significant Impact in a Low Socio-Economic Population

Conditions: Approved subject to:

- *Information Sheet:*

o Please correct the typographical error in *"why your child is being asked to participate?"* - *"…**Mid** Head Injury".*

- *Other:*

o Will there be referral for participants who are identified as having psychiatric disorders which require intervention?

NB:

1. This memo is not a clearance certificate, no research should commence prior to obtaining a clearance certificate.

2. Please submit two hard copies of the following to the Research Office:

o **Covering letter:** list all the conditions above and write your response below the each condition and attach relevant documentation, highlight/track any changes made.

o **Signed declaration** confirming that data has not been collected for the study.

o **Amendments** must be sent within **3 months** after submission.

o The default in the research office is hard copies. **Email submission will not be considered.**

3. Delivery Address for amendments:

o Research Office, Faculty of Health Sciences, Phillip Tobias Building, Third Floor, Corner York Road and 29 Princess of Wales Terrace.

4. Office hours: 08h30-16h30.

APPENDIX H: NESTED RESEARCH'S ETHICS CLEARANCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (SCHOOL OF HUMAN & COMMUNITY DEVELOPMENT

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: MASPR/17/001 IH**
PROJECT TITLE:	Exploring neurocognitive sequelae following mild traumatic brain injury and the effects that it has on school readiness
INVESTIGATORS	Billings Ashné
DEPARTMENT	Psychology
DATE CONSIDERED	28/06/17
DECISION OF COMMITTEE*	Approved

This ethical clearance is valid for 2 years and may be renewed upon application

DATE: 28 June 2017

CHAIRPERSON G. Finchilescu
(Prof. Gillian Finchilescu)

cc Supervisor: Ms Enid Schutte
Psychology

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and **one copy** returned to the Secretary, Room 100015, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure, as approved, I/we undertake to submit a revised protocol to the Committee.

This ethical clearance will expire on 31 December 2019

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES