Psychometric evaluation of the Kaufman Assessment Battery for Children, Second Edition (KABC-II) in rural South Africa

by
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*Thesis presented in fulfilment of the requirements for the degree of
Master of Arts (Psychology) in the Faculty of Arts and Social Sciences at
Stellenbosch University*

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December 2015

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December 2015

Abstract

Millions of children living in low- and middle-income countries (LMICs) are not fulfilling their cognitive potential. Early interventions may aid in alleviating the effects of risk factors and thus promote cognitive development. To determine the effectiveness of these interventions, accurate measures of cognitive development are necessary. Measuring the intelligence of children in LMICs has often been contentious, as traditional intelligence quotient (IQ) assessments have largely been used. Traditional IQ assessments measure acquired knowledge that is known to be biased towards school exposure. Recently, given improvements in our understanding of the human brain, there has been a shift towards using assessments that measure cognitive processing, i.e. the skill-set necessary to solve tasks. Given their ability to measure cognitive potential to learn, rather than acquired learning, these assessments are deemed more culture fair. The KABC-II is an example of such an assessment and is increasingly used in LMICs. The KABC-II consists of four scale indexes evaluating performance (Sequential, Learning, Simultaneous and Planning) and has often been translated and adapted for these contexts. However, studies examining the psychometric properties of these adapted assessments are sparse.

The primary aim of this research was to evaluate the psychometric properties of a translated and adapted version of the KABC-II in a sample of healthy, isiZulu-speaking children of primary school-age in rural South Africa. The evaluation was achieved through two objectives; firstly by evaluating performance on the adapted KABC-II and secondly through examining whether the underlying structure of the KABC-II was maintained. Using data from a sub-sample of 382 children (part of a larger project), performance on the KABC-II was evaluated using descriptive statistics. The underlying factor structure of the battery was examined using confirmatory and exploratory factor analyses.

The confirmatory factor analysis showed two models representing plausible structures of the KABC-II which were good fits to the data. One model included an overall factor (as in the original KABC-II) and the other excluded an overall factor. Within the model including the overall factor, correlations between two of the four scale indexes (Simultaneous and Planning) were shown to be high. This strong association was confirmed in the exploratory factor analysis, where the subtests of these scale indexes emerged as one factor. Performances on these scale indexes were the weakest, with the Planning Scale subtests having the lowest means. The low means may indicate that the Planning Scale might not be optimally culturally appropriate in this context, but could alternatively suggest a deficit in executive functioning skills required to complete these tasks. A lack of executive functioning skills may be due to the presence of biological and psychosocial risk factors, including maternal education.

In conclusion, the KABC-II was an appropriate assessment to use in this rural Zulu context, as it was appropriately translated, adapted and piloted. Future research should aim to establish the strength of the overall factor and the appropriateness of the Planning Scale subtests in LMICs. Further research should be done to investigate the effects of biological and psychosocial risk factors on cognitive development. Such studies may inform interventions which could lead to improvements in the cognitive development of children in rural South Africa and other LMICs.

Opsomming

Miljoene kinders in lae- en middelinkomste lande (LMICs) bereik nie hulle kognitiewe potensiaal nie. Vroeë intervensies kan moontlik die gevolge van risikofaktore verlig en derhalwe kognitiewe ontwikkeling bevorder. Om die doeltreffendheid van sulke intervensies te bepaal, word akkurate metings van kognitiewe ontwikkeling benodig. Meting van intelligensie van kinders in LMICs is dikwels omstrede, omrede tradisionele intelligensie kwosient (I.K.) assesserings grotendeels gebruik word. Tradisionele I.K. assesserings meet kennis wat bevooroordeeld is tot skoolblootstelling. Onlangs, gegee verbeteringe in ons begrip van die menslike brein, het daar 'n verskuiwing plaasgevind na die gebruik van assesserings wat kognitiewe verwerking meet, m.a.w. meting van die vaardighede benodig om take op te los. Gegewe hul vermoë kognitiewe potensiaal om te leer, eerder as verkry leer te meet, is hierdie assesserings word as meer kultuurbillik beskou. Die KABC-II is 'n voorbeeld van hierdie tipe assessering en word al hoe meer in LMICs gebruik. Dit bestaan uit vier skaalindekse vir prestasie evaluering (naamlik Sequential, Learning, Simltaneous en Planning) en word dikwels vertaal en aangepas vir gebuik in hierdie konteks. Studies wat die psigometriese eienskappe van hierdie assesserings ondersoek, is egter skaars.

Die primêre doel van hierdie navorsing was evaluering van die psigometriese eienskappe van 'n vertaalde en aangepaste weergawe van die KABC-II onder 'n groep gesonde, Zulusprekende kinders van laerskoolouderdom in landelike Suid-Afrika. Die evaluering is bereik deur twee doelwitte; eerstens deur die evaluering van prestasie op die aangepaste KABC-II en tweedens deur te bepaal of die onderliggende strukture van die KABC-II gehandhaaf is. Data van 'n sub-groep van 382 kinders (deel van 'n groter projek) is gebruik om prestasie op die KABC-II te evalueer met behulp van beskrywende statistiek. Die onderliggende faktorstruktuur van die toetse is ondersoek deur bevestigende en ondersoekende faktorontledings.

Die bevestigende faktorontledings het twee geloofwaardige modelstrukture van die KABC-II getoon, wat goed by die data gepas het. Een model het 'n algehele faktor ingesluit (soos in die oorspronklike KABC-II), terwyl die ander een 'n algehele faktor uitgesluit het. Die model wat die algehele faktor ingesluit het, het hoë korrelasies getoon tussen twee van die vier skaalindekse, naamlik Simultaneous en Planning. Hierdie sterk assosiasie is in die ondersoekende faktorontleding bevestig, waar die subtoetse van hiedie skale as een faktor na vore gekom het. Prestasie op hierdie skaalindekse was die swakste, met die laagste gemiddeld gevind by die Planning Skaal subtoetse. Die lae gemiddeld mag moontlik daarop dui dat die Planning Skaal in hierdie konteks nie optimaal kultureel gepas is nie, maar alternatiewelik mag dit ook dui op 'n gebrek aan die nodige uitvoerende funksionering om hierdie take te voltooi. 'n Gebrek aan uitvoerende funksionering mag te wyte wees aan die teenwoordigheid van biologiese en psigososiale risikofaktore, insluitend moeder-onderwys.

Die slotsom is bereik dat die KABC-II was'n gepaste assessering vir gebruik in hierdie landelike Zulu konteks, soos dit was gepas vertaal, aangepas en geloods word. Toekomstige navorsing moet poog om die sterkte van die algehele faktor en die toepaslikheid van die Planning Skaal subtoetse in LMICs te bepaal. Verdere navorsing word ook benodig om die gevolge van biologiese en psigososiale risikofaktore op kognitiewe ontwikkeling te ondersoek. Sulke studies mag intervensies toelig wat kan lei tot verbeterde kognitiewe ontwikkeling van kinders in landelike Suid-Afrika en ander LMICs.

Acknowledgements

I would like to thank the following people who supported me through this process:

- Thank you to my supervisor, Professor Mark Tomlinson, for guiding me through this process. I really appreciate your prompt and helpful feedback.

- To my co-supervisor, Dr Tamsen Rochat, for all your support over the last two years. Thank you to you and Dr Ruth Bland for making my Africa Centre experience possible- I would not have had all the amazing experiences I had in KZN if it hadn't been for both of you.

- To Dr James Ndirangu, thank you for your statistical support and patience as I learned how to use STATA.

- To my Africa Centre colleagues and Siyakhula team; to Samu, Hlengiwe, Mam TT, Albertina, Dumo, Thembe, Debra, Gugu, Nompilo, Vuyi and Bongi; first of all for your hard work in data collection and work on the Siyakhula study. Secondly for becoming like family to me, accepting me, teaching me some isiZulu and showing me such kindness. A special thank you to Samu, working so closely with you was a pleasure.

- A big thank you to my parents, for your unconditional love and support.

- To my friends; a special thank you to Bronwyne and Amy, for always being there with kind words and cups of tea.

- A special thank you to Jan - for everything, your support and consideration has been invaluable in me completing this dissertation.

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List of Abbreviations

ADF: Asymptotically distribution-free

Africa Centre: Africa Centre for Health and Population Studies

BREC: Biomedical Research Ethics Committee

CFA: Confirmatory factor analysis

CFI: Comparative Fit Index

CHC: Cattell-Horn-Carroll

DSS: Demographic Surveillance System

DSA: Demographic Surveillance Area

EFA: Exploratory factor analysis

HICs: High-income countries

HIV: Human immunodeficiency virus

IQ: Intelligence quotient

K-ABC: Kaufman Assessment Battery for Children

KABC-II: Kaufman Assessment Battery for Children, Second Edition

LMICs: Low- and middle-income countries

MPI: Mental Processing Index

$\boldsymbol{R^2}$: R-squared value

RMSEA: Root Mean Square Error of Approximation

RTHC: Road to Health Card

SRMR: Standardized Root Mean Square Residual

TB: Tuberculosis

VIF: Variance Inflation Factor

VTS: Vertical Transmission Study

WISC: Wechsler Intelligence Scale for Children

χ2: Chi-square statistic

Chapter 1

Introduction

1.1 Background

An estimated 200 million children born in low- and middle-income countries (LMICs) do not reach their full cognitive potential (Grantham-McGregor et al., 2007). Key risk factors contributing to this loss can be both biological and psychosocial (Walker et al., 2011). Interventions limiting the adverse effects of these risk factors in the first years of a child's life may promote children's cognitive potential in LMICs (Engle et al., 2007).

Saving Brains, funded by Grand Challenges Canada, is a grant program which has provided funding to 11 reenrollment studies in LMICs with the aim of increasing evidence in support of effective early interventions to promote children's later cognitive development (http://www.grandchallenges.ca/saving-brains/). One of these studies was the Siyakhula (translated from isiZulu; "we are growing") study, conducted at the Africa Centre for Health and Population Studies (Africa Centre), in Northern KwaZulu-Natal, South Africa. The Siyakhula study examined the impact of an exclusive breastfeeding support intervention on children's physical, cognitive and social development at ages 7-11 years. The Kaufman Assessment Battery for children (KABC-II) was used to assess cognitive development in the Siyakhula study.

Intelligence testing originated in the early 1900s and became popular as it became a primary tool for identifying children with learning disabilities and aiding in educational placements (Benson, 2003). Most of these traditional intelligence quotient (IQ) tests - such as the Wechsler Intelligence Scale for Children (WISC) - originated in the United States and are still largely used today to assess intelligence.

The use of such traditional IQ assessments has been contentious, particularly in LMICs, where they may be culturally inappropriate and biased towards school exposure (Kitsao-Wekulo, Holding, Taylor, Abubakar, & Connolly, 2012). This bias is rooted in these traditional assessments measuring acquired knowledge and not measuring cognitive processing or the potential for learning among children with less or little exposure to quality education, as is often the case in LMICs (Alcock, Holding, Mung'ala-Odera, & Newton, 2008).

With the advancement of MRI technologies, the understanding of how the human brain functions has changed, leading to the development of new theories of cognition (Folsom & Matthews, 2013). These theories represent a shift away from measuring the concept of intelligence towards the concept of cognitive processing. Cognitive processing encapsulates the underlying processes and skills necessary to solve tasks and is a dynamic concept which can be developed and promoted (Mayer, 2000), whereas intelligence represents a more static concept (Benson, 2003). These cognitive processing approaches allow for learning and practice and as a result, are found to be more culture fair and are increasingly used in LMICs (Alcock et al., 2008; Sternberg & Grigorenko, 2004).

The KABC-II is a cognitive processing assessment which overcomes many of the limitations of traditional IQ assessments (Kaufman, Lichtenberger, Fletcher-Janzen, & Kaufman, 2005). The battery consists of four scale indexes (Learning, Sequential, Simultaneous and Planning) and eight core subtests. It has been increasingly used with children in LMICs, for example in India (Malda, van de Vijver, Srinivasan, Transler, & Sukumar, 2010), Uganda (Bangirana et al., 2009), Malawi (Boivin et al., 2011) and South Africa (Baumgartner et al., 2012; Ogunlade et al., 2011). The KABC-II was selected as a core metric for majority of the Saving Brains studies because of its aim to be culturally fair. The only alternative testing method under consideration was the McCarthy Scales of Children's

Abilities, which has been validated with samples of South African and rural Zimbabwean children (Kandawasvika, Mapingure, Nhembe, Mtereredzi, & Stray-Pedersen, 2012; Richter, Griesel, & Rose, 1994). However, in contrast to the KABC-II with an upper limit of 18 years, this assessment has an upper limit of 8 years, making it inappropriate for this cohort of 7-11 year old children, since a single measure valid for all children across all age groups was required.

While the KABC-II provides a more culturally fair approach, the battery has primarily been developed and validated in high-income countries (HICs). Therefore when used in a new cultural context, three steps are vital; adequate translation, adaptation and psychometric evaluation (Nampijja et al., 2010; Oakland, 2009). The steps of translation and adaptation are important to ensure accuracy of instructions and fairness in administration (Peña, 2007). Furthermore, to ensure that these translation and adaptation steps do not alter the construction of the assessment or the assessment principles, a psychometric evaluation step is essential to ensure equivalence with the original version (Prado et al., 2010). When assessments are administered in new cultural settings without the completion of these three steps, inaccurate results may be obtained (Fischer & Milfont, 2010).

1.2 Motivation for the Current Research

While these three steps are strongly recommended, they have not been consistently applied to the use of the KABC-II in LMICs. In addition, the research which has utilized the KABC-II in Africa has been conducted with clinical samples of children with significant morbidity such as cerebral malaria or malnutrition (Bangirana et al., 2011; Boivin et al., 2011; Ogunlade et al., 2011), these morbidities have been shown to effect cognitive development (Walker et al., 2011). The prior research utilizing the KABC-II in South Africa, only administered a few individual subtests with a younger age group and no psychometric evaluation data was published (Baumgartner et al., 2012; Ogunlade et al., 2011). There is no

research to date which has evaluated the psychometric properties of a translated and adapted version of the entire KABC-II battery with a non-clinical rural sample in South Africa.

1.3 Overview of Chapters

The dissertation is presented in 4 chapters (Chapters 2 to 5). Chapter 2 gives an overview of the literature on: the loss of developmental potential in children in LMICs; the contentious nature of intelligence testing in these contexts; the use of traditional IQ assessments and cognitive processing assessments; and the importance of adequate translation, adaptation and psychometric evaluation of measures used in different contexts. The methodology utilised in this research is outlined in Chapter 3, including: the research context, the research design, recruitment procedure, sample, data sources, data collection, data entry and data analysis. Chapter 4 documents the results and Chapter 5 gives a discussion of these results including conclusions, limitations and recommendations for future research.

Chapter 2

Literature Review

2.1 Unfulfilled Cognitive Potential in LMICs

Children in LMICs are particularly at risk of lowered cognitive development as they face a myriad of risk factors in the context of poverty which contribute to this (Walker et al., 2011). These risk factors can be conceptualised as biological and psychosocial, these two classes of risk factors are interdependent and interact to shape the cognitive development process of a child (Fernald, Kariger, Engle, & Raikes, 2009; Walker et al., 2011). Some key biological and psychosocial risk factors for lowered cognitive development are described below.

2.1.1 Biological risk factors. Biological risk factors which may affect children's cognitive development in LMICs include but are not limited to: low birth weight, malnutrition, environmental exposures and exposure to diseases. Furthermore, the protective factor breastfeeding is discussed.

Low birth weight is a common complication of pregnancies in many LMICs, mainly due to poor maternal nutrition and possible maternal infections (Walker et al., 2007). An estimated 16% of children born in LMICs have a low birth weight (Walker et al., 2011), which has in turn been linked to poorer cognitive outcomes later in a child's life (J.M. Gardner, Walker, Powell, & Grantham-McGregor, 2003; Hack et al., 2002).

In addition to low birth weight, children in LMICs face chronic malnutrition which may lead to stunting, which affects an estimated 34% of children younger than five years in these countries (Walker et al., 2011). Research has consistently shown that stunting is associated with later cognitive developmental deficits and poor school performance (Daniels & Adair, 2004; Walker, Chang, Powell, & Grantham-McGregor, 2005).

Environmental exposures are more likely to be experienced in LMICs, these include contaminated drinking water leading to exposure to chemicals (Walker et al., 2007). Children exposed to environmental lead, arsenic and manganese were shown to have lower levels of cognitive development later in life (Lanphear et al., 2005; Tsai, Chou, The, Chen, & Chen, 2003; Wasserman et al., 2006).

Children's cognitive development in LMICs is also vulnerable to the presence of diseases, which are prevalent among children under five years (Carter, Neville, & Newton, 2003). Infectious diseases such as human immunodeficiency virus (HIV) can cause delays in multiple developmental domains, including cognitive development, in both positive and affected children (HIV negative but exposed in utero) (L.K. Brown & Lourie, 2000; Le Doaré, Bland, & Newell, 2012; Sherr, Croome, Castaneda, & Bradshaw, 2014). In addition to HIV, malaria and tuberculosis (TB) have also been shown to have long lasting negative effects on the cognitive development of children (Bangirana et al., 2011; Boivin et al., 2011; Dhuria, Sharma, & Ingle, 2008; Schoeman, Herbst, & Nienkemper, 1997).

Breastfeeding is a protective factor which can help curb the effects of these biological risk factors; it promotes the immune system and reduces child mortality (Dewey, Heinig, & Nommsen-Rivers, 1995). In addition to promoting a child's physical health, breastfeeding has been shown to positively influence educational attainment and levels of cognitive development, although not unequivocally so (Horwood, Darlow, & Mogridge, 2001; Kramer et al., 2008; Walfisch, Sermer, Cressman, & Koren, 2013).

2.1.2 Psychosocial risk factors. In addition to biological risk factors, children in LMICs face psychosocial risk factors which may adversely impact cognitive development. These include but are not limited to: child education, maternal education, maternal depression, maternal sensitivity and cognitive stimulation.

There is a strong association between years of education and performance on assessments in any context (O'Donnell et al., 2012), yet the number of children attending school in LMICs is fewer and the quality of education may be more varied than in HICs (Barro & Lee, 1996). In addition, these children are more likely to experience school disruption, for instance children who are HIV unaffected but have a mother who seroconverted since birth, may experience added responsibilities at home and subsequent school disruption (Foster & Williamson, 2000). In terms of how children learn, studies in both LMICs and HICs have shown that children become more sequential processing dominant when entering formal schooling (Conant et al., 2003; Kaufman & Kamphaus, 1984; Malda et al., 2010), yet in classrooms with larger numbers of children - as commonly found in LMICs - with less educational materials and books available, rote learning may be more common (Glewwe, 2002; Malda et al., 2010).

In addition to the child's level of education, maternal education level influences children's outcomes as it reduces exposure to developmental risks and promotes a better developmental trajectory for children (Wang, Wang, & Huang, 2008). Specifically in terms of cognitive development, children with educated mothers have been shown to have a higher level of cognitive development and to perform better at school than children with less educated mothers (Barros, Matijasevich, Santos, & Halpern, 2010; Tong, Baghurst, Vimpani, & McMichael, 2007).

Further risk factors which have been shown to influence children's cognitive development, and which interact and influence each other, are: maternal depression, maternal sensitivity and cognitive stimulation. Maternal depression has been shown to lead to lower levels of cognitive functioning in young children in both HICs and LMICs (Galler, Harrison, Ramsey, Forde, & Butler, 2000; Kurstjens & Wolke, 2001; Patel, DeSouza, & Rodrigues, 2003). However, prevalence rates for depression are higher in LMICs countries, with 34.7% of South African mothers living in poverty having been diagnosed with depression (Tomlinson, Cooper, Stein, Swartz, & Molteno, 2006). The effects of maternal depression on the mother-infant relationship are seen through its impact on child-rearing behaviours, as mothers suffering from depression may be less involved and less sensitive when interacting with their children (Cooper et al., 2002; Murray, Hipwell, Hooper, Stein, & Cooper, 1996; Rahman, Harrington, & Bunn, 2002).

Maternal sensitivity alone, without the added effects of maternal depression, is a risk factor for poor cognitive development (Page, Wilhelm, Gamble, & Card, 2010). The presence of maternal sensitivity may contribute to making the interactions between child and mother more rewarding, and thus, increase the amount of cognitive stimulation the child receives (Bradley et al., 1994; Burchinal, Campbell, Brayant, Wasik, & Ramey, 1997). Cognitive stimulation and learning opportunities at home are integral parts of a child's cognitive development (Guo & Harris, 2000). The provision of increased cognitive stimulation and learning opportunities has been shown to improve cognitive functioning (Eickmann et al., 2003; Kagitcibasi, Sunar, & Bekman, 2001; Watanabe, Flores, Fujiwara, & Tran, 2005).

2.2 Assessing Cognitive Development

Increasingly there has been a scale up of early childhood interventions in LMICs, in an attempt to curb the effects of these risk factors (Engle et al., 2007). A crucial component of the success of these interventions is being able to determine their impact, which requires accurate measures of cognitive development. These accurate measures are necessary as currently there are limited national statistics on the cognitive development of young children in LMICs; this gap in knowledge contributes to the problem of poor development (Fernald et al., 2009; Grantham-McGregor et al., 2007).

Accurate and reliable data on children's cognitive development are especially important when results are able to inform the provision of future funding and interventions. This issue was highlighted in a meta-analysis which found that the majority of people in Sub-Saharan Africa have IQs of well below average (Lynn & Vanhanen, 2006). These findings have fuelled rigorous debate, with some supporting the notion of a general lower IQ of the population in Sub-Saharan Africa (Rushton & Jensen, 2010). However, others argue that these findings are an underestimation as the systematic review had included studies which utilised traditional IQ assessments which had not been adequately adapted and validated for those specific contexts, and samples were included who had experienced significant morbidity, such as malaria and the effects of intestinal parasites (Wicherts, Dolan, & van der Maas, 2010).

2.2.1 Consideration of culture. To accurately assess cognitive development in other cultures and allow for valid results and interpretation, the role of culture needs to be considered. Specifically in that each assessment used should be appropriate for the cultural setting in which it is used. However given the complex nature of culture, conflicting views have emerged pertaining to the consideration of culture in regard to assessments.

One, motivating that each culture should have its own specific assessment methods as different cultures may place differential emphasis on the importance of certain skills (Bruner, 1990; Greenfield, 1997). This approach has benefits in that these assessments would capture the nuances of each culture in-depth, however there would be a loss in the ability, not to compare, but to explore potential reasons for differences in assessment scores across different cultural contexts. This ability to explore differences may be important as this could inform which contexts may be in the most need of intervention in certain areas.

Conversely others suggest that equivalence in testing across cultures should be established so scores can be compared across contexts, this involves the assessment of children across cultures being conducted in a similar manner (Poortinga, 1989; van de Vijver & Poortinga, 1997); however this approach could ignore the uniqueness of individual cultures and might disadvantage children in LMICs.

While each of these approaches has benefits, they both have limitations. Recently there has been a shift in the use of assessments which allows for a compromise between these two standpoints. This shift includes moving away from the use of traditional IQ assessments, towards cognitive processing assessments which aim to measure underlying skills necessary to solve tasks. These cognitive processing assessments have the capacity to include sensitivity to cultural context while not losing comparability (Folsom & Matthews, 2013;

Watson & Emery, 2009). Traditional IQ assessment approaches and more recent cognitive processing approaches are described below.

2.2.2 Traditional IQ assessments. Traditional IQ assessments have predominantly focused on a single score reflecting intelligence, which is then used for placement and classification decisions in schools and other institutions (Reschly & Wilson, 1990). This single score is derived mainly from the assessment of verbal abilities and performance.

The association between school exposure and subsequent performance on traditional IQ assessments has been well established, with school exposure encouraging the acceleration of cognitive skills needed to perform well on these assessments (Alcock et al., 2008; Blair, Gamson, Thorne, & Baker, 2005). Therefore, children with little school exposure such as in most LMICs, or exposure to poor quality schooling, may perform poorly on these traditional IQ assessments (Holding & Kitsao-Wekulo, 2004; Nampijja et al., 2010). This has also been shown to be the case with traditional IQ assessments administered to children with differing school exposure in HICs (Deary & Johnson, 2010). These children are also not afforded the opportunity to practice and learn as part of the testing situation, which could result in lower scores. In this sense these scores reflect a static entity, and do not realistically reflect the child's capacity to learn given exposure to schooling or better quality schooling.

Traditional IQ assessments may therefore be inappropriate in LMICs, even if adapted, translated and validated for a specific context, the underlying issue of measuring acquired knowledge and showing bias to school exposure is not addressed.

2.2.3 Cognitive processing approaches. Unlike traditional IQ assessments, cognitive processing approaches to assessing intelligence are informed by the advancement in the understanding of how the brain operates (Benson, 2003). These assessments include a focus on measuring cognitive processing and nonverbal abilities, allowing for a broader examination of strengths and potential weaknesses (Reschly & Wilson, 1990).

Implementation of these approaches with low-income minority groups in HICs has demonstrated that allowing for learning and practice while testing underlying cognitive processes results in increased cultural fairness and a more accurate reflection of cognitive potential (Kaufman et al., 2005). As a result, these approaches also provide greater specificity for measuring the impact of interventions which address deficits in cognition (Alcock et al., 2008; Kaufman et al., 2005).

The KABC-II is an example of such an assessment, which aims to measure cognitive potential and the underlying processes necessary to solve certain tasks (Kaufman & Kaufman, 2004). The KABC-II has been used in different cultural settings. It has been used in many HICs, such as the United States (Gray, Reiser, & Brinkley, 2012), Germany (Nguyen-Minh et al., 2013), France (Charkaluk et al., 2012) and Japan (Kurihara, 2010). In addition, it has been increasingly used in LMICs, including India (Malda et al., 2010), Uganda (Bangirana et al., 2009), the Democratic Republic of Congo (Boivin et al., 2013), Senegal (Boivin, 2002), Malawi (Boivin et al., 2011) and South Africa (Baumgartner et al., 2012; Ogunlade et al., 2011). In addition a few subtests have been administered to small samples in Tanzania, Kenya, Ethiopia and Cambodia (O'Donnell et al., 2012). The theoretical and methodological approach of the KABC-II is described in more detail in section 3.6.2 (page 22).

2.3 Translation, Adaptation and Psychometric Evaluation Steps

Despite cognitive processing assessments offering a more culturally fair approach, they are mostly - including the KABC-II - developed in HICs and have been subjected to rigorous examination to guarantee validity in the populations in which they were developed. Thus while the KABC-II offers significant improvement over traditional IQ assessments - for it to be optimally culturally appropriate for a specific context - three main steps should be completed with the assessment; translation, adaptation and psychometric evaluation (Alcock et al., 2008; Hunt & Carlson, 2007; Kitsao-Wekulo et al., 2012). However all three of these steps are often not completed in studies utilizing cognitive assessments in new contexts (Fernald et al., 2009).

The translation and adaptation steps are important to ensure that the instructions and content of the test are altered in light of cultural specificities, to produce a culturally appropriate test for a specific target population (Prado et al., 2010). Unfortunately, even when these steps are completed, the third step (the evaluation of the psychometric properties following translation and adaption) is seldom undertaken or published for target populations (Holding, Abubakar, & Wekulo, 2010). This step includes ensuring equivalence, confirming that the translated and adapted version of the assessment still reflects the construct under investigation (Kitsao-Wekulo et al., 2012). The absence of this step reduces the credibility of outcomes obtained with these translated assessments (Holding & Kitsao-Wekulo, 2009; Hunt & Sternberg, 2006).

There has been research conducted in LMICs which have used adapted versions of the KABC-II and completed these three steps and published data from the psychometric evaluation. For example, in Uganda, the construct validity of the KABC-II was examined in a sample of 65 children aged 7-16 years with a history of exposure to cerebral malaria. Factor analysis showed the KABC-II to maintain its factor structure in this cohort (Bangirana et al.,

2009). Similarly in Bangalore, India, the KABC-II was validated with 598 6-10 year old Kannada-speaking children, who were of low-socioeconomic status (Malda et al., 2010). These authors reported on significant adaptation of the KABC-II to accommodate the Indian cultural context (Malda et al., 2008) and showed it to be reliable and to have maintained its factor structure in this sample (Malda et al., 2010).

2.4 The KABC-II in Southern Africa

The KABC-II has been used in Southern Africa, in Malawi and South Africa. The studies in South Africa focused on cognitive outcomes in a nutrition-focused intervention for preschoolers (Baumgartner et al., 2012; Ogunlade et al., 2011) and the study in Malawi on the developmental outcomes of children with cerebral malaria (Boivin et al., 2011).

Although the KABC-II has been used in Southern and South Africa, it has been used in a limited manner, with minimal adaptation, a small number of subtests being administered and no psychometric data being published. In addition these samples of children had experienced morbidity - malnutrition and malaria.

2.5 Conclusion to Chapter

Given the concern of bias in traditional IQ assessments, cognitive processing assessments such as the KABC-II are increasingly used in LMICs. However they have often not been adequately translated, adapted and evaluated and are often used with clinical samples experiencing morbidity.

There has been no research to date in South Africa which has documented a psychometric evaluation of a translated and adapted version of the full KABC-II test battery for a rural non-clinical sample. In the light of this, and the importance and relevance of undertaking a study which evaluates psychometric properties in a non-clinical sample, this research will make a useful contribution to the literature.

2.6 Aims and Objectives

The primary aim of this research was to evaluate the psychometric properties of a translated and adapted version of the KABC-II in a sample of primary school-aged isiZulu-speaking children in rural South Africa - using data from the Siyakhula study.

The objectives of this research were:

i)   To evaluate the performances of this sample of children - on the subtests and scale indexes of the KABC-II battery.

ii)   To examine whether the underlying structure of the KABC-II is maintained in this sample.

This research will contribute to the literature as it will inform future research which may utilize this battery with isiZulu-speaking children and more widely, with children in other LMICs.

Chapter 3

Methods

This research used data collected as part of the Siyakhula study, which was a follow up study of the Vertical Transmission Study (VTS). Both of these studies took place at the Africa Centre and are described in more detail below. I worked at the Africa Centre as data coordinator on the Siyakhula study, assisting with coordination of the collection and intake of data. I then conducted this secondary analysis for this research using the data of a sub-sample of the larger Siyakhula study sample.

3.1 Research Context

The Africa Centre is a Wellcome Trust funded research centre located in the Hlabisa sub-district of Umkhanyakude in rural Northern KwaZulu-Natal, South Africa. The Africa Centre conducts annual demographic and HIV surveillance of the community (Demographic Surveillance System - DSS) in a predefined geographical area called the Demographic Surveillance Area (DSA). The DSA spans 438 square kilometres of the Hlabisa sub-district and includes a population of 85 000 people who are members of around 11 000 households (Tanser et al., 2008). The Hlabisa sub-district health services include a district hospital with 296 beds and 16 primary health care clinics, serving a population of 228 000 over a geographical area of approximately 1500 square kilometres (Houlihan et al., 2011).

3.2 Vertical Transmission Study and Siyakhula Study

VTS was designed to examine the risk of post-natal HIV transmission through different infant feeding practices in HIV positive women (Bland et al., 2008). The study originated from a need for an acceptable, feasible and sustainable approach to promote breastfeeding while reducing post-natal transmission of HIV (Bland, Coovadia, Coutsoudis, Rollins, & Newell, 2010). VTS was a non-randomized cohort intervention study, and took

place between 2001 and 2007. One of the main findings of VTS was that exclusive breastfeeding significantly reduced the likelihood of mother-to-child transmission of HIV compared to mixed feeding (Bland et al., 2010). The Siyakhula Saving Brains study aimed to examine the longer-term effects of the exclusive breastfeeding support intervention provided in VTS on the physical, cognitive and socio-emotional development of the children at age 7 to 11 years.

3.3 Research Design

The Siyakhula study was a cross-sectional assessment of a longitudinal cohort, consisting of an intervention and a comparison group of children. Figure 1 shows the composition of the sample and the visits completed with each participant. The study was conducted from late-2012 until mid-2014, and was led by Dr Ruth Bland as the primary investigator and Dr Tamsen Rochat as co-investigator.

The intervention group was drawn from the pool of participants from the VTS study, and the comparison group consisted of children captured in the Africa Centre's DSS, who fell within the 7 to 11 year age range, but were not part of VTS. From here on, the intervention group will be referred to as the "VTS group", and the comparison group as the "DSS group". All of the children enrolled in the Siyakhula study were HIV negative. The motivation for excluding HIV positive children was that HIV infection could act as a confounder to the effects of exclusive breastfeeding on the child's developmental trajectory. Although the children included in the Siyakhula study were all HIV negative, the HIV status of the mothers was not an inclusion criterion. Therefore, the intervention and comparison groups were further split into two sub-groups based on the mother's HIV status during pregnancy: children whose mothers were HIV positive and those who were HIV negative (Figure 1).

VTS Intervention Group	**DSS Comparison Group**
Children in this group have mothers who received the exclusive breastfeeding support intervention provided in the VTS study and resided in the Hlabisa sub-district.	Children in this group have mothers who did not receive the exclusive breastfeeding support intervention but did reside in the DSA of the Africa Centre.

VTS Positive Group	**VTS Negative Group**	**DSS Positive Group**	**DSS Negative Group**
Children in this group have a HIV positive mother who was part of VTS.	Children in this group have a HIV negative mother who was part of VTS.	Children in this group have a HIV positive mother who was not part of VTS.	Children in this group have a HIV negative mother who was not part of VTS.
Visit 1: With the mother and caregiver (if applicable)	Visit 1: With the mother and caregiver (if applicable)	Visit 1: With the mother and caregiver (if applicable)	Visit 1: With the mother and caregiver (if applicable)
Visit 2: With the mother and caregiver (if applicable)	Visit 2: With the mother and caregiver (if applicable)	Visit 2: With the mother and caregiver (if applicable)	Visit 2: With the mother and caregiver (if applicable)
Visit 3: With the child	Visit 3: With the child	Visit 3: With the child	**Visit 3: With the child**

Figure 1. Overview of the Siyakhula study research design. The sub-sample used for this research is highlighted in grey, the main data source (KABC-II) for the this research was derived from visit 3, highlighted in bold

The sub-sample used in this research, highlighted in grey in Figure 1, consisted of only the children from the DSS group, who had an HIV negative mother (DSS negative group). This group's data was chosen, as my aim was to assess performance and the underlying structure of the KABC-II in a sample free of the effects of an intervention (exclusive breastfeeding) and of HIV exposure (in pregnancy or through a HIV positive mother). Therefore the final sub-sample included only DSS negative children of currently negative mothers.

Data were collected through three separate visits for all participants of the Siyakhula study. The first visit was completed with the mother and in cases where the mother was not the primary caregiver, the relevant caregiver was included. It consisted of ensuring the

mother and her child were eligible to participate, and the completion of an enrolment form (Appendix A) for those who were eligible and willing to participate. Once visit one was completed, visit two was scheduled. This visit was an extensive visit with the mother, again if the mother was not the primary caregiver; the relevant caregiver was also included in this visit. This visit included forms pertaining to: her socioeconomic status, pregnancy, delivery, infant feeding, medical information, child's medical information, child's school information, mental health, alcohol use, parenting stress, child's behaviour and home environment. On completion of visit two, visit three (the assessment session with the child) was scheduled. During visit 3 the KABC-II was administered to all children. The data sources used in this secondary analysis are described further in section 3.6 (page 22).

3.4 Recruitment Procedure

Before the data for this research was drawn, the entire Siyakhula study sample was recruited and had completed data collection. The Siyakhula study sample was recruited according to two sets of recruitment criteria, one for the VTS group and one for the DSS group. Both recruitment procedures are described below.

3.4.1 VTS participants. Of the mothers who were part of VTS, those with children between the ages of 7 and 11, were contacted either by phone or by a home tracing visit and were invited to participate. For the VTS mothers to be eligible to participate they had to: have an HIV negative child between the ages of 7 and 11, know their HIV status during pregnancy, know their current HIV status within the last 12 months, be willing to be visited at home and be willing for their child to participate in an assessment session. If the mother did not meet the above eligibility criteria, she was not enrolled.

3.4.2 DSS participants. A list of randomly selected mothers residing within the DSA with children between the ages of 7 and 11 was retrieved from the DSS of the Africa Centre. Through a home tracing visit these mothers were invited to participate. For the DSS mothers to be eligible to participate they had to: not have participated in the VTS study, have an HIV negative child between the ages of 7 and 11, know their HIV status during pregnancy, know their current HIV status within the last 12 months, have received their antenatal and postnatal care at a clinic within the DSA, have a Road to Health Card (RTHC) for their child, be willing to be visited at home and be willing for their child to participate in an assessment session. If the mother did not meet the above eligibility criteria, she was not enrolled.

Having received antenatal and postnatal care within the DSA and having a RTHC for their child were additional criteria for the DSS group. The RTHC records early growth data, details of the child's health during subsequent visits to the clinic and the result of rapid testing for HIV. As there is limited data available for the DSS mothers, these criteria allow for more certainty that the mothers received a standard level of care and allow for insight into the child's general health and verification of HIV status.

3.4.3 Ethical clearance. Ethical clearance for the Siyakhula study was received from the Biomedical Research Ethics Committee (BREC) of the University of KwaZulu-Natal (reference number: BF184/12). Ethical clearance for 2012 to 2013 was first obtained (Appendix B), followed by recertification for 2013 to 2014 (Appendix C). The activities outlined in this research are covered by this ethical clearance.

3.5 Sample Size

Figure 2 shows the size and composition of the complete Siyakhula study sample, with the sub-sample used in this research highlighted in grey. There were a total of 925 children enrolled into the VTS intervention group (341 in VTS positive and 584 in VTS negative) and 671 children enrolled into the DSS comparison group (157 in DSS positive and 514 in DSS negative). Of the 514 DSS negative mothers, 14 withdrew from the study and 118 mothers had seroconverted after the birth of their child. Therefore, the final sample size of the sub-sample consisted of 382 HIV negative children of HIV negative mothers (Figure 2). This sample size was sufficient for the utilized data analysis approach, see further description of sample size justification in section 3.8.1.2.3 (page 39), where data screening steps are discussed.
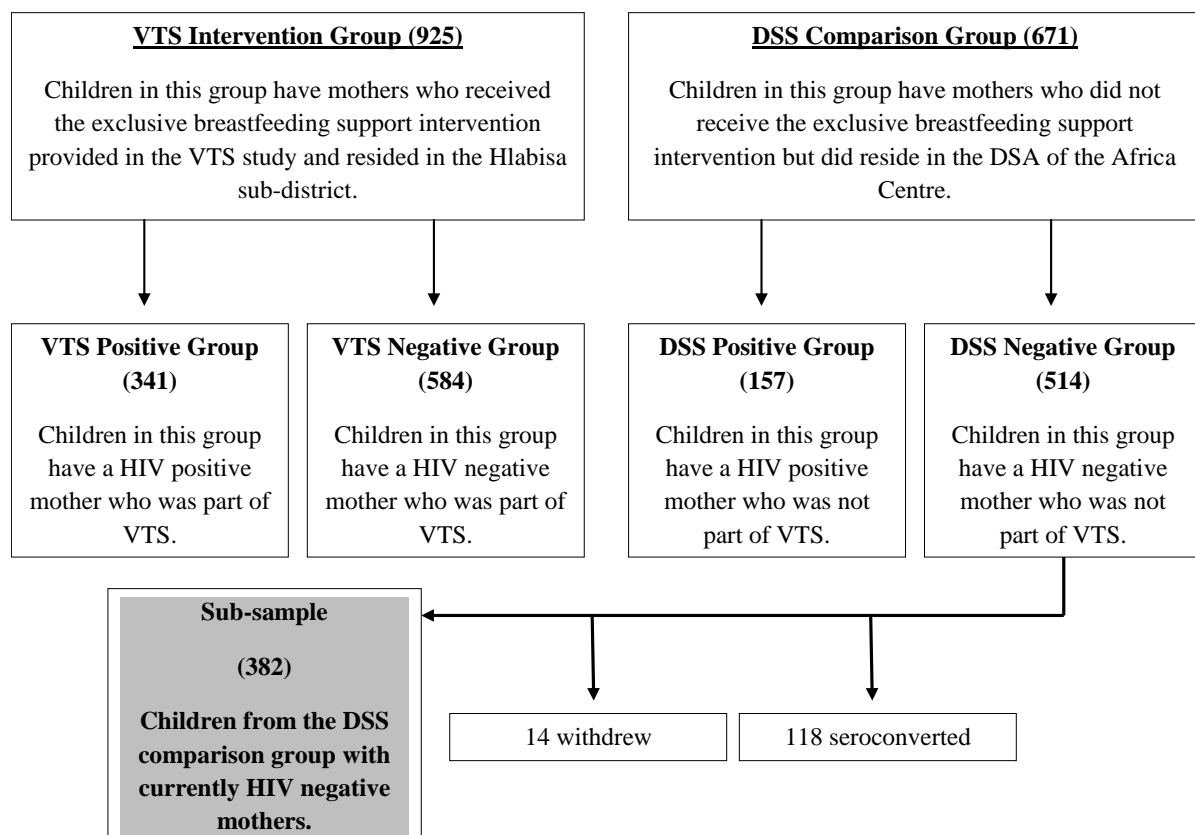
Figure 2. Size and composition of the Siyakhula sample. The grey box highlights the sub-sample used in this research

3.6 Data Sources

This section describes the data sources used in this research, and is divided into two sub-sections. The first sub-section describes the socio-demographic data, and the second gives a detailed description of the main data source of this research, the KABC-II, and how the battery was adapted for this context.

3.6.1 Socio-demographic data. Socio-demographic data were compiled drawing from data collected through the Siyakhula study forms. The following data were used: child's date of birth and sex (Appendix A); current caregiver to the child and educational details of the caregiver (Appendix D); if the child attends school and current grade (Appendix E); child's birth weight (Appendix F); child's current weight (Appendix G); whether the child has ever had TB and is on any chronic medication (Appendix H).

3.6.2 Kaufman Assessment Battery for Children Second Edition. This section describes the theoretical underpinnings and structure of the KABC-II, the selection of the theoretical framework and the subtests for this context, as well as the translation and adaptation of the selected subtests to make it appropriate for South African isiZulu-speaking children. In addition, a brief description of the assessor-training and an outline of the pilot study (including post-pilot adaptations) are provided.

3.6.2.1 Selection of the theoretical framework. The KABC-II can be administrated and scored from two theoretical frameworks: Luria's neuropsychological theory (Luria, 1970); and the Cattell-Horn-Carroll's (CHC) (McGrew, 2005) approaches. The Luria approach relies on motor processing and measuring cognitive potential and is less dependent on exposure to formal education. In contrast, the CHC approach is similar to traditional IQ assessment approaches as it focuses more on verbal skills and includes the assessment of acquired knowledge (Kaufman & Kaufman, 2004). The KABC-II is designed

so that an assessor can use their judgement based on the specific context to decide how to best approach the assessment. In this way a child with exposure to schooling in a culturally appropriate setting can benefit from a more traditional verbal approach to testing, while children with less exposure to school and/or from atypical cultural contexts can benefit from a more nonverbal approach (Kaufman et al., 2005).

Given that the children in the Siyakhula study live in a rural area, speak isiZulu as their mother-tongue, and are from an atypical cultural background to normative samples, the Luria approach was used. In this approach there are three main functional systems - or blocks - which represent the brain's basic functions. Block 1 is responsible for the arousal and attention to incoming stimuli, block 2 is responsible for analysing these stimuli and making connections to block 3, where planning decisions can be made. While the separate functioning of these blocks is important, the integration and interdependence between them is also emphasised. This integration is demonstrated through the interdependent nature of the functions of the blocks (Figure 3).

Luria's Neuropsychological Theory
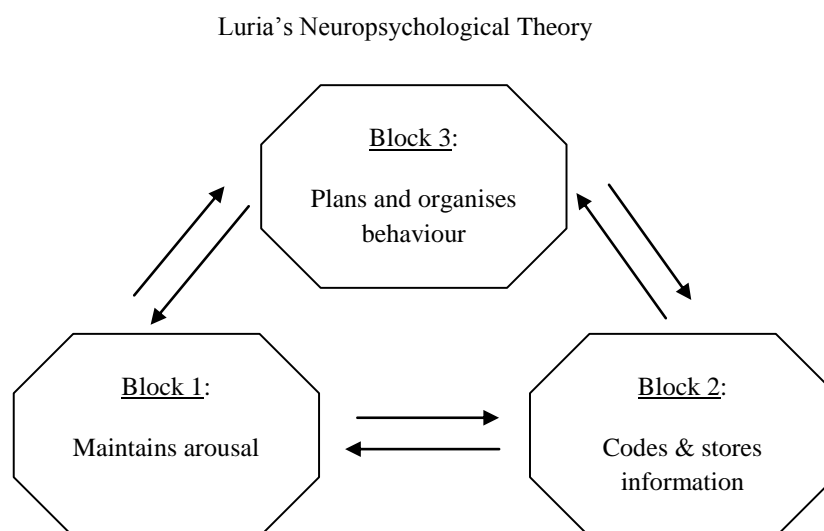
Figure 3. The three blocks of Luria's neuropsychological theory. Adapted from "Kaufman Assesment Battery for Children: Second Edition (p.12)," by A. Kaufman, and N.L. Kaufman, 2004, *Minnesota: AGS Publishing*

The KABC-II consists of five domains of intelligence, which are represented in the form of scale indexes: the Learning, Sequential, Simultaneous, Planning, and Knowledge Scales. In the Luria approach, only four of these five scale indexes are assessed; the knowledge Scale is omitted. A description of each scale index and its relation to the Luria theory is given in Table 1.

Table 1

Description and Relation of Each KABC-II Scale Index to the Luria Theory

	Relation to the Luria Theory
Learning Scale	These problems require focused, sustained and selective attention and the ability to code and store information and integrate it with visual stimuli. These reflect a combination of all three Blocks, with emphasis on the arousal in Block 1, the coding and storage involved with Block 2 and developing strategies, which is associated with Block 3.
Sequential Scale	Completing these activities relies on successive processing, in which the emphasis is on the order of the stimuli. This process is associated primarily with Block 2.
Simultaneous Scale	These problems require a process of spatial integration of stimuli, with maximum efficiency. The input must be processed simultaneously, such that separate stimuli are integrated and conceptualised as a whole. These problems are associated with Block 2; however do overlap with Block 3, given the planning abilities required.
Planning Scale	These activities involve high-level decision-making and executive processes, the ability to generate hypotheses, to revise one's plan of action and to monitor and evaluate the best solution to the problem. These high-level skills are associated with frontal-lobe executive functioning in Block 3.
Knowledge Scale (omitted)	*Omitted in the Luria approach as it is a measure of crystallized ability, reflecting acquired knowledge. This acquired knowledge is assessed from a western perspective therefore inappropriate for this rural Zulu context.*

Note. Text adapted from "Kaufman Assesment Battery for Children: Second Edition (p.43-44)," by A. Kaufman, and N.L. Kaufman, 2004, *Minnesota: AGS Publishing*. Omitted Knowledge Scale shown in italics.

3.6.2.2 KABC-II subtests and subtest selection. The four scale indexes included in the Luria approach and described in Table 1 each have specific subtests: eight core subtests and five supplementary subtests. The eight core subtests are used to calculate the Mental Processing Index (MPI) which is a global score which reflects overall performance on the KABC-II. Supplementary subtests provide a broader coverage of the domains measured by the KABC-II. Both core and supplementary subtests include culturally friendly aspects such as the inclusion of teaching items and trial items which provide multiple attempts at certain items. In addition every subtest has different start points for children of different ages and includes "basal rules" which refer to dropping back to a previous start point for a younger age group if the child obtains incorrect answers in the first three items of their age group's start point. For the age group in this sample (7-11 years), there were 13 subtests available for assessment.

When selecting subtests to be included in a battery, it is recommended that a review panel is involved (Beaton, Bombardier, Guillemin, & Ferraz, 2000; Holding et al., 2010). The review panel for the Siyakhula study consisted of child development experts, namely; Professor Alan Stein (Child Psychiatrist), Dr. Ruth Bland (Paediatrician), Professor Mark Tomlinson (Developmental Psychologist), Dr. Tamsen Rochat (Clinical Psychologist) and Ms Sarah Skeen (Speech and Hearing therapist). Table 2 shows the available subtests that were under consideration and the decisions made regarding inclusion or exclusion. Three subtests - Rebus, Rebus Delayed and Gestalt Closure - were excluded because they would have required significant adaptation, which was not feasible within the time frame of the study.

Table 2

Subtests Included and Excluded in the KABC-II Battery for this Sample

	Core/Supplementary	Included/Excluded
Learning Scale		
Atlantis	Core	Included
Rebus	Core	Excluded
Atlantis Delayed	Supplementary	Included
Rebus Delayed	Supplementary	Excluded
Sequential Scale		
Number Recall	Core	Included
Word Order	Core	Included
Hand Movements	Supplementary	Included
Simultaneous Scale		
Rover	Core	Included
Triangles	Core	Included
Block Counting	Supplementary	Included
Gestalt Closure	Supplementary	Excluded
Planning Scale		
Story Completion	Core	Included
Pattern Reasoning	Core	Included

The MPI traditionally consists of the eight core subtests, yet the exclusion of Rebus meant that there were only seven core subtests included. However, there are acceptable substitutions which can be made between core and supplementary subtests. The review panel decided that Atlantis Delayed was to be included and considered a core subtest in place of Rebus. Therefore, in this sample the MPI was calculated using: Atlantis, Atlantis Delayed, Number Recall, Word Order, Rover, Triangles, Story Completion and Pattern Reasoning (descriptions of subtests found in Table 3). In addition, the supplementary subtests Hand Movements and Block Counting were included. The appropriateness of the selected subtests and substitution made were confirmed through email discussions with the test developers, Nadeen and Alan Kaufman, who are both psychologists and work at Yale University.

Table 3

Descriptions of KABC-II Subtests Included for this Sample

	Description of Subtests
Atlantis	The child is taught nonsense names for fanciful pictures of fish, plants and shells. The child demonstrates learning by pointing to each picture (out of an array of pictures) when it is named.
Atlantis Delayed	The child demonstrates delayed recall of paired associations learned about 15-25 minutes earlier during Atlantis.
Number Recall	The child repeats a series of numbers in the same sequence as the examiner said them.
Word Order	The child touches a series of silhouettes of common objects in the same order as the examiner said the names of the objects; more difficult items include an interference task (colour naming) between the stimulus and response.
Hand Movements	The child copies the examiner's precise sequence of taps on the table with the fist, palm, or side of the hand.
Rover	The child moves a toy dog to a bone on a checkerboard - like grid that contains obstacles (rocks and weeds) and tries to find the shortest path.
Triangles	For most items, the child assembles several identical foam triangles (blue on one side, yellow on the other) to match a picture of an abstract design; for easier items, the child assembles a set of colourful plastic shapes to match a model constructed by the examiner or shown on the easel.
Block Counting	The child counts the exact number of blocks in pictures of stacks of blocks. One or more of the blocks are hidden or partially hidden from view.
Story Completion	The child is shown a row of pictures that tell a story, but some of the pictures are missing. The child must select the pictures need to complete the story from a set of pictures.
Pattern Reasoning	The child is shown a series of stimuli that form a logical, linear pattern, but one stimulus is missing; the child completes the pattern by selecting the correct stimulus from an array of 4 to 6 options at the bottom of the page.

Note. Text adapted from "Kaufman Assesment Battery for Children: Second Edition (p.61-69)," by A. Kaufman, and N.L. Kaufman, 2004, *Minnesota: AGS Publishing*.

These subtests all have specific discontinue rules, for example obtaining three consecutive scores of zero, which when reached, the assessor must stop the assessment. Some of the subtests also involve timing rules, including; time points, where scores achieved are dependent on the time it takes the child to solve the task; and time limits where if the child does not complete the item in the allotted time, they score zero for that item; both or only one of these rules may apply to these subtests. Table 4 illustrates details of the discontinue rules and, where applicable, the timing rules of each subtest.

Table 4

Descriptions of Discontinue and Timing Rules of KABC-II Subtests Included for this Sample

	Discontinue rule	Timing rules
Learning Scale		
Atlantis	If cumulative score is below a certain value at 4 specific points in the subtest.	No timing
Atlantis Delayed	Either at the designated stopping item, specified by Atlantis or after 4 consecutive scores of zero.	No timing
Sequential Scale		
Number Recall	3 consecutive scores of zero.	No timing
Word Order	3 consecutive scores of zero.	No timing
Hand Movements	3 consecutive scores of zero.	No timing
Simultaneous Scale		
Rover	5 consecutive scores of less than 2.	Each item has a time limit, ranging from 30 seconds on easier items to 80 seconds on more difficult items.
Triangles	3 consecutive scores of zero.	Items 1 to 10 have no time limit. Items 11 to 27 each has a time limit; ranging from 30 seconds on the easier items and 105 seconds on the more difficult items. Later items have time points, where more points are awarded the quicker the child completes the item.
Block Counting	4 consecutive scores of zero.	Items 1 to 10 have no time limit. Items 11 to 27 each have a time limit; ranging from 30 seconds on the easier items and 105 seconds on the more difficult items.
Planning Scale		
Story Completion	3 consecutive scores of zero.	Each item has a time limit, ranging from 30 seconds on easier items to 120 seconds on more difficult items. Majority of items have time points, where more points are awarded the quicker the child completes the item.
Pattern Reasoning	4 scores of zero in 5 consecutive items.	No time limits. Majority of items have time points, where more points are awarded the quicker the child completes the item.

3.6.2.3 Translation and adaptation of selected subtests. The initial translation of the KABC-II from English to isiZulu was undertaken by a panel of local isiZulu-speaking psychology graduates, who were also proficient in English. Once the initial translation was completed, two sets of blind back translations were undertaken, one by an isiZulu-speaking research psychologist and the other by an isiZulu-speaking public health PhD student. Initial forward translation and a blind back translation are widely recommended in literature to ensure adequate translation (Chen & Boore, 2010; Lund, Oestergaard, & Maribo, 2013). In addition, a three day adaptation workshop was conducted which included Siyakhula staff, who are representatives of the local culture and language. The items of each subtest were discussed to assess if there were any potential cultural nuances which could influence how children would respond. A summary of the translation and adaptation that took place for each subtest is described in Table 5.

Table 5

Translation and Adaptation of Selected KABC-II Subtests Included for this Sample

KABC-II Scale	Translation and Adaptation Comments
Learning Scale	
Atlantis	Instructions were translated into isiZulu. Test stimuli were not altered.
Atlantis Delayed	Instructions were translated into isiZulu. As with Atlantis the content of the test was not altered.
Sequential Scale	
Number Recall	Instructions were translated into isiZulu. The test stimuli were left unaltered as in this context children are taught to count in English at home and in schools.
Word Order	Instructions were translated into isiZulu. Test stimuli were translated into isiZulu and during the interference task the child can choose to call out the colours in English or isiZulu.
Hand Movements	Instructions were translated into isiZulu. Test stimuli were not altered.
Simultaneous Scale	
Rover	Instructions were translated into isiZulu. Test stimuli were not altered.
Triangles	Instructions were translated into isiZulu. Test stimuli were not altered.
Block Counting	Instructions were translated into isiZulu. Test stimuli were not altered.
Planning Scale	
Story Completion	Instructions were translated into isiZulu. Test stimuli were not altered.
Pattern Reasoning	Instructions were translated into isiZulu. Test stimuli were not altered.

3.6.2.4 Training. The Siyakhula study employed a team of 18 experienced, isiZulu-speaking fieldworkers to complete the three study visits with all the participants, with each fieldworker trained to complete different visits. Of the 18 fieldworkers, six were child assessors who completed the KABC-II with the children. Before the pilot study was initiated, three training workshops were completed, led by the project investigators, each centred on a study visit, and included the fieldworkers who would be completing that specific visit. Following the training, competency tests were completed with the fieldworkers, before they began collecting data.

One other study in South Africa received funding from the Saving Brains grant program: the Thula Sana study, which took place in Cape Town, and examined the long term cognitive and socio-emotional impact of an intervention designed to enhance the mother-infant relationship. Both the Siyakhula and Thula Sana studies administered the KABC-II with their respective cohorts; therefore an initial joint training session on the assessment was hosted at the Africa Centre.

This training of the child assessors in administering the KABC-II was led by project investigators of the Siyakhula study and the project coordinator of the Thula Sana study. Training with a translated and adapted version of an assessment is vital to ensure that the assessment is administered in a uniform manner (Holding et al., 2010). This is especially important when using a complex battery such as the KABC-II, where each subtest is administered slightly differently and has different discontinue and timing rules. Competency tests were repeated throughout the Siyakhula study.

3.6.2.5 Pilot study. A pilot study with the translated and adapted version of the KABC-II was conducted with 24 children from the VTS group. Older children were selected as it was assumed that they would reach discontinue rules later in the subtests, which would allow more items to be administered and tested. Pilot studies are important as they allow for the evaluation of the ease of administration and the face validity of the assessment (Thabane et al., 2010).

Two changes were made as a result of the pilot study; firstly, an operational change. In the pilot study the children were assessed at home, however the assessors voiced concerns that this seemed to be a distracting environment and could affect the equivalence of assessments. Therefore post-pilot, as far as possible, children were assessed at the local clinic or at schools. These locations proved to be more controlled environments where the children were comfortable and less affected by external stimuli.

Secondly, a post-pilot alteration was made to Story Completion. The assessors raised a concern about the potential cultural influence on the children's responses to item 8. This item depicts the story of the preparation and cooking of an egg. The child is given several pictures and is required to place three of these into the three missing places to complete this story. The first picture should be the egg being cracked into a pan, the second the egg in the pan with the egg white still pale and thirdly the egg being cooked through. However one of the picture options is of the pan being washed and the assessors reported that many children were putting this card first; this was further confirmed by the results of the pilot study. In this rural Zulu context it is common for utensils to be washed before cooking food, therefore it was decided that the children would also get maximum points if they placed this picture first.

3.7 Data Collection and Data Entry

The data were quantitative and collected over three study visits, using a total of twenty-one hard copy forms, with the data recorded in English.

I received all the hard copies of the KABC-II assessments from the full sample and scored them manually, first calculating the raw scores and then converting these into scaled scores using conversion tables found in the KABC-II manual (Kaufman & Kaufman, 2004). The conversion tables for the subtests are divided into three month age ranges, which allows for the conversion of subtest raw scores to subtest scaled scores with a range of 1-19. As a result, scaled scores allow for direct comparison of performance across all ages. The MPI and the scale index scores were then calculated by summing the scaled scores of the appropriate subtests and converting these totals into standard scores, again using conversion tables from the manual. The conversion tables for the standard scores are grouped into age ranges, and the two age ranges relevant for this sample were 7 to 9 years and 10 to 12 years. The resulting standard scores range from 43 to 160, and are also comparable across age groups.

All hard copy forms containing data, including the scored KABC-II assessment, were entered into Microsoft Access, a database management system, by the Siyakhula study's data management and entry team. The data for the KABC-II entered into Microsoft Access included only the raw and scaled scores for the subtests and the standard scores. However, the data of the 382 KABC-II assessments of this sub-sample were entered on item level into an excel spreadsheet. This spreadsheet included: scores of all the items of each subtest administered; raw and scaled scores of the subtests; and the raw and standard scores of the MPI and scale indexes. This allowed for a more in-depth examination of performance on individual subtests.

3.8 Data Analysis

This section consists of three parts detailing data analyses performed: data preparation and confirmatory factor analysis (CFA); exploratory factor analysis (EFA); and an in-depth investigation of subtests. All data analyses were conducted using the statistical package, STATA, version 13 (StataCorp, 2007). The results of the data analyses are presented in Chapter 4, where for the most part if statistics appear in tables they are not repeated in the text.

3.8.1 Part One: Data preparation and confirmatory factor analysis. This part of the research examined whether the structure of the KABC-II global score, the MPI, was maintained in this sample. This involved an examination of psychometric properties and performance on the KABC-II; data preparation procedures and the CFA.

3.8.1.1 Psychometric properties and performance on KABC-II core battery. The psychometric properties and performance of the children on the KABC-II, specifically the MPI, the scale indexes and their respective subtests, were explored. This was completed in two stages: firstly examining the overall properties and performance on the KABC-II; secondly, an evaluation of performance stratified by age group (7 to 9 years and 10 to 11 years) and sex.

For the first stage (the overall performance and psychometric properties) the following descriptive statistics were reported: measures of central tendency, distribution of scores, age equivalents and measures of reliability. The measures of central tendency included the mean, standard deviation and range. The distribution of scores was shown using graphics, and normality was determined using the Shapiro-Wilk statistic. This statistic is a good indicator of whether the assumption of normality is violated, with a significant p value showing it to be significantly different from a normal distribution

(Ahad, Yin, Othman, & Yaacob, 2011). Using the test manual (Kaufman & Kaufman, 2004), age equivalents for each subtest were calculated, these represent the expected age of a child based on their raw score.

Two measures of reliability were determined: Cronbach's alpha (for the MPI) and split-half reliability, corrected with the Spearman-Brown formula (for the scale indexes and subtests). Cronbach's alpha measures the amount of interrelatedness between items in a test, giving an indication of its internal consistency (Tavakol & Dennick, 2011). This was calculated for the MPI using the scaled scores of the eight subtests. Split-half reliability is an alternative method to assessing internal reliability, which involves splitting the test into two halves and assessing the extent of correlation between these two halves (Streiner, 2003). This approach was appropriate for the subtests, as Cronbach's alpha was not feasible due to the missing data as a result of the discontinue rules of each subtest (Kaufman & Kaufman, 2004). In addition, it was appropriate for the scale indexes as using the Cronbach's alpha would have underestimated the actual reliability because there would only be two items per scale (namely, the relevant subtests) (Eisinga, Grotenhuis, & Pelzer, 2013). To assess split-half reliability, the items of the subtests were divided into halves by grouping odd and even item numbers.

In the second stage (the evaluation of performance stratified by age and sex) the mean scores were reported along with *p* values of *t* tests to determine whether mean scores were significantly different between sexes of each age group.

3.8.1.2 Confirmatory factor analysis procedures. Next, CFA was used to investigate whether the original structure of the KABC-II, as defined in Kaufman and Kaufman (2004), was maintained in this sample. CFA is a type of structural equation modelling, and is used to explore the relationships between observed and unobserved variables - which are latent variables (Comrey & Lee, 2013). In CFA, the researcher specifies a model which has been previously hypothesized and tests it against the data to determine the closeness of fit between the hypothesized model and the data (T.A. Brown, 2012). This was an appropriate method to use to test the underlying structure of the KABC-II, as it has an hypothesized structure which is theoretically driven and has been validated in previous research (Bangirana et al., 2009; Kaufman & Kaufman, 2004; Malda et al., 2010; Morgan, Rothlisberg, McIntosh, & Hunt, 2009; Reynolds, Keith, Fine, Fisher, & Low, 2007).

Before a model fit can be estimated, three procedures must take place to ensure these models will converge and yield accurate results; the models must be specified, identified and the data screened. Guidelines outlined by (Kline, 2011) were largely followed for these procedures. These are further expanded on below.

3.8.1.2.1 Model specification. Model specification refers to the presentation of the hypothesized structure of the expected model in the form of a structural equation model, which shows the expected relationships between the variables. This includes specifying the number of variables in your model (observed and latent), the direction of influence between variables, and the number of parameters to be estimated in the model.

Testing alternative theoretical models with the CFA technique is recommended to assess how well a model fits in comparison to others (Cabrera-Nguyen, 2010). Three theoretical CFA models were tested in this research, ranging from the most simple to the

most complex. Figure 4 shows the graphic representations of the three models; the first

model (model 1; Figure 4A) was a one-factor model of the MPI with the eight subtests as

indicators; the second model (model 2; Figure 4B) was a two-stratum model without an

overall factor, allowing the scale indexes to correlate; and the third model (model 3; Figure

4C) combined model 1 and 2, and included an overall MPI factor. Model 3 represents the

previously validated original structure of the KABC-II global score, the MPI (Kaufman &

Kaufman, 2004).
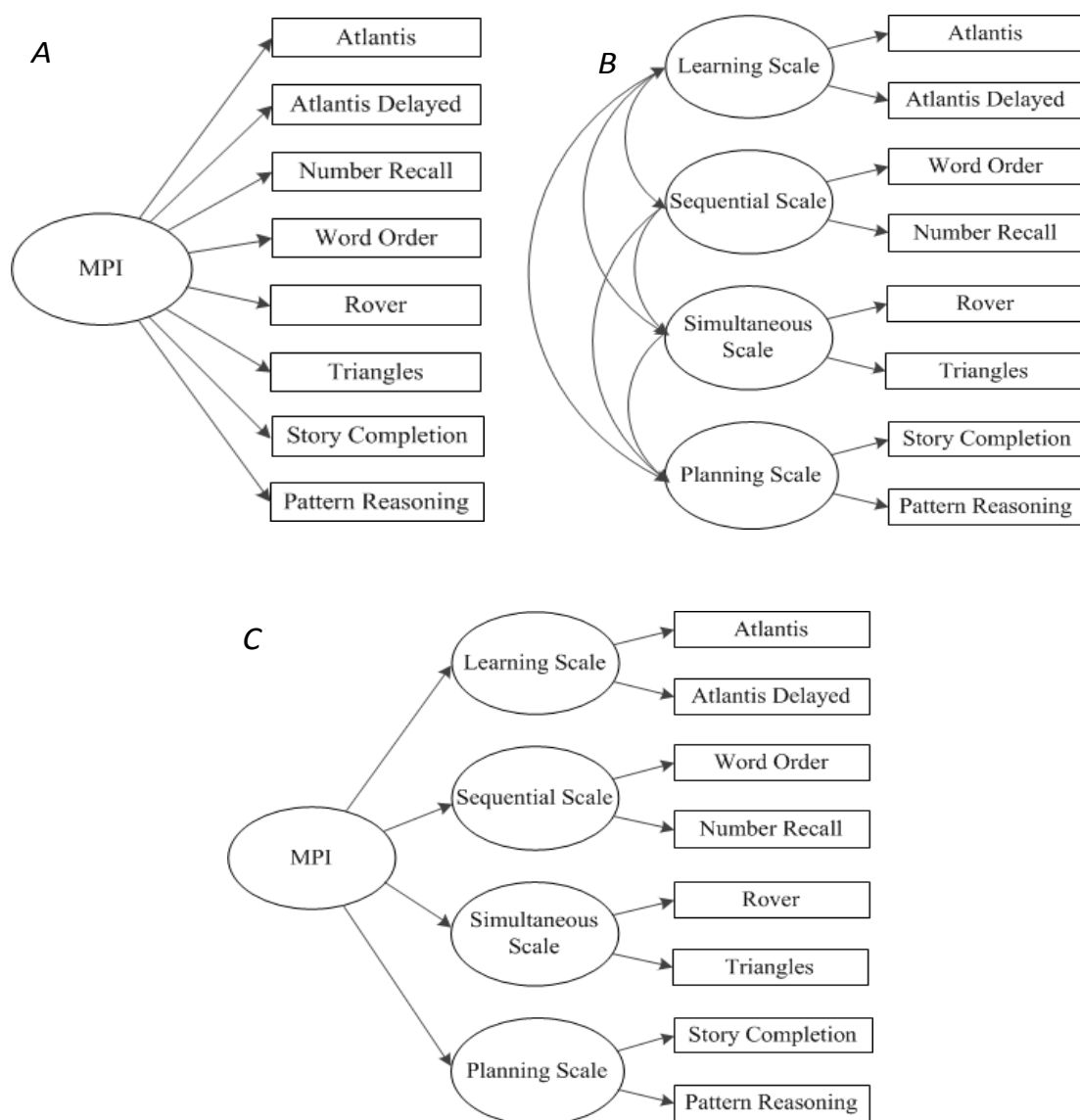
Figure 4. Theoretical models of the three CFA models, *A.* Theoretical structure of
Model 1; *B.* Theoretical structure of Model 2; *C.* Theoretical structure of Model 3

Observed variables are variables that are directly measured, and are shown in the graphics in rectangle boxes (Figure 4). Latent variables are derived from the observed variables, and are shown in oval shapes in the Figure 4. Model 1 contained nine variables: the MPI (latent) and the eight subtests (observed). Model 2 had 12 variables, the four scale indexes (latent) and the eight subtests. Model 3 had 13 variables: the MPI, the four scale indexes, and the eight subtests.

The arrows in Figure 4 show the compositions of the models (where each variable was expected to fit in relation to the others); these will translate to regression coefficients, representing the strengths of these relationships. The arrows also indicate which variables are indicators and which are factors. Variables with arrows drawn from them are factors and the variables to which the arrow is drawn are indicators. For example, in model 1 the MPI was the factor and the subtests were indicators, in model 3 Atlantis and Atlantis Delayed were indicators of the Learning Scale and the Sequential Scale was a factor of Number recall and Word Order. The number of parameters in the model refers to the number of relationships which are specified, this can be calculated by summing the number of paths in the model. Thus model 1 had eight parameters, model 2 had 14 parameters and model 3 had 12 parameters.

3.8.1.2.2 Model identification. Model identification involves ensuring that it is theoretically possible to obtain unique estimates for each of the parameters in the specified models; this is a necessary condition for CFA. Two issues of identification were addressed: degrees of freedom must be more than zero ($df>0$); and the two-indicator rule must be maintained, meaning that at least two indicators must measure a single factor. The degrees of freedom is the difference between the largest number of feasible parameters which can be estimated and the number of actual parameters to be estimated. The largest number of feasible parameters was calculated through the following formula: $v(v+1)/2$

(Kline, 2011), where *v* is the number of observed variables. As all three models (Figure 4) contained the same amount of observed variables, the largest number of feasible parameters for each model was 36. Model 1 had eight parameters, giving it a degrees of freedom value of 28; model 2 had 14 parameters, giving it a degrees of freedom value of 22; and model 3 had 12 parameters, giving it a degrees of freedom value of 24. Thus, the *df*>0 requirement was satisfied for all three models. The two-indicator rule was also satisfied in all three models, as each factor being measured had at least two indicators (Figure 4).

    3.8.1.2.3 Data screening. The next step involved screening the data to ensure that it was appropriate for CFA and to inform the choice of the estimation method to be used (Jackson, Gillaspy, & Purc-Stephenson, 2009). The maximum likelihood method of estimation is most commonly used, and assumes multivariate normality of the observed variables (Kline, 2011). There are alternatives such as the asymptotically distribution-free (ADF) method, which does not assume multivariate normality (Browne, 1984; Thompson, 2004). As the same observed variables (the subtests) were used in all three models, the data screening steps outlined below were applicable to all of them. Data screening consisted of six steps, these steps and their results are outlined below.

    First, it is important to know the extent of missing data so, if applicable, appropriate steps of handling missing data can be taken. As there were only two cases where there was missing data in a subtest, which was missing at random, no imputations were applied but listwise deletion was used, where the two participants were removed from the subsequent CFA. This brought the final sample size for the CFA to 380.

    Second, data were screened for outliers as an integrity check, to ensure data was accurately entered; this was completed using boxplots and summary statistics. All cases

which were flagged as potential outliers were inspected and found to be valid entries and therefore no outliers were excluded.

Third, sample size was considered, this is an essential issue, as this may affect accuracy of fit statistics and parameter estimates (Schmitt, 2011). The ratio suggested by Jackson et al. (2009) of 20 participants per parameter was used to determine whether the sample size was sufficient. With 380 participants, the suggested ratio was satisfied for all the CFA models tested: model 1, with eight parameters to be estimated would require a minimum sample of 160, model 2 with 14 parameters would require a minimum sample of 280 and model 3 with 12 parameters would require a minimum sample of 240.

Fourth, it is important to examine multivariate normality in order to make a choice of CFA estimation method. Univariate normality measures the normality of a single variable, and multivariate normality measures the normality of the joint distributions of all the variables (Doornik & Hansen, 2008). Univariate normality was examined using the Shapiro-Wilk statistic, and the Doornik-Hansen omnibus test was used to assess multivariate normality. Only Number Recall and Atlantis Delayed showed univariate normality (Table 7, page 50). The Doornik-Hansen statistic showed that the joint distribution of all variables was significantly different from a normal distribution (p<.001), confirming that the assumption of multivariate normality was violated. Log transformations of the observed variables were conducted but this failed to improve the normality of the distributions.

Fifth, reliability coefficients (Cronbach's alpha and split-half) were examined to ensure acceptable values were obtained, defined as values of >.7 (Nunnally & Bernstein, 1994). Acceptable values will provide preliminary evidence for the specified models, and show that the items under each subtest have sufficient internal consistency. Acceptable

reliability values were achieved for the variables: with a Cronbach's alpha of .78 for the

MPI, and the mean split-half coefficient of the scale indexes and subtests being .94 and .89

respectively (Table 7, page 50), all exceeding the acceptable threshold of .7.

Sixth, the degree of collinearity between the different variables was determined, if

extreme collinearity occurs; it suggests that variables may reflect the same underlying

construct (Kline, 2011). To investigate the presence of collinearity, several multivariable

linear regressions were run, each using a different variable as the criterion and the rest as

predictors. The thresholds of R-squared (R^2) values larger than .90 and Variance Inflation

Factors (VIF) larger than 10.0 were used to indicate extreme multivariate collinearity

(Kline, 2011). No evidence of multivariate collinearity was detected as all the R^2 values

and VIF values of the multivariable linear regressions were less than .90 and 10.0

respectively.

3.8.1.2.4 Model fit. As the models were specified, adequately identified and

the data screening revealed no issues, the CFA approach, using the appropriate estimation

method, was deemed suitable. Given that the assumption of multivariate normality was

violated (data screening step four), the ADF method was the appropriate estimation

method to use to fit the models. Four fit statistics were reported: model chi-square ($\chi2$) and

its *p* value, Root Mean Square Error of Approximation (RMSEA) along with the lower and

upper bound of its 90% confidence interval, Comparative Fit Index (CFI) and Standardized

Root Mean Square Residual (SRMR). The $\chi2$ value assesses the level of discrepancy

between the data and the hypothesized model, a good fit between the model and the data

indicated by a non-significant *p* value (Hu & Bentler, 1999). The RMSEA measures the

difference between the specified model and observed data per degree of freedom,

attempting to minimize the effects of degrees of freedom and sample size. An acceptable

fit indicated by; a value of less than .07 and regarding confidence intervals by a lower

bound value of close to 0.00 and an upper bound of less than 0.08 (Kline, 2011). The CFI ranges from 0 to 1, and an acceptable fit is indicated with a score of .95 or higher. The SRMR is the square root of the difference between the residuals of the observed sample covariance matrix and the specified covariance model, with an acceptable fit shown by a value of less than .08 (Hooper, Coughlan, & Mullen, 2008).

For the models which provided a good overall fit to the data, the equation level fit was examined to evaluate how well the variables (the subtests and the scale indexes) loaded onto their corresponding factors. Loadings were determined using standardized regression coefficients. The loadings range from 0 to 1, with a higher value indicating a stronger association between the indicator and the corresponding factor (Morgan et al., 2009).

3.8.2 Part Two: Exploratory factor analysis. Based on the findings in the CFA, this part of the research further investigated the underlying structure of the MPI, specifically of the scale indexes. This involved conducting an EFA using the observed variables (the subtests). Unlike CFA, EFA does not include any assumptions as to an expected structure thus is exploratory in nature (Williams, Brown, & Onsman, 2012). The orthogonal varimax method of rotation was used as we expect the indicators to clearly load onto one factor, and this rotation method effectively minimizes the complexity of the structure (Abdi, 2003). Factors extracted were reported along with their respective eigenvalues. Eigenvalues represent how much of the variance in the data is accounted for by a certain factor. Factor loadings were reported, which show how strongly each indicator (subtests) loaded onto each factor (scale indexes).

3.8.3 Part Three: In-depth investigation of subtests. This part of the research was informed by the EFA results, it involved exploring certain subtests further, to examine the effects of test content, procedures and factors which may have influenced performance and contributed to the EFA results. This exploration included: examining the performance on certain subtests at item level to examine trends in performance and possible effects of time points procedure; the effect of the inclusion of a supplementary subtest in order to explore aspects of test content which may have influenced performance; and multivariable linear regressions to explore associations between child and caregiver characteristics and performance on certain KABC-II outcomes, to assess the potential effect of these factors on performance.

Firstly, Story Completion, Pattern Reasoning and Triangles were examined on item level. For each subtest a graphic is shown which displays the scores achieved on each item for the children who completed that item. This allowed for an evaluation of the trend of children discontinuing the subtest and potential insight into the possible effects of timing rules.

Secondly, the performance on supplementary subtests was considered. Two supplementary subtests were administered to the children: Block Counting (Simultaneous) and Hand Movements (Sequential) (See Table 3; page 27, for content descriptions). Given previous results obtained, only analyses including Block Counting were conducted. The effect of substituting the Simultaneous Scale subtest Triangles for the supplementary Block counting was examined, as Block Counting is an acceptable substitution to be used to calculate the MPI and the Simultaneous Scale standard score with this age group. This examination included: a comparison of the performance on Block Counting to performance on other Simultaneous Scale subtests and the effect its inclusion had on the MPI and the Simultaneous Scale standard score and distribution of the scale indexes.

In addition both methods of factor analyses (CFA and EFA) were repeated with this substitution to determine whether the resulting model differed to model 3, which was hypothesised to represent the original MPI structure. The model used for this supplementary CFA is shown in Figure 5 and is referred to as model 4.
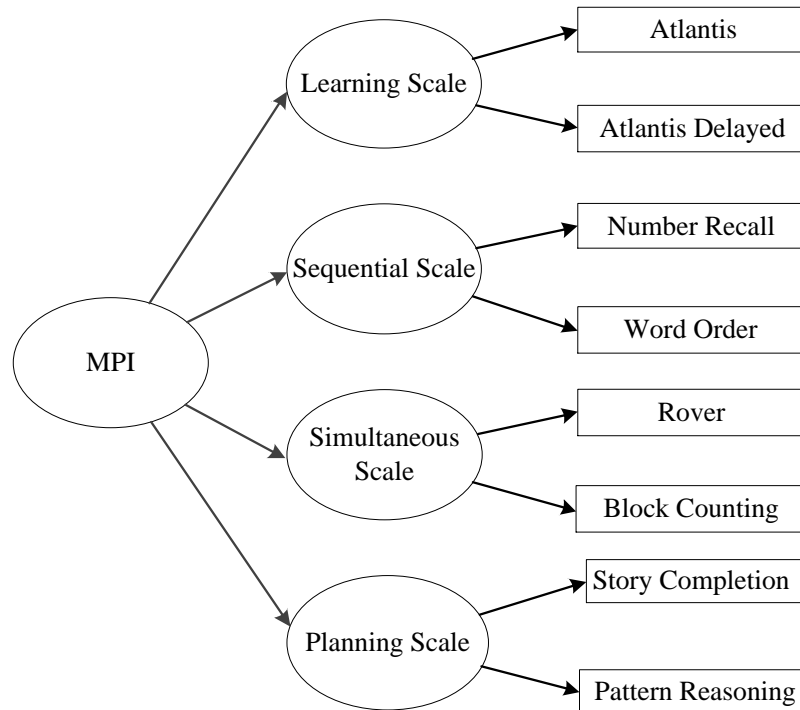
Figure 5. Theoretical structure of model 4

Thirdly, multivariable linear regressions were conducted to determine whether child related biological factors and caregiver characteristics, which are commonly associated with children's cognitive performance, were associated with children's poor performance on the lowest scoring subtests and scale indexes in this sample. Using data available, the analysis examined associations between these factors and certain KABC-II outcomes (Simultaneous Scale, Triangles, Planning Scale, Pattern Reasoning and Story Completion). The child related biological factors included: birth weight (continuous), current weight (continuous), whether a child has had TB (yes/no) and is on chronic medication (yes/no). The caregiver characteristics included: current caregiver (mother/other) and education level of current caregiver (none/some primary/primary completed/grade 10/matriculation/post matriculation).

Chapter 4

Results

This chapter presents the sample characteristics, followed by the results of the three part data analysis plan presented in section 3.8 (page 34).

4.1 Sample Characteristics

The socio-demographic characteristics of the children in the sample are shown in Table 6. There were a total of 382 children, of whom 65% were girls and 35% boys. The children ranged from 7 to 11 years, with a mean age of 8.96 years. The majority resided with their mother as their primary caregiver, with only 6% living with another caregiver. In terms of the education level of the primary caregiver, a quarter had completed high school (finished grade 12), while 28% had reached grade 10. All the children in the sample, except one child, attended school at the time of data collection and the average grade the children were in was grade 3. The average birth weight of the children was 3.12kg and their average current weight was 28.86kg. Few children were taking any chronic medication (2%) or had previously had TB (5%).

Table 6

Socio-demographic Characteristics of the Children in the Sample

	Frequency (%)	*M* (*SD*)	Range
Age (*n*=382)		8.96 (0.82)	7-11
Sex (*n*=382)			
Female	250 (65%)		
Male	132 (35%)		
Primary Caregiver (*n*=381)			
Mother	359 (94%)		
Other	22 (6%)		
Caregiver Education Level (*n*=370)			
None	29 (8%)		
Some Primary	76 (21%)		
Primary Completed	58 (16%)		
Grade 10	105 (28%)		
Matriculation	93 (25%)		
Post matriculation	9 (2%)		
Child Attend School (*n*=382)			
Yes	381 (100%)		
No	1 (0%)		
Current Grade (*n*=380)		3.37 (1.08)	1-7
Birth Weight (*n*=325)		3.12 (0.56)	1.5-4.5
Current Weight (*n*=382)		28.86 (6.48)	17.2-74.6
Had TB (*n*=380)			
Yes	17 (5%)		
No	363 (95%)		
Any Chronic Medication (*n*=378)			
Yes	7 (2%)		
No	371 (98%)		

4.2 Part One: Data Preparation and Confirmatory Factor Analysis

This part included determining psychometric properties, preparing data for the

CFA and conducting the CFA to examine whether the structure of the MPI was

maintained. The results are presented in two parts: first, a description of the results

showing the psychometric properties and the performance of the children on the KABC-II

battery; and second the results of the CFA.

4.2.1 Psychometric properties and performance on KABC-II core battery.

This section reports on: the overall properties and performance on the KABC-II; and the

performance stratified by age group (7 to 9 year olds and 10 to 11 year olds) and sex.

4.2.1.1 Overall psychometric properties and performance. Table 7 shows the

overall performance of the children on the MPI, scale indexes, and subtests of the KABC-

II battery. The scores reported are standard scores (MPI and scale indexes), with a possible

range of 43 to 160, and scaled scores (subtests), with a possible range of 1 to19. Figure 6

shows the distributions of the MPI (Figure 6A), scale indexes (Figure 6B), and subtests

(Figure 6C to 6F).

The mean performance of the children on the MPI was 76.12 (SD=11.0), with a

range of 45 to 115 (Table 7). The MPI was found to have acceptable reliability with a

Cronbach's alpha coefficient of .78 and was significantly different from a normal

distribution (S-W=.99, p=.002).

Of the four scale indexes, mean scores of the children on the Sequential Scale were

the highest, followed by the Learning Scale and the Simultaneous Scale, with the Planning

Scale having the lowest mean (Table 7). Split-half reliability adjusted with Spearman-

Brown formula showed excellent reliability for the scale indexes, ranging from .89 to .96.

Only the Sequential Scale appears to be normally distributed (S-W=.995, p=.282), with the

Learning Scale (S-W=.99, p=.009), Simultaneous Scale (S-W=.99, p=.001), and Planning Scale (S-W=.97, p<.001) being significantly different from a normal distribution.

Age equivalent values showed that for half of the subtests, the children performed at the age equivalent of 6 years of age (Atlantis, Atlantis Delayed, Triangles and Story Completion), while the other half showed age equivalents of 7 years and above (Number Recall, Word Order, Rover and Pattern Reasoning) (Table 7).

Of the Learning Scale subtests, the mean score on Atlantis Delayed was higher than for Atlantis (Table 7). Split-half reliability for these subtests was high, with an average reliability of .89. Atlantis Delayed was normally distributed (S-W= .998, p=.895) while Atlantis was significantly different from a normal distribution (S-W= .99, p=.014).

For the Sequential Scale subtests, children obtained a higher mean for Number Recall compared to Word Order (Table 7). Both subtests showed good split-half reliability, while Shapiro-Wilk statistics showed that Number Recall was normally distributed (S-W=.966, p=.494) and Word Order was not normally distributed (S-W=.98, p<.001).

On the Simultaneous Scale subtests, the mean score of the children was higher on Rover than on Triangles (Table 7). Split-half reliability of both subtests showed excellent reliability, Rover with .93 and Triangles with .92. The values of the Shapiro-Wilk statistic show both were not normally distributed, Rover (S-W=.98, p=.0002) and Triangles (S-W=.97, p<.001).

Finally, on the Planning Scale subtests, children had a higher mean score on Pattern Reasoning than on Story Completion (Table 7). Both subtests showed high reliability but both were significantly different from a normal distribution, with Story Completion (S-

W=.96, *p*<.001) and Pattern Reasoning (*S-W*=.95, *p*<.001) being positively skewed;

showing majority of the children had lower scores on these subtests (Figure 6F).

Table 7

Overall Performance on KABC-II Core Battery, Including the MPI, Scale Indexes and Subtests

	M	*SD*	Range	Age Equivalent	Reliability	Normality (*p*)
MPI	*76.12*	*11.0*	*45-115*		*.78*	*.002*
Learning	**84.94**	**11.59**	**52-120**		**.96**	**.009**
Atlantis	6.99	2.36	2-14	6.77	.96	.014
Atlantis Delayed	7.53	2.54	1-15	6.77	.81	.895
Sequential	**91.47**	**13.64**	**51-144**		**.89**	**.282**
Number Recall	9.95	3.01	1-19	10.00	.83	.494
Word Order	7.1	2.33	2-17	7.03	.84	<.001
Simultaneous	**77.16**	**13.75**	**43-116**		**.95**	**.001**
Rover	7.16	3.02	1-16	7.62	.93	.0002
Triangles	5.41	2.5	1-12	6.49	.92	<.001
Planning	**72.61**	**11.92**	**51-117**		**.94**	**<.001**
Story Completion	4.38	2.47	1-14	6.38	.89	<.001
Pattern Reasoning	5.81	2.84	1-19	7.14	.94	<.001

Note: Standard scores (MPI; scale indexes) range of 43-160; scaled scores (subtests) range of 1-19
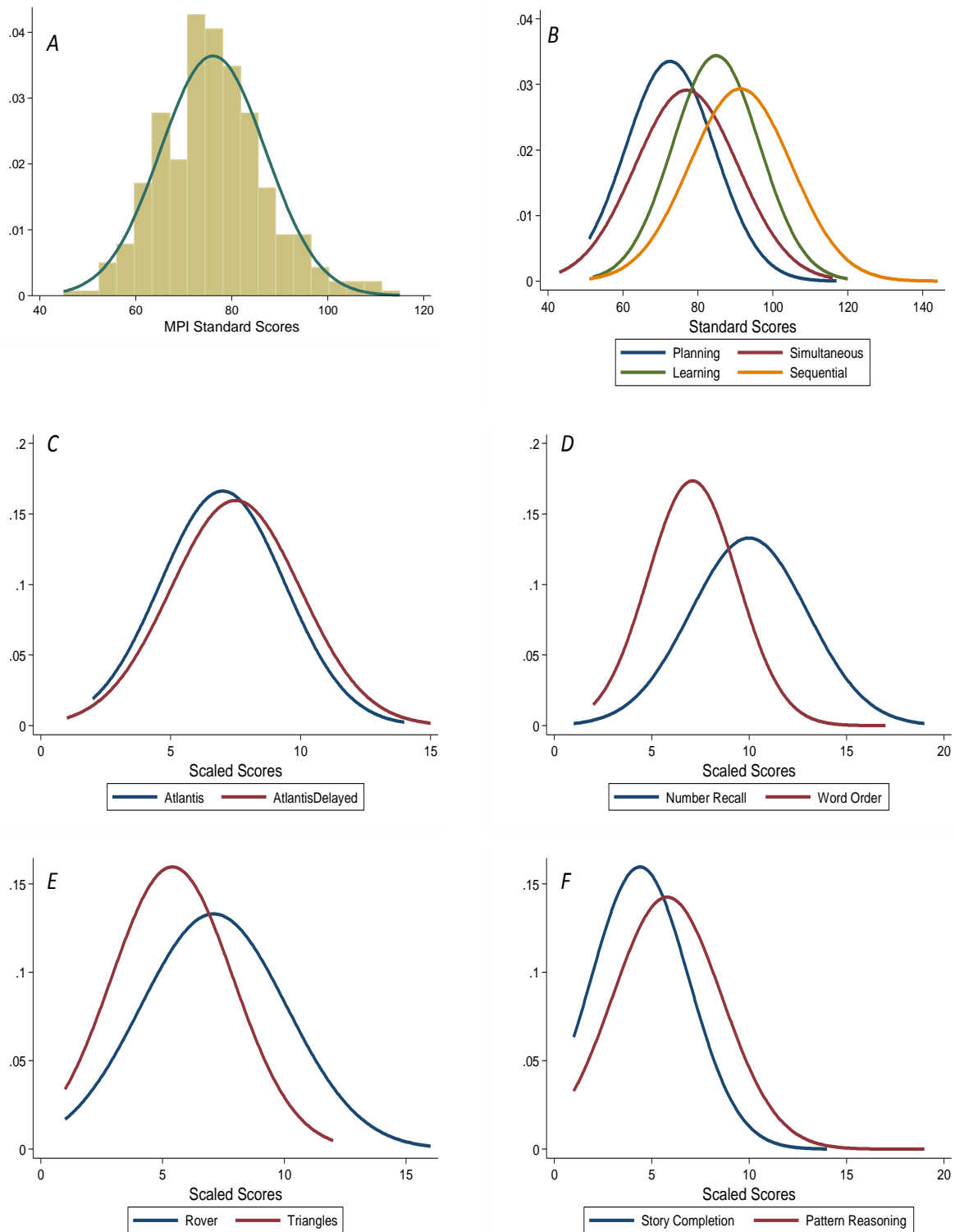
Figure 6. Distributions of the scores on the MPI, the scale indexes and the subtests. *A.* Distribution of the MPI scores; *B.* Distributions of the scale index scores; *C.* Distribution of scores on the Learning Scale subtests; *D.* Distribution of scores on the Sequential Scale subtests; *E.* Distribution of scores on the Simultaneous Scale subtests; *F.* Distribution of Planning Scale subtests

4.2.1.2 Performance disaggregated by age and sex. The mean scores of the children on the KABC-II battery stratified by age group and sex are found in Table 8, with p values of t tests shown to indicate significant differences between boys and girls.

MPI scores for children aged 7 to 9 years were similar for girls and boys, 75.72 and 75.80 respectively. Although girls aged 10 to 11 scored higher on the MPI compared to boys of the same age (78.50 and 75.28 respectively), the difference was not statistically significant.

On the scale indexes, two significant differences were found between boys and girls: on the Sequential Scale, girls aged 7 to 9 years performed significantly better; and girls aged 10 to 11 years performed significantly better on the Planning Scale (Table 8).

Girls aged 7 to 9 years performed significantly better on both subtests of the Sequential Scale (Number Recall and Word Order) while all other subtest scores for this age group were similar for girls and boys. Girls aged 10 to 11 performed significantly better on: Atlantis, Story Completion, and Pattern Reasoning (Table 8), while differences between girls and boys on other subtests in this age group were non-significant.

Table 8

Performance on the KABC-II (MPI, Scale Indexes and Subtests) Disaggregated by Age and Sex

| | Ages 7-9 | | | | | | | Ages 10-11 | | | | | | |
| | Girls | | Boys | | | | | Girls | | Boys | | | | |
	M	SD	M	SD	t	df	p	M	SD	M	SD	t	df	p
MPI	*75.72*	*10.19*	*75.80*	*10.64*	*-0.06*	*274*	*.526*	*78.50*	*12.35*	*75.28*	*12.59*	*1.30*	*104*	*.097*
Learning	**83.61**	**11.06**	**85.35**	**10.93**	**-1.22**	**274**	**.888**	**88.27**	**13.59**	**85.37**	**11.54**	**1.16**	**104**	**.124**
Atlantis	6.71	2.30	7.00	2.20	-1.09	274	.862	7.83	2.65	6.93	2.28	1.84	104	.035
Atlantis Delayed	7.32	2.51	7.59	2.39	-0.85	274	.800	7.90	2.67	7.76	2.70	0.26	104	.396
Sequential	**92.61**	**13.56**	**88.53**	**12.01**	**2.57**	**274**	**.005**	**92.40**	**14.05**	**89.83**	**15.54**	**0.89**	**104**	**.187**
Number Recall	10.30	2.93	9.34	2.65	2.60	274	.005	9.93	3.27	9.65	3.47	0.43	104	.335
Word Order	7.24	2.21	6.73	2.21	1.76	274	.040	7.45	2.37	6.80	2.85	1.27	104	.102
Simultaneous	**75.60**	**12.43**	**79.74**	**14.08**	**-2.46**	**274**	**.992**	**77.75**	**14.95**	**77.98**	**16.1**	**-0.08**	**104**	**.530**
Rover	6.82	2.66	7.78	3.02	-2.65	273	.995	7.27	3.33	7.28	3.80	-0.01	103	.507
Triangles	5.32	2.42	5.66	2.71	-1.06	274	.856	5.38	2.48	5.37	2.48	0.03	104	.489
Planning	**72.64**	**11.84**	**71.67**	**12.04**	**0.63**	**274**	**.266**	**75.63**	**11.68**	**70.26**	**11.89**	**2.33**	**104**	**.011**
Story Completion	4.42	2.39	4.29	2.54	0.39	274	.347	4.83	2.55	3.80	2.48	2.08	104	.020
Pattern Reasoning	5.78	2.98	5.55	2.74	0.61	274	.270	6.52	2.65	5.48	2.62	2.01	104	.024

4.2.2 Confirmatory factor analysis. This section describes the overall fit of the three models and the equation level fit of the CFA models which provided an acceptable overall fit. The procedures of specification, identification and data screening (and the results thereof) for the CFA models were extensively discussed in section 3.8.1.2 (page 36). A summary of the results of the data screening procedure are provided below.

The data screening revealed only two cases of missing data for which listwise deletion was used, no outliers were excluded as they were all found to be valid entries and sample size was sufficient for CFA. The ADF method of estimation was chosen as the assumption of multivariate normality was violated, data showed excellent reliability and no multivariate collinearity was evident. Therefore data was suitable for CFA.

4.2.2.1 Overall fit statistics. This section discusses the overall fit of the three theoretical CFA models (as specified in Figure 4, page 37) to the data. The means and standard deviations of the observed variables used for the CFAs (the subtests) are found in Table 7 (page 50) and the intercorrelations are found in Table 9.

Table 9

Intercorrelations between Observed Variables Included in Models 1, 2, and 3

Subtests	1	2	3	4	5	6	7	8
1. Atlantis	1.00							
2. Atlantis Delayed	.48	1.00						
3. Number Recall	.30	.17	1.00					
4. Word Order	.29	.14	.52	1.00				
5. Rover	.29	.20	.22	.24	1.00			
6. Triangles	.31	.24	.27	.26	.40	1.00		
7. Story Completion	.36	.27	.35	.32	.33	.37	1.00	
8. Pattern Reasoning	.32	.27	.33	.26	.41	.43	.45	1.00

The four fit statistics used to assess the fit of the three theoretical CFA models to the data are reported in Table 10, along with the acceptable threshold levels. Model 1 was not a good fit to the data, with a highly significant *p* value of the χ2 statistic (*p*<.001), a RMSEA value of 0.086, a CFI value of 0.783 and a SRMR value of 0.098. All these values fall out of the boundaries of the acceptable threshold levels. In contrast, model 2 and model 3 showed acceptable fits to the data, with non-significant *p* values of the χ2 statistic (*p*=.448, *p*=.464 respectively) and the RMSEA, CFI and SRMR falling within the threshold limits indicating an acceptable fit.

Table 10

Overall Fit Statistics of the Hypothesised Models (1, 2, 3) and Acceptable Threshold Levels

Fit Statistics	Model 1	Model 2	Model 3	Acceptable Threshold Levels
χ2	76.29, *p*<.001	14.02, *p*=.448	15.84, *p*=.464	$p > 0.05$
RMSEA	0.086	0.002	0.00	$< .07$
90% CI; Lower bound	0.066	0.000	0.00	Close to 0.00
Upper bound	0.107	0.050	0.047	$<.08$
CFI	0.783	1.00	1.00	$\geq .95$
SRMR	0.098	0.028	.029	$<.08$

Note. Acceptable threshold values taken from (Hooper et al. 2008; Hu & Bentler, 1999; Kline, 2011)

4.2.2.2 Equation level fit statistics of models 2 and 3. As model 1 was not a good fit to the data, this section shows only the equation level fit of model 2 (Figure 7A) and model 3 (Figure 7B), which both showed a good overall fit to the data (Table 10). The strength of the relationships between the observed variables and their respective factors showed similar coefficients in both models.

Among the latent factors in model 2, the strongest covariance was between the Simultaneous and Planning Scales (.91). The strength of the relationship between these two scales was further demonstrated in model 3, which includes the overall MPI factor, where the coefficients of the Simultaneous and Planning Scales were extremely high (0.99 and 0.91 respectively), indicating a strong association between the MPI and these two scale indexes.
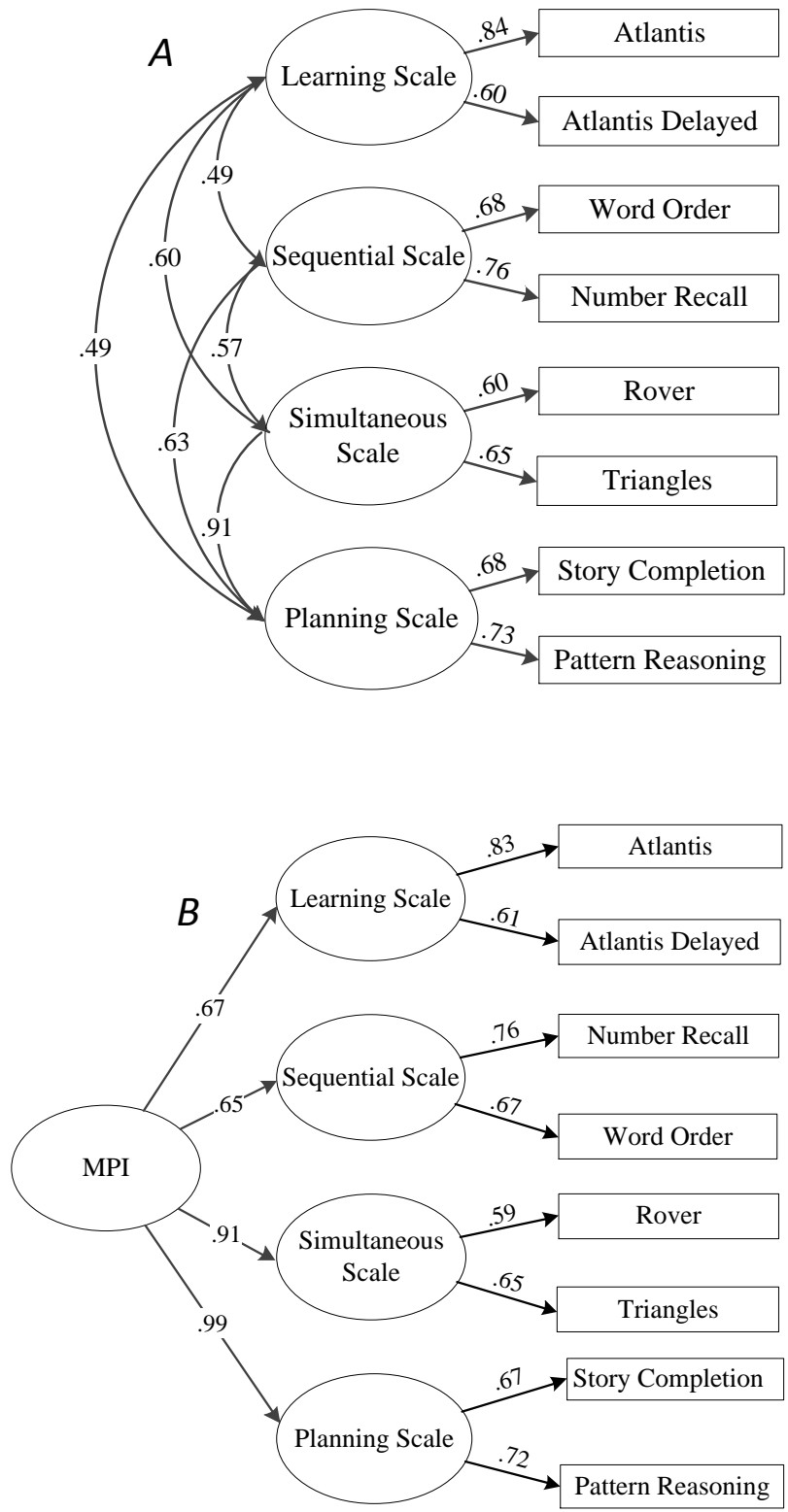
Figure 7. Resulting standardized regression coefficients; *A*. Standardized regression coefficients of model 2; *B*. Standardized regression coefficients of model 3

4.3 Part Two: Exploratory Factor Analysis

This part included further exploring the strong relationship between the Simultaneous and Planning Scales uncovered in part one (Figure 7A and 7B). An EFA, using the orthogonal varimax method of rotation and the observed variables from the CFA (the subtests) as input, was conducted.

Results showed that three factors were extracted from the data (Figure 8), with factor 1 accounting for the biggest proportion of variance, with an eigenvalue of 1.25. The second and third factors had eigenvalues of 1.04 and 0.87 respectively.
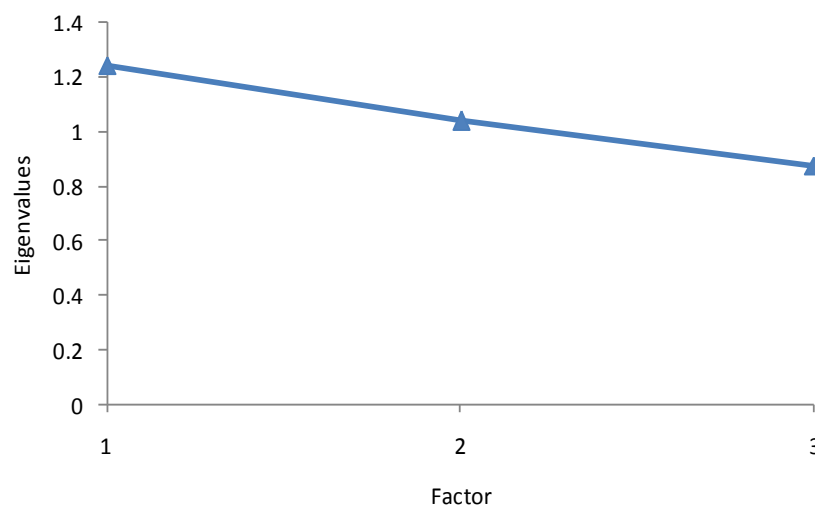
Figure 8. Scree plot showing the amount of variance accounted for by each factor

The factor loadings of each subtest on their respective factors are shown in Table 11. Two of the factors emerged as expected: the Learning Scale (factor 3), which Atlantis and Atlantis Delayed loaded the highest onto; and Sequential Scale (factor 2), which Number Recall and Word Order loaded the highest onto. In contrast, the Simultaneous and Planning Scale subtests: Rover, Triangles, Story Completion, and Pattern Reasoning, clustered together, all loading the highest onto factor 1.

Table 11

Rotated Factor Loadings of the EFA

	Factor 1	Factor 2	Factor 3
Atlantis	.26	.25	**.56**
Atlantis Delayed	.19	.08	**.55**
Number Recall	.21	**.61**	.16
Word Order	.19	**.60**	.13
Rover	**.52**	.17	.18
Triangles	**.52**	.21	.22
Story Completion	**.45**	.33	.27
Pattern Reasoning	**.57**	.25	.24

Note. Highest loading of each subtest indicated in bold

4.4 Part Three: In-Depth Investigation of Subtests

The low means on Story Completion, Pattern Reasoning and Triangles in this sample (Table 7, page 50) could account for the clustering together of the Simultaneous and Planning Scale subtests found in the EFA (Table 11). This part of the data analysis examined aspects of the test content, procedures and potential child factors which may have influenced performance on these subtests. This includes: an examination of the performance at an item level on these subtests; the effect of the inclusion of the supplementary subtest Block Counting; and potential associations between socio-demographic factors and scores on these scale indexes and subtests.

4.4.1 Item level performance. Figure 9A to 9C (page 63) presents graphically a summary of each subtest (of Story Completion, Pattern Reasoning and Triangles), indicating the scores achieved on each item, illustrating the variation in scores, the discontinuation trends and the potential effects of timing rules. These timing rules were defined in general in section 3.6.2.2 (page 28) and how they are applicable to each subtest in Table 4 (page 29).

4.4.1.1 Story Completion at item level. Story Completion has 18 items. The first seven items have a maximum score of one point; from item 8 to 11 a maximum score of three points can be achieved; and from item 12 to 18 a maximum score of four points can be achieved. All these items have a time limit; the child scores zero if they exceed the time limit or if they get the item incorrect. From item 8, time points are introduced where the child gets get one, two, three or four points depending on whether they answer correctly and how quickly they answer correctly. The discontinue rule is three consecutive scores of zero.

From item 8 onwards (when time points are introduced) the amount of children who were still completing the items started to decrease sharply and of the proportion that were still completing the items, majority scored zero points (Figure 9A). Of the children who

scored one or more points on items 8 onwards, few achieved four points. It is not possible to determine from the data whether they scored zero on items because they got the item incorrect or because they exceeded the time limit.

4.4.1.2 Pattern Reasoning at item level. Pattern Reasoning has 36 items. Items 1 to 9 have no time limit and have a maximum score of one point. Item 10 to 36 have a maximum score of two points with no time limit, but with time points: the child gets two points if he/she gets the correct answer within a certain time limit (mostly under 15 seconds; under 45 seconds for more difficult items). The child still gets one point if he/she gets it correct outside that time frame. Zero points are obtained if the incorrect answer is given. The discontinue rule is four scores of zero in five consecutive items.

On items 1 to 9, most children who completed those items scored one point (Figure 9B). The number of children who were still completing items (who had not reached the discontinue rule) started to decrease more sharply after item 15. However from item 10, where with time points a maximum of two points can be achieved, of the children who answered correctly, the majority scored two points.

4.4.1.3 Triangles at item level. Triangles has 27 items; the first two items have a maximum of two points available. From item 3 to 10, there is a maximum of one point available, with no time limit. From item 11 to 16, there is one point available with a 30 second time limit. For items 17 to 22; there are time points where there is a maximum of two points available (where to get two points a child needs to complete the task within 15/20 seconds), and there is a 45 second time limit. For items 23 to 27; a time limit of 90 seconds (items 23 and 24) and then 105 seconds (items 25, 26 and 27) is used. For these items (23 to 27) time points are also used, where a maximum of three points can be obtained if the

correct answer is given in less than 20 seconds and then 35 seconds on more difficult items. The discontinue rule is three consecutive scores of zero.

The number of children who met the discontinue rule increased sharply after item 16, where time points are introduced (Figure 9C). From item 17, a small proportion of children scored two points, and no children scored three points. Again, it cannot be determined from the data whether children scored zero on items because they got the answer incorrect or they had exceeded the time limit.
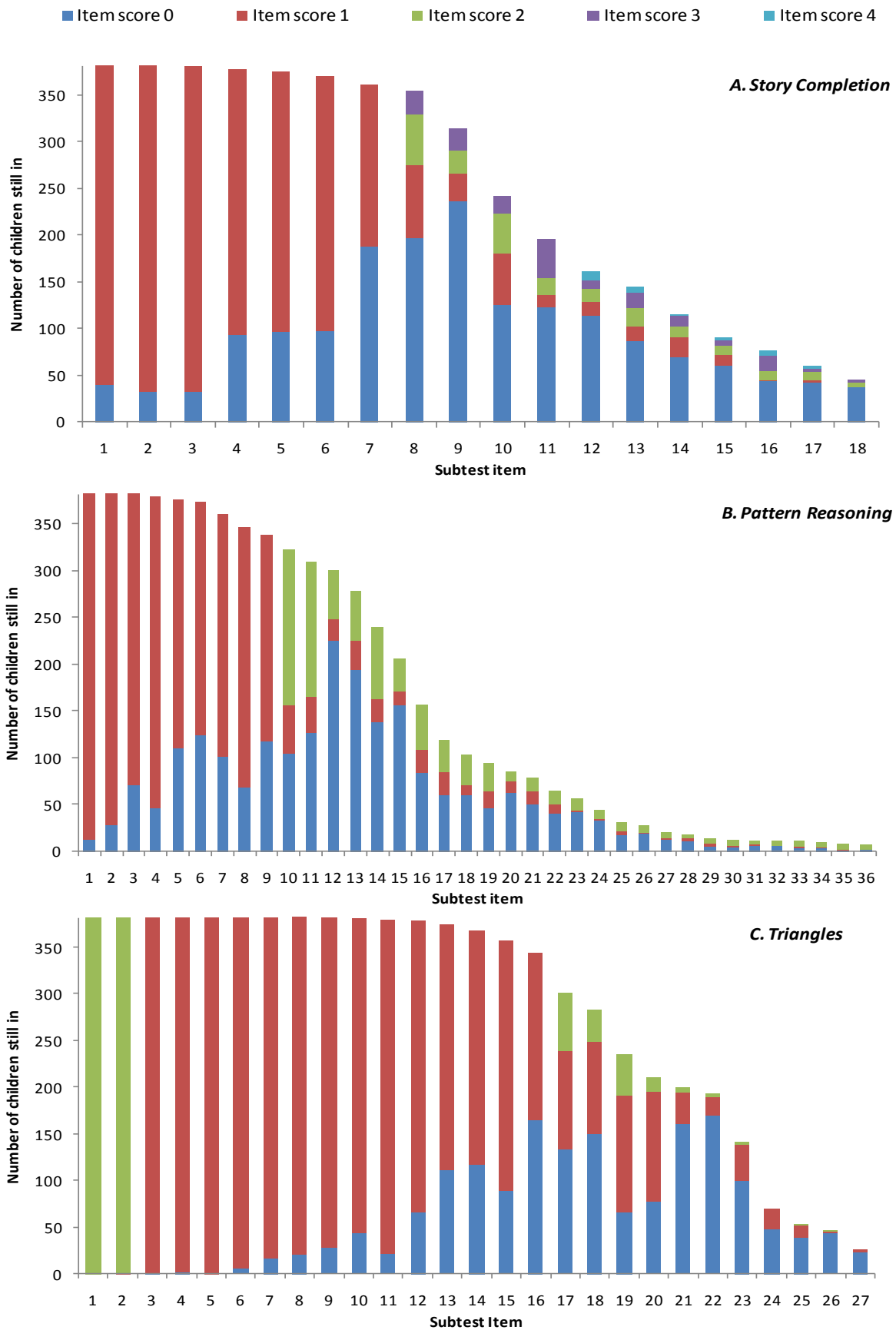
Figure 9. Performance at item level, *A*. Performance at item level on Story Completion; *B*. Performance at item level on Pattern Reasoning; *C*. Performance at item level on Triangles

4.4.2 Block Counting supplementary subtest. Two supplementary subtests were administered to the children: Hand Movements (Sequential Scale) and Block Counting (Simultaneous Scale). As performance on the Simultaneous Scale was low, specifically on Triangles (Table 7, page 50); the performance on Block Counting in comparison to other Simultaneous Scale subtests, and the effect of substituting Triangles with Block Counting on the standard scores of the Simultaneous Scale and the MPI were examined. In comparison to the other Simultaneous Scale subtests, children obtained the highest mean on Block Counting and the lowest mean on Triangles (Table 12, Figure 10).

Table 12

Description of Overall Performance on the Core and Supplementary Simultaneous Scale Subtests

Simultaneous Scale Subtests	*M*	*SD*	Range	Reliability	Normality (p)
Rover	7.16	3.02	1-16	.93	.0002
Triangles	5.41	2.5	1-12	.92	<.001
Block Counting	8.00	2.8	1-19	.93	.005

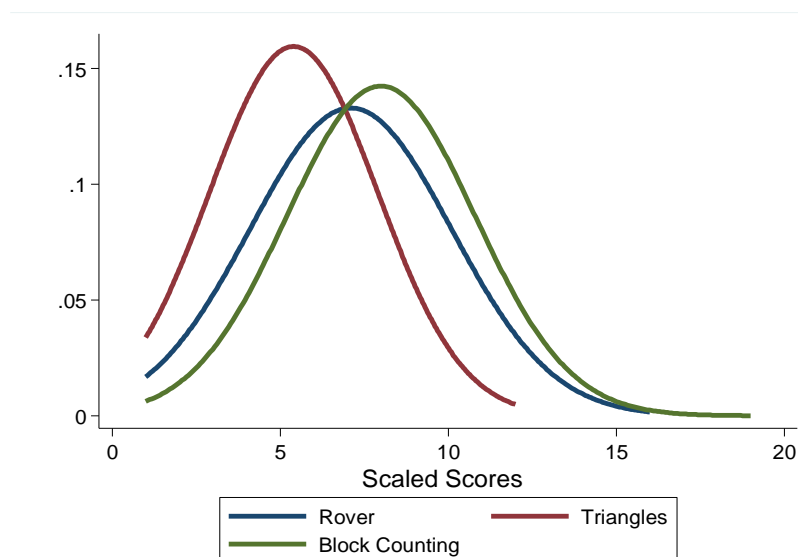Note: Units are scaled scores with a possible range of 1 to 19

Figure 10. Performance on core and supplementary Simultaneous Scale subtests

Table 13 shows the differences in the means on the MPI and the Simultaneous Scale when using the core subtests and when substituting Triangles with Block Counting. The average MPI using Block Counting was slightly higher than when Triangles was used, however the standard score on the Simultaneous Scale was considerably higher when calculated using Block Counting instead of Triangles, bringing it to a similar mean score as the Learning Scale (Table 13, Figure 11).

Table 13

Performance on MPI and Scale Indexes Including and Excluding Block Counting

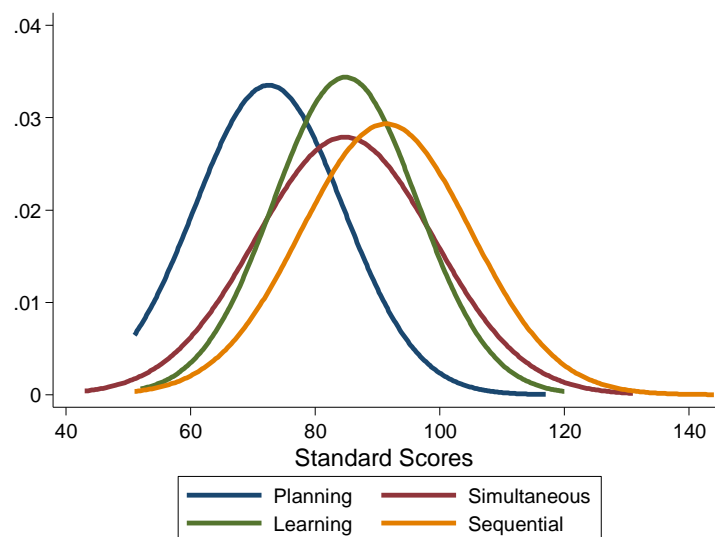| MPI and Scale Indexes	*M*	*SD*	Range	Reliability	Normality (*p*)
MPI (with Triangles)	**76.12**	**11.0**	**45-115**	**.78**	**.002**
MPI (with Block Counting)	**78.19**	**11.0**	**45-117**	**.77**	**.012**
Learning	84.94	11.59	52-120	.96	.009
Sequential	91.47	13.64	51-144	.89	.282
Simultaneous (with Triangles)	**77.16**	**13.75**	**43-116**	**.95**	**.001**
Simultaneous (with Block Counting)	**84.8**	**14.3**	**43-131**	**.95**	**.268**
Planning	72.61	11.92	51-117	.94	<.001

Figure 11. Distribution of the standard scores of the scale indexes, with the Simultaneous Scale calculated using Block Counting instead of Triangles

4.4.2.1 Confirmatory factor analysis with Block Counting. As children achieved higher means on Block Counting, the CFA was re-run using Block Counting instead of Triangles (referred to as model 4); this was to determine if the structure would still be maintained and whether the coefficients would alter in comparison to model 3.

As a new observed variable was introduced, the applicable data screening steps outlined in section 3.8.1.2.3 (page 39) were repeated. There were three cases of missing data and listwise deletion was used, bringing the sample size to 379, which with 12 parameters satisfied the 20 participants per parameter ratio (Jackson, 2003). Block Counting had excellent split-half reliability of .93 however was not normally distributed (*S-W*=.99, *p*=.005), it was negatively skewed showing majority of the children achieved higher scores − see Table 12 and Figure 10 (page 64). The Doornik-Hansen statistic confirmed that the joint distribution, including Block Counting, was still significantly different from a normal distribution (*p*<.001), therefore the ADF method of estimation was again used to estimate the fit of the model 4. The means and standard deviations of the observed variables used in this CFA are found in Table 7 (page 50) and Table 12 (page 64) and the intercorrelations are found in Table I1 (Appendix I).

Table 14 shows the fit statistics of model 3 (which included only the core subtests) and model 4 (included Block Counting in place of Triangles). Model 4 gave a slightly poorer fit to the data compared to model 3, with a higher RMSEA value (0.033), lower CFI (0.965) and a higher SRMR (0.051). However, as these values are still within the acceptable threshold levels and the *p* value of the $\chi 2$ statistic was non-significant (*p*=.1191), model 4 still provides a good fit to the data.

Table 14

Overall fit Statistics of Models 3 and 4

Fit Indices	Model 3	Model 4	Acceptable Threshold Levels
$\chi 2$	15.84, *p*=.4641	22.8, *p*=.1191	*p* > 0.05
RMSEA	0.00	0.033	< .07
90% CI; Lower bound	0.00	0.00	Close to 0.00
Upper bound	0.047	0.062	<.08
CFI	1.00	0.965	$\geq$ .95
SRMR	.029	0.051	<.08

Figure 12 shows the standardised regression coefficients of model 4. Among the observed variables, the coefficients were similar to those found using model 3 (Figure 7B, page 57). Block Counting has the lowest coefficient, however this is expected as it is a supplementary subtest and the rest are core subtests (Kaufman & Kaufman, 2004).
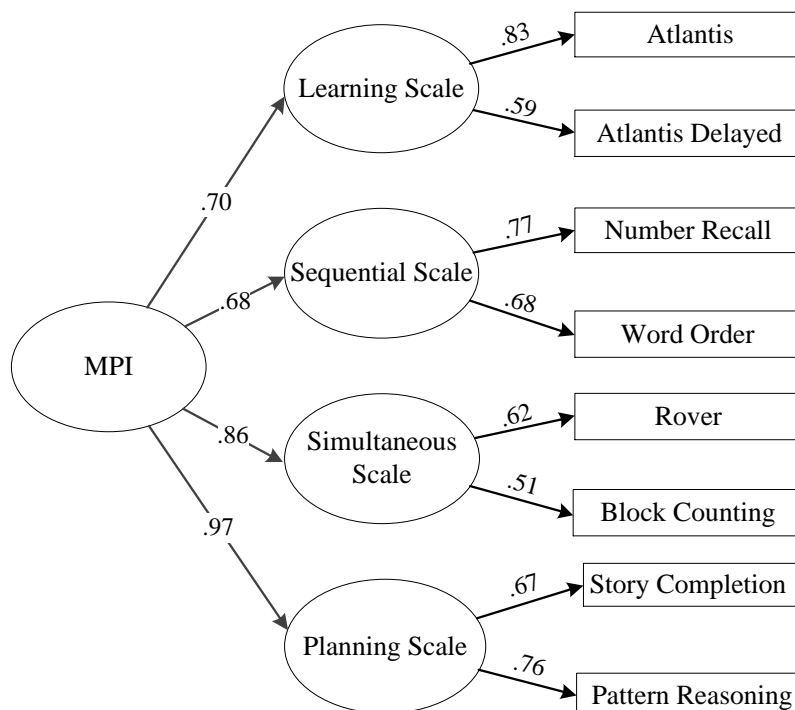

Figure 12. Resulting standardized regression coefficients of model 4

The regression coefficients for the latent variables (the scale indexes) found in model 3 and 4 are shown in Table 15. In model 4, the coefficients for the Learning and Sequential Scales are slightly higher; .70 and .68 respectively, and slightly lower for the Simultaneous and Planning Scales; .86 and .97 respectively, showing a slightly more even distribution of the coefficients of the scale indexes.

Table 15

Standardized Regression Coefficients for Latent Factors of Models 3 and 4

	Regression Coefficients (Model 3)	Regression Coefficients (Model 4)
Learning Scale	.67	. 70
Sequential Scale	.65	.68
Simultaneous Scale	.91	.86
Planning Scale	.99	.97

4.4.2.2 Exploratory factor analysis with Block Counting. To evaluate if the slight change of distributions in the coefficients of the scale indexes in the CFA model 4 (Table 15) helped to further distinguish the factors, the EFA was re-run, with Block Counting replacing Triangles.

Despite the slight change in coefficients in model 4, four separate factors were not produced (Table 16). The same subtests loaded onto each factor as in section 4.3 (Table 11, page 59); however the eigenvalues extracted when including Block Counting (model 4) were slightly more evenly distributed than when including Triangles (model 3).

Table 16

Comparing Eigenvalues of Factors Extracted in EFA for Models 3 and 4

	Factor 1	Factor 2	Factor 3
Model 3	1.25	1.04	0.87
Model 4	1.17	1.00	0.95

4.4.3 Potential influences of biological factors and caregiver characteristics on

performance. While the sections on item level performance and the inclusion of the supplementary subtest Block Counting examined whether test procedures and content could have influenced performance on these subtests, this section examines potential external factors which may have had influence. Multivariable linear regressions were used to evaluate associations between child related factors and poor performance on low scoring subtests and scale indexes. These child related factors included child related biological factors and caregiver characteristics (drawn from socio-demographic characteristics first described in Table 6, page 47). The following KABC-II subtest and scale indexes were included: Simultaneous Scale, Triangles, Planning Scale, Pattern Reasoning and Story Completion.

The multivariable linear regressions using the child related biological factors (birth weight, current weight, whether a child has had TB and if on chronic medication) showed significant associations with Triangles (p value=.039), the Planning Scale (p value=.049) and Story Completion (p value=.040) (Table 17, page 71). However despite being significant they account for a small amount of variance in the outcome score, 3% of the variance in both Triangles and the Planning Scale and 4% in Story Completion. Individually, current weight was found to be significantly associated with higher Story Completion scores, while chronic medication (if a child was taking it) was found to be significantly associated with higher scores on Triangles, Planning Scale, Pattern Reasoning and Story Completion (Table 17), noting that only 2% of the children were taking chronic medication (Table 6, page 47).

Of the multivariable linear regressions using the caregiver characteristics (current caregiver and education level of current caregiver), all five were significantly associated with higher scores on the Simultaneous Scale (p=.002), Triangles (p=.0002), Planning Scale

(p=.0004), Pattern Reasoning (p=.0262), with the association with Story Completion being highly significant (p=<.001) (Table 18, page 72). Despite being significant, the R^2 value indicates that, while more than the biological factors, a small amount of variance was accounted for; 4% for Pattern Reasoning, 6% for the Simultaneous Scale, 7% for the Planning Scale and Triangles and 9% for Story Completion (Table 18). While current caregiver (mother or other) was not significantly associated with performance on KABC-II outcomes, the education level of the caregiver was, with an increased level of education being related to higher scores on these low scoring subtests and scale indexes (Table 18).

Table 17

Multivariable Linear Regression Results Indicating the Effects of Child Related Biological Factors on Selected KABC-II Outcomes

	Simultaneous Scale		Triangles		Planning Scale		Pattern Reasoning		Story Completion	
Biological Factors	β	p	β	p	β	p	β	p	β	p
Birth weight	0.39	.776	0.11	.651	-0.48	.685	0.04	.899	-0.23	.336
Current weight	0.08	.507	-0.002	.922	0.15	.133	0.06	.807	0.05	.009
Had TB										
Yes	5.87	.174	1.07	.176	-2.65	.474	-7.6	.389	-0.15	.846
On Chronic medication										
Yes	11.20	.091	2.55	.035	15.30	.007	2.84	.038	2.76	.018
Model Summary										
R^2	.026		.032		.030		0.014		0.04	
F (degrees of freedom)	2.07(4)		2.55(4)		2.41(4)		1.13(4)		3.30(4)	
p	.085		.039		.049		.344		.040	

Table 18

Multivariable Linear Regression Results Indicating the Effects of Caregiver Characteristics on Selected KABC-II Outcomes

Caregiver Characteristics	Simultaneous Scale β	p	Triangles β	p	Planning Scale β	p	Pattern Reasoning β	p	Story Completion β	p
Current caregiver										
Other	0.67	.837	0.57	.332	0.47	.868	-0.49	.474	0.70	.222
Mother (ref)	0.00		0.00		0.00		0.00		0.00	
Highest education level of caregiver										
None	-4.41	.123	-0.60	.241	-4.26	.083	-.77	.198	-1.06	.034
Some Primary	-2.22	.282	-0.24	.520	-4.27	.017	-1.06	.014	-0.56	.126
Primary	2.37	.285	0.43	.287	-0.54	.775	.005	.999	-0.18	.642
Grade 10 (ref)	0.00		0.00		0.00		0.00		0.00	
Matriculation	5.12	.008	1.20	.001	3.50	.035	.24	.550	1.12	.001
Post matriculation	9.1	.055	2.13	.013	6.96	.086	1.06	.280	1.62	.051
Model Summary										
R^2	.056		.070		.066		.039		.09	
F (degrees of freedom)	3.62(6)		4.52(6)		4.2 (6)		2.42(6)		5.70(6)	
p	.002		.0002		.0004		.0262		<.001	

Chapter 5

Discussion

5.1 Summary of Main Findings

The aim of this research was to evaluate the psychometric properties of the KABC-II in a rural, non-clinical sample of primary school aged South African isiZulu-speaking children. This aim was achieved through three data analysis procedures.

Part one of this data analysis procedure involved: the examination of the psychometric properties of the KABC-II; an examination of the overall performance of children, and their performance disaggregated by age and sex; and the CFA. Results revealed that the KABC-II had excellent reliability, although the mean MPI score of 76.12 was lower than expected, suggesting that overall the battery of tests were difficult for children.

Children's performance was strongest on the Sequential and Learning Scales, while performance on the Simultaneous and Planning Scales was weaker, with the Planning Scale having the lowest mean score. Thus while the MPI score indicated children found the battery of tests difficult, when performance on scale indexes was examined, it seemed that children found the subtests of the Simultaneous and Planning Scales particularly difficult.

In terms of performance stratified by sex and age, girls performed slightly better on most subtests, yet differences between boys and girls were small and mostly non-significant.

The CFA showed that the hypothesized original structure of the KABC-II was maintained in this sample. However, an alternative structure, which excluded the MPI as the overall factor and allowed the scale indexes to correlate, also provided a similarly good fit to

the data. The CFA revealed a strong association between the Simultaneous and Planning Scales.

Part two examined these results further and involved conducting the EFA; this analysis investigated the strong relationship between the Simultaneous and Planning Scales, which was demonstrated in part one. This strong association was confirmed as the subtests of these two scales emerged as one factor.

Part three explored the subtests of the Simultaneous and Planning Scales in-depth. Given that the mean scores of children on these scale indexes were lower than expected, and the coefficients were higher than expected, it was important to understand the aspects within both the subtests and the children themselves which might explain the weaker performance. In terms of aspects of the subtests which may have had influence, these difficult subtests were examined at an item level, and the effect of the inclusion of the supplementary subtest Block Counting was assessed. The item level examination revealed that the use of time points may have disadvantaged the children on Story Completion and Triangles. Block Counting was shown to have the highest mean of the Simultaneous Scale subtests and when used as a substitute for Triangles in a CFA model, acceptable fit statistics were found.

Thereafter data analysis explored whether characteristics of the child (child related biological factors) or mother (caregiver characteristics) were associated with test performance. These potential associations were assessed using multivariable linear regressions. Together the child related biological factors had significant associations with scores on Triangles and Story Completion, which were two of the lowest scoring tests. In addition, caregiver education level was found to be significantly associated with scores on Triangles, Story Completion and Pattern Reasoning, with higher maternal education consistently associated with higher scores on these outcomes. The variance explained in

both the multivariable linear regressions using the child related biological factors and the caregiver characteristics was fairly low, potentially indicating the characteristics assessed didn't greatly influence performance on these outcomes.

These findings are explored in detail below.

5.2 Structure of the KABC-II

The underlying structure of the KABC-II global score, the MPI, was maintained in this sample. This is consistent with findings in other samples, including with samples of children in the United States (Morgan et al., 2009; Reynolds et al., 2007) and in LMICs such as Uganda (Bangirana et al., 2009) and India (Malda et al., 2010). A more comprehensive examination of the KABC-II structure - examining alternative CFA models, path coefficients, and an EFA - revealed some important issues to discuss. These include the appropriateness of the MPI as a global score and the close association between the Planning and Simultaneous Scales.

5.2.1 Appropriateness of the MPI. Given that a model excluding the MPI - as an overall factor - gave a similar fit to the data compared to a model including the MPI, the strength of the overall MPI factor in this sample was questionable. Similar results were found in a study which investigated the underlying structure of the KABC-II from the CHC theoretical approach with a sample of American preschool children (Morgan et al., 2009). Three models were tested, also increasing in complexity and both the model with no overall factor and the one with an overall factor provided tenable explanations for the factor structure of the KABC-II. While bearing in mind that Morgan et al. (2009) examined a different age group and used a different theoretical approach, these findings are largely consistent with the results of this research.

The importance and validity of an overall factor has been the subject of debate. Many support the existence of an overall factor (Carroll, 2003; Jensen, 1998; Spearman & Jones, 1950), while others have questioned this, arguing that it may lead to bias and discrimination in interpretation (Flynn, 1999; Fraser, 1995; R.C. Gardner, 1985). Gould (1996) commented on the morality of ranking people based on a number, especially if disadvantaged groups are labelled as "inferior" as a result. The test authors of the KABC-II support that the MPI should not be presented alone, but should be accompanied by the scale index scores (Kaufman & Kaufman, 2004). They argue it offers a clearer picture of the developmental status of the child, and allows for meaningful analysis and interpretation of strengths and weaknesses in cognition. Such an approach is more appropriate when making educational or diagnostic decisions, despite an overall global score being a useful reference in clinical practise (Morgan et al., 2009). The results of this research support this position.

5.2.2 Relationship between the Simultaneous and Planning Scales. Results of the CFA and EFA showed the Learning and Sequential Scales to emerge as expected, as two clear factors (Table 11, page 59), but the Simultaneous and Planning Scales were found to be more strongly associated than expected. This strong association evident in that the subtests of these scale indexes clustered together and loaded onto the same factor in the EFA, and both scale indexes had relatively high path coefficients in the CFA. This clustering together could be due to trends in performance, or how the test worked in this sample of children.

It could be that the Simultaneous and Planning Scales are measuring distinct abilities in this sample and the strong association is explained by the low means achieved on majority of the subtests of these two scales (specifically on Story Completion, Pattern Reasoning and Triangles) (Table 7, page 50). These low means indicate little variation in scores which in turn results in high correlations and likely accounts for the clustering of

these subtests. This potential source for clustering was suggested in a study in India, which examined the validity of an adapted version of the KABC-II (Malda et al., 2010). It was reported that Triangles and Rover, hypothesised to load onto the Simultaneous Scale, loaded onto the same factor as Pattern Reasoning and Picture Arrangement - a task akin to Story Completion, taken from the WISC. Similar to this research, the subtests of the Simultaneous and Planning Scales had lower means and higher intercorrelations (Malda et al., 2010), suggesting there may be a common pattern amongst the findings of this research and other research from LMIC settings.

Alternatively, the clustering could show that the Simultaneous and Planning Scales are not separable, suggesting that they measure similar underlying constructs. By way of comparison to the original structure of the KABC-II, for the age range in this sample (7-11 years), these two scales were found to be separable in the KABC-II normative sample (Kaufman & Kaufman, 2004; Reynolds et al., 2007). However they were not found to be as easily separable for the younger age group of 6 year old children in the normative sample (Kaufman & Kaufman, 2004). Therefore the theoretical model for the 6 year old age group only includes three scale indexes: Learning Scale, Sequential Scale and Simultaneous Scale (which includes Pattern Reasoning but not Story Completion).

While the children in this sample ranged in age from 7-11 years old, it is noteworthy that the mean age equivalents for Story Completion and Triangles were lower, at 6 years (Table 7, page 50). Therefore if the Simultaneous and Planning Scales are not distinct in the original normative data for younger children, and children in this sample scored younger for their age on these subtests, these results may not reflect an issue with how the test worked, but rather reflect the level of cognitive functioning and developmental capacity of the children in this sample. Thus, given the possibility of the cognitive functioning of a child of a certain age in this sample being below that of a child of a similar age in the normative

sample, it is plausible that the KABC-II worked as expected, but that the CFA reflects the structure suitable to the developmental capacity of a lower age range - of 6 year old children.

5.3 Performance on the Simultaneous and Planning Scales

While it is not possible to establish definitively why there is a strong association between these two scale indexes (whether it is rooted in children's performance or how the test worked with these children) what is clear is that performance was weak on these subtests. Understanding how children performed on each subtest relative to in other research in LMICs warranted further investigation. This section discusses the performance of children in this sample and findings of other studies conducted in LMICs which have utilised the K-ABC (the predecessor to the KABC-II) and the KABC-II.

This research found that rural South African children performed well on the Sequential Scale. These subtests measure successive processing which emphasises the order of stimuli and reflects children's short-term memory capacity for words, images and numbers. In contrast, children's performance was weakest on the Planning Scale subtests, which are high-level skills that are associated primarily with frontal-lobe executive functioning skills of Luria's Block 3. In addition, children performed weakly on the Triangles subtest (of the Simultaneous Scale) which is associated with spatial manipulation and visualization processes (Luria's Block 2) but also taps into planning abilities (Luria's Block 3). See Figure 3 (page 23) for a diagram illustrating Luria's theory.

Strong performance on the Sequential Scale of the K-ABC has also been reported in studies which limited their investigation to only the Sequential and the Simultaneous Scales, in cross-cultural validity studies in Laos and Zaire (now the Democratic republic of Congo) (Conant et al., 2003; Giordani, Boivin, Opel, Nseyila, & Lauer, 1996). In addition, these

studies found a large difference in scores between the Sequential and Simultaneous Scale (referred to as a Sequential-Simultaneous split), with the Simultaneous Scale subtests having lower means, as was found in this research. This split has also been found in clinical samples in Uganda and Senegal, where the K-ABC was utilised to examine the effects of Malaria and HIV in children (Bagenda et al., 2006; Boivin, 2002).

Further, consistently lower scores on the Planning Scale in comparison to other scale indexes were found when subtests of the KABC-II were administered to samples in Cambodia, Ethiopia, Kenya, India, Tanzania, Uganda, Democratic Republic of Congo and South Africa (Bangirana et al., 2011; Boivin et al., 2013; O'Donnell et al., 2012; Taljaard et al., 2013; Veena et al., 2010). In addition, in a number of these cohorts, like in this research, Triangles had the lowest means of the Simultaneous Scale subtests (Boivin et al., 2013; O'Donnell et al., 2012; Ogunlade et al., 2011).

Despite the studies described above examining either interventions or the effects of disease on child development, poorer performance on the Planning Scale and Triangles were consistently found in both the intervention and control groups of these studies, and thus may be common in LMICs and in Africa.

In the normative sample of the K-ABC and the KABC-II, similar scores were obtained across all applicable scale indexes (Kaufman, 1983; Kaufman & Kaufman, 2004). With the original K-ABC, the test authors noted that if a Sequential-Simultaneous split was present it may be indicative of a learning disability.

As illustrated above, performance on the scale indexes in a number of LMICs were varied and included this split. While the poverty which is widespread in these LMICs has been shown to be associated with a higher presence of learning disabilities among children (Fujiura & Yamaki, 2000), these patterns in performance may be the result of other factors.

These factors could be related to the cultural fairness of the subtests, or underdeveloped skills related to the high risk environments these children live in.

5.4 Factors Influencing Performance on the Simultaneous and Planning Scales

These two potential reasons which could contribute to poor performance on these subtests are outlined in this section. Firstly that subtests may show cultural bias, they could contain elements that are not culturally meaningful or commonly practised in the local population. Secondly that these children, given the risk factors they face (including poverty, under nutrition, poor school access and quality), have not fully developed the skills necessary to solve these tasks. Suggesting that children may have the potential to learn but are affected by risk factors as opposed to suggesting they have a deficit or a learning disability. These potential factors are explored further below.

5.4.1 Cultural bias. Of the subtests of the four scale indexes, the Learning and Sequential Scale subtests do not directly involve the child in working with materials. However in the Simultaneous and Planning Scale subtests the children are required to use materials to solve tasks. The complex figural nature of these tasks and a lack of previous exposure to such stimuli and materials which involve different shapes, forms and textures could have resulted in the lower scores on these subtests (Holding & Kitsao-Wekulo, 2004; Malda et al., 2010).

In addition, the use of time points (extra points given for rapid responses) in these subtests (specifically Story Completion, Pattern Reasoning, and Triangles) may not be culturally sensitive. This stemming from the assertion that different cultures tend to put different emphasis on the importance of completing a task quickly (Brislin & Kim, 2003; Oakland, 2009). In addition, children in this context may not only need more time to solve

the tasks in these subtests, but may feel it appropriate to take time to consider tasks and respond in a manner not suited to timed responses (Agranovich & Puente, 2007).

The potential effects of these time points were examined in section 4.4.1 (page 60). For Pattern Reasoning, there were time points but there was not a time limit, therefore children would always get credit for a correct answer. In this study, from item 12 onward, the majority of the children got the answer incorrect on each item; however, of the children who answered correctly, the majority scored 2 points. This indicates that the children found this subtest difficult, but for those who were able to grasp it, the time points did not greatly influence performance.

It was not possible to determine the effects of time points on performance on Story Completion and Triangles, as they contain time limits for successful completion of the item; therefore it is unknown whether the child scored zero because he/she got the item incorrect or because he/she exceeded the time limit. It could be that time points were a disadvantage to children as they could have achieved higher scores on these two subtests if time points were not awarded.

All three subtests do have a 'no-time-points' version which could be utilised if the researcher has reason to believe that the use of time points will be disadvantaging to the child (Kaufman & Kaufman, 2004). Reynolds et al. (2007) tested an alternative CFA model with the normative sample, which utilized the no-time-points versions of these subtests. It was found that the alternative model provided a better fit to the data compared to the time-point version (Reynolds et al., 2007). This may indicate that the use of time points results in the subtests providing weaker explanations of their underlying factors.

Using the no-time-points option will help differentiate between children not being able to solve the task or not being able to complete the task in the allotted time. These

results are important and call into question the value of time points and support the significance of implementing no-time-points options when tests are initially used in diverse cultural contexts.

In terms of the content of the tests themselves, the KABC-II provides supplementary subtests, for use as substitutions where there are cultural or individual attributes which suggest they would be useful over a core subtest. In this research supplementary subtests were included in the battery, given that the test battery was being implemented for the first time in this population. These provide a useful source of further information to examine performance on the scale indexes, in particular when core subtests show potential for cultural bias. The Planning Scale does not include a supplementary subtest, while the Simultaneous Scale does - Block Counting, which was included in this research.

Block Counting has been shown to be a good measure of the Simultaneous Scale (Reynolds et al., 2007), however, it has not been widely used with children in LMICs. In this research, the mean score for Block Counting was the highest of the Simultaneous Scale subtests and when it was used as a substitute for Triangles, the average MPI increased by two units and the Simultaneous Scale standard score increased by seven units (Table 13, page 65). As such it is possible that Block Counting may be more culturally and developmentally appropriate for this rural Zulu context in that children, given poor school exposure and quality, these children may not be overly familiar with the concept of shapes. Furthermore they may have been more likely to have been exposed to games involving blocks in their daily lives, than they would to cutting out shapes and arranging them.

Given that the EFA which included Block Counting instead of Triangles did not produce four separate factors and the CFA using Block Counting (model 4) was not a better fit than model 3 (Table 14, page 67) suggests this test alone does not adjust the overloading

of those two scales. Nevertheless it is still important to note that acceptable fit statistics were found in model 4. There is thus not sufficient evidence to support the generalised substitution of Block Counting for Triangles, but there is enough evidence to suggest it as an additional subtest to administer, as Block Counting may be more culturally appropriate to children in LMICs.

It was not possible to directly compare the performance on the Planning Scale core subtests to alternative subtests. However, other studies have included other subtests which may measure similar abilities. For instance, Conceptual Thinking - a KABC-II subtest for the Simultaneous Scale in the 6 year old level battery which contains elements of Planning (Kaufman & Kaufman, 2004; Reynolds et al., 2007). In this subtest, the child views a set of four or five pictures and must identify the one picture which does not belong (Kaufman & Kaufman, 2004). This subtest was used in a study in South Africa (Ogunlade et al., 2011), where a higher mean was found in comparison to Story Completion in a similar sample (Taljaard et al., 2013).

Furthermore, some studies in LMICs have utilized Planning subtests from other batteries, such as Picture Arrangement and Picture Completion from the WISC (Malda et al., 2010; Rushton, 2001; Rushton & Jensen, 2003; Skuy, Schutte, Fridjhon, & O'Carroll, 2001). Picture Arrangement consists of a series of pictures which depict a story but are in the incorrect order and the child must arrange them in order. A study conducted in India used Picture Arrangement with the children instead of Story Completion as they motivated it was less culturally specific (Malda et al., 2008; Malda et al., 2010). In Picture Completion, a child is shown several pictures one at a time, each picture has a part missing and the child must identify the missing part from several options. Both these subtests tap into planning and reasoning abilities and show skills in understanding a series of events (Wechsler, 1991, 2003) and could be considered simpler versions of Story Completion.

They have been used in South Africa, abet not recently (Rushton, 2001; Skuy et al., 2001), and in Zimbabwe (Rushton & Jensen, 2003) and all studies showed higher means for these subtests in comparison to the Story Completion mean in this research.

These alternative tests may offer further lines of enquiry in future research which could explore whether these subtests elicit better performance amongst children. These results would allow for further insight into the whether the KABC-II Planning Scale subtests are culturally appropriate in LMIC settings.

In summary children's poor performance on some subtests may have skewed the structure of the KABC. This poor performance may be a result of these subtests not being culturally appropriate in this setting, potentially stemming from the use of time points, or the figural nature or content of the tasks.

In addition to the presence of cultural bias, children could have performed poorly on these subtests due to not having fully developed the skills necessary to complete these tasks. However, the higher means achieved for Rover and Block Counting by the children in this sample may indicate that there is not in fact a deficit in the visual-spatial abilities required to solve the Simultaneous Scale tasks, but that Triangles was a difficult subtest for most children in this sample. In contrast, the performance on the Planning Scale subtests was consistently low, which could equally reflect underdeveloped frontal-lobe executive functioning skills in this context and other LMICs.

5.4.2 Underdeveloped executive functioning skills. Executive functioning skills are further explored in this section and are known to be highly sensitive to environmental context. Hence factors which may have influenced the development of these skills are also discussed.

Executive function is an umbrella term that includes a collection of inter-related processes which are responsible for purposeful, goal-directed behaviour (P. Anderson, 2002; V. Anderson, 1998; Duncan, 1986). Executive functions have been conceptualised to be mediated by frontal lobe functions and to consist of four components; the ability to form goals, planning, executing goal-directed plans and effective performance (Jurado & Rosselli, 2007). Collectively these allow for adaptation in an ever changing diverse environment.

In the context of poverty, children in LMICs face a multitude of risk factors which could result in a deficit in the acquisition of executive functioning abilities and subsequently, lowered cognitive skills (Burchinal et al., 1997; Walker et al., 2011). The potential effects of child related biological factors (birth weight, current weight, whether a child had TB and whether on chronic medication) and caregiver characteristics (current caregiver and caregiver education level) are outlined below.

5.4.2.1 Child related biological factors. The multivariable linear regression analyses using all the child related biological factors were found to be significantly associated with scores on Triangles, the Planning Scale and Story Completion; however the amount of variance explained was small (Table 17, page 71), showing the overall influence to be low.

Individually, current weight was significantly associated with higher Story Completion scores. While it is plausible that chronic malnutrition may have affected concentration and hence performance, in particular on subtests such as Story Completion which require high-level problem solving skills, it is not possible to determine this within the scope of this research.

Furthermore, whether a child was on chronic medication was found to be significantly associated with increased scores on Triangles, Planning Scale, Pattern Reasoning and Story Completion, this is a surprising result. It is possible that the known diagnosis of a chronic disease amongst these children would result in increased familial resources and health care, this improvement in quality of care may in turn lead to improved performances of children on cognitive tasks. However it is not possible to test this hypothesis within this data set and given that only 2% of children were on chronic medication and the low variance explained in the overall model, the strength of this relationship requires confirmation.

Of the child related biological factors assessed, the effects on performance were not extensive. This may be due to the limited number of biological factors assessed and that this sample was non-clinical. For example, the presence of disease was limited, with all the children being HIV negative and HIV unaffected and the vast majority having never had

TB, and the incidence of malaria in the area being low (Craig, Kleinschmidt, Nawn, Le Sueur, & Sharp, 2004; Dhuria et al., 2008).

5.4.2.2 Caregiver characteristics. The psychosocial factors examined in this research were limited and included only two caregiver characteristics; however the multivariable linear regressions including the two characteristics showed significant associations with higher scores on the Simultaneous Scale, Triangles, Planning Scale, Pattern Reasoning and Story Completion (Table 18, page 72). However while the overall variance explained was greater than for the biological factors, it was still low.

Individually whether the current caregiver was the mother or an alternative caregiver was not significantly associated with scores; however an increase in caregiver education level was associated with higher scores, as shown numerous times in literature (Barros et al., 2010; Tong et al., 2007; Wang et al., 2008).

Given the findings of the multivariable linear regressions, the strong literature base and the difference in the caregiver education level of the normative sample and this sample, it seems likely that caregiver education level may have affected test performance among these children. In the normative sample, only 14.4% of the mothers had an education level of grade 11 or less (Kaufman & Kaufman, 2004), and in this sample, 73% of caregivers had an educational level of less than grade 11, and of those mothers, 45% had only received primary school or less (Table 6, page 47).

The number of psychosocial factors assessed in this sample were limited and beyond the scope of this research. Only the effects of these caregiver characteristics (mother or alternate and maternal education) could be examined, but there are many known psychosocial factors which could have influenced performance which could not be assessed, hence results should be interpreted with caution.

5.5 Strengths and Limitations

This research had strengths, in that it used a well established measure of cognitive processing, the KABC-II, and included rigorous translation, adaptation and psychometric evaluation steps for this Zulu context. This research aimed to assess psychometric properties and performance on a cognitive processing assessment in a sample free of the effects of intervention or HIV infection which is fairly unique for research conducted in Africa.

However, this research has a number of limitations.

While the sample size was sufficient for the factor analysis, a larger sample size may have provided clearer results relating to the strength of the overall factor (MPI) and the relationship between the Planning and Simultaneous Scales.

In addition, the distribution of the sample across age and sex was not evenly distributed, with majority girls and few 7 and 11 year olds, which may have affected the variation in scores.

Further, not including or piloting the no-time-points version of Story Completion and Triangles limited the ability to examine the effects of time points on these subtests as it cannot be determined whether these affected the children's scores on the Story Completion and Triangles subtests.

In addition, the ability to further examine influences on the performance on the Planning Scale subtests was limited as there was no supplementary subtest available and no other subtest measuring Planning was administered.

Finally, not all data collected in the Siyakhula study was available for this sub-sample at the time this secondary analysis was conducted. Therefore the association

between a broader range of biological and psychosocial factors and performance on the KABC-II, specifically the Planning Scale subtests could not be fully examined.

5.6 Conclusions

This study examined the psychometric properties of the KABC-II in a sample of non-clinical rural isiZulu-speaking children of primary school age. The KABC-II showed excellent reliability and was found to maintain its original structure when used in this context. Therefore, it can be concluded that, with appropriate translation, adaptation and piloting, the KABC-II was an appropriate assessment to use in this rural Zulu context.

Importantly, while there is a shortage of evidence from Africa, all results found in this research support existing evidence in the literature, and unusual results provide interesting avenues for future research. For example, the lower performance on the Planning Scale subtests of the children in this research may indicate a weakness in the Planning Scale subtests of the KABC-II, specifically that they may not be culturally appropriate, or it may indeed reflect a deficit in the required executive functioning skills of children this age. If a deficit is present, it is possibly a result of the presence of risk factors, specifically with maternal education influencing performance.

Future research should aim to establish the appropriateness of the Planning Scale and interventions could be primarily aimed at increasing maternal education and investigating a broader range of biological and psychosocial risk factors and their effects on performance and cognitive development. This may be necessary to alleviate cycles of poverty and unfulfilled cognitive potential of children in LMICs.

5.7 Recommendations

There are four main recommendations arising out of this study:

First, administering the whole KABC-II battery (including supplementary subtests) with larger samples in other LMICs would allow for further investigation of a number of the issues presented in this chapter. This would allow for an evaluation of: whether the KABC-II maintains its structure in other cultures; the strength of the MPI; and the relationship between the Simultaneous and Planning Scales in different settings. Specifically whether the Simultaneous and Planning Scales cluster together due to low variation in scores or whether they are not separable in certain LMIC settings where children may function at lower developmental age equivalents due to cognitive deficits or poor educational opportunities. Further, this would allow for across site comparison of scores, examining whether the trends in performance (low scores on the Planning Scale subtests and on Triangles versus other Simultaneous Scale subtests) is present in other LMICs.

Second, when the KABC-II is administered, other measures of Planning and executive functioning from other batteries could be administered. As some of these batteries, such as in the case of the WISC, may be historically considered traditional IQ assessments, this recommendation does not include replacing any of the KABC-II subtests but only that these additional measures could be used to supplement the Planning Scale. This would allow for the applicability and cultural appropriateness of the Planning Scale subtests in other LMICs to be examined. This would aid to address the issue of whether low performance is due to a weakness in measurement (that these subtests do not adequately measure planning in other settings) or whether there is a deficit in required executive functioning skills. An assessment which could be useful in potentially identifying a deficit in executive functioning skills is the Developmental Neuropsychological Assessment (NEPSY), which predominantly assesses domains of executive functioning.

Third, research utilizing the KABC-II and including extensive data collection capturing a broader presence of biological (including birth weight, nutrition, presence of diseases, access to good quality water and breastfeeding) and psychosocial risk factors (including maternal education, maternal depression, maternal sensitivity and cognitive stimulation) could be conducted to provide further insight into the effects of these determinants.

Fourth, future research could aim to pilot/administer both the time-point and no-time-point versions of specifically Story Completion and Triangles in different LMICs. This would assist in establishing the effects of time points in these subtests and the importance of timing on performance in other LMICs which are non-western settings.

References

Abdi, H. (2003). Factor rotations in factor analyses. In M. Lewis-Beck, A. Bryman & T. Futing (Eds.), *Encyclopedia for research methods for the social sciences* (pp. 792-795). Thousand Oaks, CA: Sage.

Agranovich, A. V., & Puente, A. E. (2007). Do Russian and American normal adults perform similarly on neuropsychological tests? Preliminary findings on the relationship between culture and test performance. *Archives of Clinical Neuropsychology, 22*(3), 273-282. doi: 10.1016/j.acn.2007.01.003

Ahad, N. A., Yin, T. S., Othman, A. R., & Yaacob, C. R. (2011). Sensitivity of normality tests to non-normal data. *Sains Malaysiana, 40*(6), 637-641.

Alcock, K. J., Holding, P. A., Mung'ala-Odera, V., & Newton, C. R. J. C. (2008). Constructing tests of cognitive abilities for schooled and unschooled children. *Journal of Cross-Cultural Psychology, 39*(5), 529-551. doi: 10.1177/0022022108321176

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology, 8*(2), 71-82. doi: 10.1076/chin.8.2.71.8724

Anderson, V. (1998). Assessing executive functions in children: Biological, psychological, and developmental considerations. *Neuropsychological Rehabilitation, 8*(3), 319-349. doi: 10.1080/13638490110091347

Bagenda, D., Nassali, A., Kalyesubula, I., Sherman, B., Drotar, D., Boivin, M. J., & Olness, K. (2006). Health, neurologic, and cognitive status of HIV-infected, long-surviving, and antiretroviral-naive Ugandan children. *Pediatrics, 117*(3), 729-740. doi: 10.1542/peds.2004-2699

Bangirana, P., Allebeck, P., Boivin, M., John, C., Page, C., Ehnvall, A., & Musisi, S. (2011). Cognition, behaviour and academic skills after cognitive rehabilitation in

Ugandan children surviving severe malaria: A randomised trial. *BMC Neurology, 11*(1), 96-104. doi: 10.1186/1471-2377-11-96

Bangirana, P., Seggane, M., Allebeck, P., Giordani, B., John, C. C., Opoka, O. R., . . . Boivin, M. J. (2009). A preliminary examination of the construct validity of the KABC-II in Ugandan children with a history of cerebral malaria. *African Health Sciences, 9*(3), 186-192.

Barro, R. J., & Lee, J. W. (1996). International measures of schooling years and schooling quality. *The American Economic Review, 86*(2), 218-223.

Barros, A. J., Matijasevich, A., Santos, I. S., & Halpern, R. (2010). Child development in a birth cohort: Effect of child stimulation is stronger in less educated mothers. *International Journal of Epidemiology, 39*(1), 285-294. doi: 10.1093/ije/dyp272

Baumgartner, J., Smuts, C. M., Malan, L., Kvalsvig, J., van Stuijvenberg, M. E., Hurrell, R. F., & Zimmermann, M. B. (2012). Effects of iron and n− 3 fatty acid supplementation, alone and in combination, on cognition in school children: A randomized, double-blind, placebo-controlled intervention in South Africa. *The American Journal of Clinical Nutrition, 96*(6), 1327-1338. doi: 10.3945/ajcn.112.041004

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25*(24), 3186-3191. doi: 10.1097/00007632-200012150-00014

Benson, E. (2003, February). Intelligent intelligence testing. *Monitor on Psychology, 34,* 48-58.

Blair, C., Gamson, D., Thorne, S., & Baker, D. (2005). Rising mean IQ: Cognitive demand of mathematics education for young children, population exposure to formal

schooling, and the neurobiology of the prefrontal cortex. *Intelligence, 33*(1), 93-106.

doi: 10.1016/j.intell.2004.07.008

Bland, R. M., Coovadia, H. M., Coutsoudis, A., Rollins, N. C., & Newell, M. L. (2010).

Cohort profile: Mamanengane or the Africa centre vertical transmission study.

International Journal of Epidemiology, 39(2), 351-360. doi: 10.1093/ije/dyp165

Bland, R. M., Little, K. E., Coovadia, H. M., Coutsoudis, A., Rollins, N. C., & Newell, M.

L. (2008). Intervention to promote exclusive breast-feeding for the first 6 months of

life in a high HIV prevalence area. *AIDS, 22*(7), 883-891. doi:

10.1097/QAD.0b013e3282f768de

Boivin, M. J. (2002). Effects of early cerebral malaria on cognitive ability in Senegalese

children. *Journal of Developmental & Behavioral Pediatrics, 23*(5), 353-364. doi:

10.1097/00004703-200210000-00010

Boivin, M. J., Gladstone, M. J., Vokhiwa, M., Birbeck, G. L., Magen, J. G., Page, C., . . .

Taylor, T. E. (2011). Developmental outcomes in Malawian children with

retinopathy-positive cerebral malaria. *Tropical Medicine & International Health,*

16(3), 263-271. doi: 10.1111/j.1365-3156.2010.02704.x

Boivin, M. J., Okitundu, D., Makila-Mabe Bumoko, G., Sombo, M. T., Mumba, D.,

Tylleskar, T., . . . Tshala-Katumbay, D. (2013). Neuropsychological effects of

konzo: A neuromotor disease associated with poorly processed cassava. *Pediatrics,*

131(4), 1231-1239. doi: 10.1542/peds.2012-3011d

Bradley, R. H., Whiteside, L., Mundfrom, D. J., Casey, P. H., Kelleher, K. J., & Pope, S. K.

(1994). Early indications of resilience and their relation to experiences in the home

environments of low birthweight, premature children living in poverty. *Child*

Development, 65(2), 346-360. doi: 10.1111/j.1467-8624.1994.tb00755.x

Brislin, R. W., & Kim, E. S. (2003). Cultural diversity in people's understanding and uses of time. *Applied Psychology, 52*(3), 363-382. doi: 10.1111/1464-0597.00140

Brown, L. K., & Lourie, K. J. (2000). Children and adolescents living with HIV and AIDS: A review. *Journal of Child Psychology and Psychiatry, 41*(1), 81-96.

Brown, T. A. (2012). *Confirmatory factor analysis for applied research*. New York, NY: Guilford Press.

Browne, M. W. (1984). Asymptotically distribution-free methods for the analysis of covariance structures. *The British Journal of Mathematical and Statistical Psychology, 37*(1), 62-83. doi: 10.1111/j.2044-8317.1984.tb00789.x

Bruner, J. (1990). Culture and human development: A new look. *Human Development, 33*(6), 344-355. doi: 10.1159/000276535

Burchinal, M. R., Campbell, F. A., Brayant, D. M., Wasik, B. H., & Ramey, C. T. (1997). Early Intervention and mediating processes in cognitive performance of children of low-income African American families. *Child Development, 68*(5), 935-954. doi: 10.1111/j.1467-8624.1997.tb01972.x

Cabrera-Nguyen, P. (2010). Author guidelines for reporting scale development and validation results. *Journal of the Society for Social Work and Research, 1*(2), 99-103. doi: 10.5243/jsswr.2010.8

Carroll, J. B. (2003). The higher-stratum structure of cognitive abilities: Current evidence supports g and about ten broad factors. In H. Nyborg (Ed.), *The scientific study of general intelligence: Tribute to Arthur R. Jensen* (pp. 5-21). Oxford, England: Elsevier.

Carter, J. A., Neville, B. G., & Newton, C. R. (2003). Neuro-cognitive impairment following acquired central nervous system infections in childhood: A systematic review. *Brain Research Reviews, 43*(1), 57-69. doi: 10.1016/s0165-0173(03)00192-9

Charkaluk, M. L., Marchand-Martin, L., Ego, A., Zeitlin, J., Arnaud, C., Burguet, A., . . .
Kaminski, M. (2012). The influence of fetal growth reference standards on
assessment of cognitive and academic outcomes of very preterm children. *The
Journal of Pediatrics, 161*(6), 1053-1058. doi: 10.1016/j.jpeds.2012.05.037

Chen, H. Y., & Boore, J. R. (2010). Translation and back-translation in qualitative nursing
research: Methodological review. *Journal of Clinical Nursing, 19*(1-2), 234-239.
doi: 10.1111/j.1365-2702.2009.02896.x

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. New York, NY:
Psychology Press.

Conant, L. L., Fastenau, P. S., Giordani, B., Boivin, M. J., Chounramany, C., Xaisida, S., . .
. Pholsena, P. (2003). Environmental influences on primary memory development: A
cross-cultural study of memory span in Lao and American children. *Journal of
Clinical and Experimental Neuropsychology, 25*(8), 1102-1116. doi:
10.1076/jcen.25.8.1102.16722

Cooper, P. J., Landman, M., Tomlinson, M., Molteno, C., Swartz, L., & Murray, L. (2002).
Impact of a mother-infant intervention in an indigent peri-urban South African
context: Pilot study. *The British Journal of Psychiatry, 180*(1), 76-81. doi:
10.1192/bjp.180.1.76

Craig, M. H., Kleinschmidt, I., Nawn, J. B., Le Sueur, D., & Sharp, B. L. (2004). Exploring
30 years of malaria case data in KwaZulu-Natal, South Africa: Part I. The impact of
climatic factors. *Tropical Medicine and International Health, 9*(12), 1247-1257. doi:
10.1111/j.1365-3156.2004.01340.x

Daniels, M. C., & Adair, L. S. (2004). Growth in young Filipino children predicts schooling
trajectories through high school. *The Journal of Nutrition, 134*(6), 1439-1446.

Deary, I. J., & Johnson, W. (2010). Intelligence and education: Causal perceptions drive analytic processes and therefore conclusions. *International Journal of Epidemiology, 39*(5), 1362-1369. doi: 10.1093/ije/dyq072

Dewey, K. G., Heinig, M. J., & Nommsen-Rivers, L. A. (1995). Differences in morbidity between breast-fed and formula-fed infants. *The Journal of Pediatrics, 126*(5), 696-702. doi: 10.1016/s0022-3476(95)70395-0

Dhuria, M., Sharma, N., & Ingle, G. K. (2008). Impact of tuberculosis on the quality of life. *Indian Journal of Community Medicine, 33*(1), 58-59. doi: 10.4103/0970-0218.39249

Doornik, J. A., & Hansen, H. (2008). An omnibus test for univariate and multivariate normality. *Oxford Bulletin of Economics and Statistics, 70*, 927-939. doi: 10.1111/j.1468-0084.2008.00537.x

Duncan, J. (1986). Disorganisation of behaviour after frontal lobe damage. *Cognitive Neuropsychology, 3*(3), 271-290. doi: 10.1080/02643298608253360

Eickmann, S. H., Lima, A. C., Guerra, M. Q., Lima, M. C., Lira, P. I., Huttly, S. R., & Ashworth, A. (2003). Improved cognitive and motor development in a community-based intervention of psychosocial stimulation in northeast Brazil. *Developmental Medicine and Child Neurology, 45*(8), 536-541. doi: 10.1017/s0012162203000987

Eisinga, R., Grotenhuis, M., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health, 58*(4), 637-642. doi: 10.1007/s00038-012-0416-3

Engle, P. L., Black, M. M., Behrman, J. R., Cabral de Mello, M., Gertler, P. J., Kapiriri, L., . . . Young, M. E. (2007). Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *The Lancet, 369*(9557), 229-242. doi: 10.1016/S0140-6736(07)60112-3

Fernald, L. C. H., Kariger, P., Engle, P. L., & Raikes, A. (2009). Examining early child development in low-income countries: A toolkit for the assessment of children in the first five years of life. *Washington, DC: The World Bank*.

Fischer, R., & Milfont, T. L. (2010). Standardization in psychological research. *International Journal of Psychological Research, 3*(1), 88-96.

Flynn, J. R. (1999). Searching for justice: The discovery of IQ gains over time. *American Psychologist, 54*(1), 5-20. doi: 10.1037//0003-066x.54.1.5

Folsom, C., & Matthews, D. J. (2013). Making connections: Cognition, emotion and a shifting paradigm. In T. Balchin, B. Hymer & D. J. Matthews (Eds.), *The Routledge international companion to gifted education* (pp. 18-25). New York, NY: Routledge.

Foster, G., & Williamson, J. (2000). A review of current literature on the impact of HIV/AIDS on children in sub-Saharan Africa. *AIDS, 14*(Suppl. 3), 275-284.

Fraser, S. (1995). *The bell curve wars: Race, intelligence, and the future of America*. New York, NY: Basic books.

Fujiura, G. T., & Yamaki, K. (2000). Trends in demography of childhood poverty and disability. *Exceptional Children, 66*(2), 187-199. doi: 10.1177/001440290006600204

Galler, J. R., Harrison, R. H., Ramsey, F., Forde, V., & Butler, S. C. (2000). Maternal depressive symptoms affect infant cognitive development in Barbados. *Journal of Child Psychology and Psychiatry, 41*(6), 747-757. doi: 10.1111/1469-7610.00662

Gardner, J. M., Walker, S. P., Powell, C. A., & Grantham-McGregor, S. (2003). A randomized controlled trial of a home-visiting intervention on cognition and behavior in term low birth weight infants. *The Journal of Pediatrics, 143*(5), 634-639. doi: 10.1067/s0022-3476(03)00455-4

Gardner, R. C. (1985). *Social psychology and second language learning: The role of attitudes and motivation*. London, England: Edward Arnold.

Giordani, B., Boivin, M. J., Opel, B., Nseyila, D. D., & Lauer, R. E. (1996). Use of the K-ABC with children in Zaire, Africa: An evaluation of the sequential-simultaneous processing distinction within an intercultural context. *International Journal of Disability, Development and Education, 43*(1), 5-24. doi: 10.1080/0156655960430102

Glewwe, P. (2002). Schools and skills in developing countries: Education policies and socioeconomic outcomes. *Journal of Economic Literature, 40*(2), 436-482. doi: 10.1257/002205102320161258

Gould, S. J. (1996). *The mismeasure of man*. New York, NY: W.W. Norton & Company.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., & Strupp, B. (2007). Developmental potential in the first 5 years for children in developing countries. *The Lancet, 369*(9555), 60-70. doi: 10.1016/S0140-6736(07)60032-4

Gray, S., Reiser, M., & Brinkley, S. (2012). Effect of onset and rhyme primes in preschoolers with typical development and specific language impairment. *Journal of Speech, Language, and Hearing Research, 55*(1), 32-44. doi: 10.1044/1092-4388(2011/10-0203)

Greenfield, P. M. (1997). You can't take it with you: Why ability assessments don't cross cultures. *American Psychologist, 52*(10), 1115-1124. doi: 10.1037/0003-066x.52.10.1115

Guo, G., & Harris, K. M. (2000). The mechanisms mediating the effects of poverty on children's intellectual development. *Demography, 37*(4), 431-447. doi: 10.1353/dem.2000.0005

Hack, M., Flannery, D. J., Schluchter, M., Cartar, L., Borawski, E., & Klein, N. (2002). Outcomes in young adulthood for very-low-birth-weight Infants. *New England Journal of Medicine, 346*(3), 149-157. doi: doi:10.1056/NEJMoa010856

Holding, P., Abubakar, A., & Wekulo, P. (2010). Where there are no tests: A systematic approach to test adaptation. In M. L. Landow (Ed.), *Cognitive impairment: Causes, diagnosis and treatment*. New York, NY: Nova Publishers.

Holding, P., & Kitsao-Wekulo, P. (2009). Is assessing participation in daily activities a suitable approach for measuring the impact of disease on child development in African children? *Journal of Child & Adolescent Mental Health, 21*(2), 127-138. doi: 10.2989/jcamh.2009.21.2.4.1012

Holding, P., & Kitsao-Wekulo, P. K. (2004). Describing the burden of malaria on child development: What should we be measuring and how should we be measuring it? *The American Journal of Tropical Medicine and Hygiene, 71*(Suppl. 2), 71-79.

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53-60.

Horwood, L. J., Darlow, B. A., & Mogridge, N. (2001). Breast milk feeding and cognitive ability at 7–8 years. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 84*(1), 23-27. doi: 10.1136/fn.84.1.F23

Houlihan, C. F., Bland, R. M., Mutevedzi, P. C., Lessells, R. J., Ndirangu, J., Thulare, H., & Newell, M.-L. (2011). Cohort profile: Hlabisa HIV treatment and care programme. *International Journal of Epidemiology, 40*(2), 318-326. doi: 10.1093/ije/dyp402

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation*

Modeling: A Multidisciplinary Journal, 6(1), 1-55. doi: 10.1080/10705519909540118

Hunt, E., & Carlson, J. (2007). Considerations relating to the study of group differences in intelligence. *Perspectives on Psychological Science, 2*(2), 194-213. doi: 10.1111/j.1745-6916.2007.00037.x

Hunt, E., & Sternberg, R. J. (2006). Sorry, wrong numbers: An analysis of a study of a correlation between skin color and IQ. *Intelligence, 34*(2), 131-137. doi: 10.1016/j.intell.2005.04.004

Jackson, D. L., Gillaspy, J. A., & Purc-Stephenson, R. (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological Methods, 14*(1), 6-23. doi: 10.1037/a0014694

Jensen, A. R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review, 17*(3), 213-233. doi: 10.1007/s11065-007-9040-z

Kagitcibasi, C., Sunar, D., & Bekman, S. (2001). Long-term effects of early intervention: Turkish low-income mothers and children. *Journal of Applied Developmental Psychology, 22*(4), 333-361. doi: 10.1016/s0193-3973(01)00071-5

Kandawasvika, G. Q., Mapingure, P. M., Nhembe, M., Mtereredzi, R., & Stray-Pedersen, B. (2012). Validation of a culturally modified short form of the McCarthy Scales of Children's Abilities in 6 to 8 year old Zimbabwean school children: A cross section study. *BMC Neurology, 12*(1), 147-153. doi: 10.1186/1471-2377-12-147

Kaufman, A. S. (1983). *K-ABC: Kaufman Assessment Battery for Children: Interpretive manual*. Circle Pines, MN: American Guidance Service.

Kaufman, A. S., & Kamphaus, R. W. (1984). Factor analysis of the Kaufman Assessment Battery for Children (K-ABC) for ages 2½ through 12½ years. *Journal of Educational Psychology, 76*(4), 623-637. doi: 10.1037//0022-0663.76.4.623

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Assesment Battery for Children: Second Edition (KABC-II)*. Minnesota, MN: AGS Publishing.

Kaufman, A. S., Lichtenberger, E. O., Fletcher-Janzen, E., & Kaufman, N. L. (2005). *Essentials of KABC-II assessment*. New Jersey, NJ: Wiley.

Kitsao-Wekulo, P. K., Holding, P. A., Taylor, H. G., Abubakar, A., & Connolly, K. (2012). Neuropsychological testing in a rural african school-age population: Evaluating contributions to variability in test performance. *Assessment, 20*(10), 1-9. doi: 10.1177/1073191112457408

Kline, R. B. (2011). *Principles and practice of structural equation modeling, third edition*. New York, NY: Guilford Press.

Kramer, M. S., Aboud, F., Mironova, E., Vanilovich, I., Platt, R. W., Matush, L., . . . Shapiro, S. (2008). Breastfeeding and child cognitive development: New evidence from a large randomized trial. *Archives of General Psychiatry, 65*(5), 578-584. doi: 10.1001/archpsyc.65.5.578

Kurihara, M. (2010). Care continuity for pediatric patients with higher cortical dysfunction after traumatic brain injury. *Nihon Rinsho: Japanese Journal of Clinical Medicine, 68*(1), 63-68.

Kurstjens, S., & Wolke, D. (2001). Effects of maternal depression on cognitive development of children over the first 7 years of life. *The Journal of Child Psychology and Psychiatry and Allied Disciplines, 42*(5), 623-636. doi: 10.1017/S0021963001007296

Lanphear, B. P., Hornung, R., Khoury, J., Yolton, K., Baghurst, P., Bellinger, D. C., . . . Roberts, R. (2005). Low-level environmental lead exposure and children's intellectual function: An international pooled analysis. *Environmental Health Perspectives, 113*(7), 894-899. doi: 10.1289/ehp.7688

Le Doaré, K., Bland, R. M., & Newell, M. L. (2012). Neurodevelopment in children born to HIV-infected mothers by infection and treatment status. *Pediatrics, 130*(5), 1326-1344. doi: 10.1542/peds.2012-0405

Lund, K., Oestergaard, L. G., & Maribo, T. (2013). Danish translation and adaptation of Loewenstein Occupational Therapy Cognitive Assessment 2nd Edition (LOTCA-II). *Scandinavian Journal of Occupational Therapy, 20*(4), 302-305. doi: 10.3109/11038128.2013.768292

Luria, A. R. (1970). *Traumatic aphasia, Its syndromes, psychology and treatment*. Berlin, Germany: De Gruyter.

Lynn, R., & Vanhanen, T. (2006). *IQ and global inequality*. Atlanta, GA: Washington Summit Publishers.

Malda, M., Van de Vijver, F., Srinivasan, K., Transler, C., Sukumar, P., & Rao, K. (2008). Adapting a cognitive test for a different culture: An illustration of qualitative procedures. *Psychology Science Quarterly, 50*(4), 451-468.

Malda, M., van de Vijver, F. J. R., Srinivasan, K., Transler, C., & Sukumar, P. (2010). Traveling with cognitive tests: Testing the validity of a KABC-II adaptation in India. *Assessment, 17*(1), 107-115. doi: 10.1177/1073191109341445

Mayer, R. E. (2000). Intelligence and education. In R. J. Sternberg (Ed.), *The handbook of intelligence* (pp. 519-533). New York, NY: Cambridge University Press.

McGrew, K. S. (2005). The Cattell-Horn-Carroll theory of cognitive abilities: Past, present, and future. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues*. New York, NY: Guilford Press.

Morgan, K. E., Rothlisberg, B. A., McIntosh, D. E., & Hunt, M. S. (2009). Confirmatory factor analysis of the KABC-II in preschool children. *Psychology in the Schools, 46*(6), 515-525. doi: 10.1002/pits.20394

Murray, L., Hipwell, A., Hooper, R., Stein, A., & Cooper, P. (1996). The cognitive development of 5-year-old children of postnatally depressed mothers. *Journal of Child Psychology and Psychiatry, 37*(8), 927-935. doi: 10.1111/j.1469-7610.1996.tb01490.x

Nampijja, M., Apule, B., Lule, S., Akurut, H., Muhangi, L., Elliott, A. M., & Alcock, K. J. (2010). Adaptation of Western measures of cognition for assessing 5-year-old semi-urban Ugandan children. *British Journal of Educational Psychology, 80*(1), 15-30. doi: 10.1348/000709909x460600

Nguyen-Minh, S., Drossel, K., Horn, D., Rost, I., Spors, B., & Kaindl, A. M. (2013). Combined deletion 18q22. 2 and duplication/triplication 18q22. 1 causes microcephaly, mental retardation and leukencephalopathy. *Gene, 523*(1), 92-98. doi: 10.1016/j.gene.2013.03.078

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory, 3rd edition*. New York, NY: McGraw-Hill.

O'Donnell, K., Murphy, R., Ostermann, J., Masnick, M., Whetten, R. A., Madden, E., . . . Whetten, K. (2012). A brief assessment of learning for orphaned and abandoned children in low and middle income countries. *AIDS and Behavior, 16*(2), 480-490. doi: 10.1007/s10461-011-9940-z

Oakland, T. (2009). How universal are test development and use? In E. L. Grigorenko (Ed.), *Multicultural psychoeducational assessment*. New York, NY: Springer Publishing Company.

Ogunlade, A. O., Kruger, H. S., Jerling, J. C., Smuts, C. M., Covic, N., Hanekom, S. M., . . . Kvalsvig, J. (2011). Point-of-use micronutrient fortification: Lessons learned in implementing a preschool-based pilot trial in South Africa. *International Journal of Food Sciences and Nutrition, 62*(1), 1-16. doi: 10.3109/09637486.2010.495710

Page, M., Wilhelm, M. S., Gamble, W. C., & Card, N. A. (2010). A comparison of maternal sensitivity and verbal stimulation as unique predictors of infant social–emotional and cognitive development. *Infant Behavior and Development, 33*(1), 101-110. doi: 10.1016/j.infbeh.2009.12.001

Patel, V., DeSouza, N., & Rodrigues, M. (2003). Postnatal depression and infant growth and development in low income countries: A cohort study from Goa, India. *Archives of Disease in Childhood, 88*(1), 34-37. doi: 10.1136/adc.88.1.34

Peña, E. D. (2007). Lost in translation: Methodological considerations in cross-cultural research. *Child Development, 78*(4), 1255-1264. doi: 10.1111/j.1467-8624.2007.01064.x

Poortinga, Y. H. (1989). Equivalence of cross-cultural data: An overview of basic issues. *International Journal of Psychology, 24*(1), 737-756. doi: 10.1080/00207598908246809

Prado, E. L., Hartini, S., Rahmawati, A., Ismayani, E., Hidayati, A., Hikmah, N., . . . Alcock, K. J. (2010). Test selection, adaptation, and evaluation: A systematic approach to assess nutritional influences on child development in developing countries. *British Journal of Educational Psychology, 80*(1), 31-53. doi: 10.1348/000709909x470483

Rahman, A., Harrington, R., & Bunn, J. (2002). Can maternal depression increase infant risk of illness and growth impairment in developing countries? *Child: Care, Health and Development, 28*(1), 51-56. doi: 10.1046/j.1365-2214.2002.00239.x

Reschly, D. J., & Wilson, M. S. (1990). Cognitive processing versus traditional intelligence: Diagnostic utility, intervention. *School Psychology Review, 19*(4), 443-458.

Reynolds, M. R., Keith, T. Z., Fine, J. G., Fisher, M. E., & Low, J. A. (2007). Confirmatory factor structure of the Kaufman Assessment Battery for Children- Second Edition: Consistency with Cattell-Horn-Carroll theory. *School Psychology Quarterly, 22*(4), 511-539. doi: 10.1037/1045-3830.22.4.511

Richter, L. M., Griesel, R. D., & Rose, C. (1994). The McCarthy Scales of Children's Abilities: Adaptation and norms for use amongst black South African children. *South African Journal of Occupational Therapy, 24*, 17-30.

Rushton, J. P. (2001). Black–White differences on the g-factor in South Africa: A "Jensen Effect" on the Wechsler Intelligence Scale for Children- revised. *Personality and Individual Differences, 31*(8), 1227-1232. doi: 10.1016/S0191-8869(00)00210-5

Rushton, J. P., & Jensen, A. R. (2003). African–White IQ differences from Zimbabwe on the Wechsler Intelligence Scale for Children-Revised are mainly on the g factor. *Personality and Individual Differences, 34*(1), 177-183. doi: 10.1016/S0191-8869(02)00192-7

Rushton, J. P., & Jensen, A. R. (2010). Race and IQ: A theory-based review of the research in Richard Nisbett's intelligence and how to get it. *The Open Psychology Journal, 3*(1), 9-35. doi: 10.2174/1874350101003010009

Schmitt, T. A. (2011). Current methodological considerations in exploratory and confirmatory factor analysis. *Journal of Psychoeducational Assessment, 29*(4), 304-321. doi: 10.1177/0734282911406653

Schoeman, C. J., Herbst, I., & Nienkemper, D. C. (1997). The effect of tuberculous meningitis on the cognitive and motor development of children. *South African Medical Journal, 87*(1), 70-72.

Sherr, L., Croome, N., Castaneda, K. P., & Bradshaw, K. (2014). A systematic review of psychological functioning of children exposed to HIV: Using evidence to plan for tomorrow's HIV needs. *AIDS and Behavior, 18*(11), 2059-2074. doi: 10.1007/s10461-014-0747-6

Skuy, M., Schutte, E., Fridjhon, P., & O'Carroll, S. (2001). Suitability of published neuropsychological test norms for urban African secondary school students in South Africa. *Personality and Individual Differences, 30*(8), 1413-1425. doi: 10.1016/S0191-8869(00)00123-9

Spearman, C., & Jones, L. W. (1950). *Human ability*. Oxford, England: Macmillian.

StataCorp, L. (2007). Stata data analysis and statistical Software. *Special Edition Release, 10*.

Sternberg, R. J., & Grigorenko, E. L. (2004). Intelligence and culture: How culture shapes what intelligence means, and the implications for a science of well-being. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*(1449), 1427-1434. doi: 10.1098/rstb.2004.1514

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80*(1), 99-103. doi: 10.1207/s15327752jpa8001_18

Taljaard, C., Covic, N. M., Van Graan, A. E., Kruger, H. S., Smuts, C. M., Baumgartner, J., . . . Jerling, J. C. (2013). Effects of a multi-micronutrient-fortified beverage, with and without sugar, on growth and cognition in South African schoolchildren: A

randomised, double-blind, controlled intervention. *British Journal of Nutrition, 110*(12), 2271-2284. doi: 10.1017/S000711451300189X

Tanser, F., Hosegood, V., Bärnighausen, T., Herbst, K., Nyirenda, M., Muhwava, W., . . . Newell, M.-L. (2008). Cohort profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. *International Journal of Epidemiology, 37*(5), 956-962. doi: 10.1093/ije/dym211

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55. doi: 10.5116/ijme.4dfb.8dfd

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L., . . . Goldsmith, C. (2010). A tutorial on pilot studies: The what, why and how. *BMC Medical Research Methodology, 10*(1), 1-10. doi: 10.1186/1471-2288-10-1

Thompson, B. (2004). *Exploratory and confirmatory factor analysis: Understanding concepts and applications*. Washington, DC: American Psychological Association.

Tomlinson, M., Cooper, P. J., Stein, A., Swartz, L., & Molteno, C. (2006). Post-partum depression and infant growth in a South African peri-urban settlement. *Child: Care, Health and Development, 32*(1), 81-86. doi: 10.1111/j.1365-2214.2006.00598.x

Tong, S., Baghurst, P., Vimpani, G., & McMichael, A. (2007). Socioeconomic position, maternal IQ, home environment, and cognitive development. *The Journal of Pediatrics, 151*(3), 284-288. doi: 10.1016/j.jpeds.2007.03.020

Tsai, S. Y., Chou, H. Y., The, H. W., Chen, C. M., & Chen, C. J. (2003). The effects of chronic arsenic exposure from drinking water on the neurobehavioral development in adolescence. *Neurotoxicology, 24*(4-5), 747-753. doi: 10.1016/s0161-813x(03)00029-9

van de Vijver, F. J. R., & Poortinga, Y. H. (1997). Towards an integrated analysis of bias in cross-cultural assessment. *European Journal of Psychological Assessment, 13*(1), 29-37. doi: 10.1027/1015-5759.13.1.29

Veena, S. R., Krishnaveni, G. V., Wills, A. K., Kurpad, A. V., Muthayya, S., Hill, J. C., . . . Srinivasan, K. (2010). Association of birthweight and head circumference at birth to cognitive performance in 9-10 year old children in South India: Prospective birth cohort study. *Pediatric Research, 67*(4), 424-429. doi: 10.1203/PDR.0b013e3181d00b45

Walfisch, A., Sermer, C., Cressman, A., & Koren, G. (2013). Breast milk and cognitive development - the role of confounders: A systematic review. *BMJ Open, 3*(8), e003259. doi: 10.1136/bmjopen-2013-003259

Walker, S. P., Chang, S. M., Powell, C. A., & Grantham-McGregor, S. M. (2005). Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: Prospective cohort study. *The Lancet, 366*(9499), 1804-1807. doi: 10.1016/s0140-6736(05)67574-5

Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L., . . . Richter, L. (2011). Inequality in early childhood: Risk and protective factors for early child development. *The Lancet, 378*(9799), 1325-1338. doi: 10.1016/s0140-6736(11)60555-2

Walker, S. P., Wachs, T. D., Meeks Gardner, J., Lozoff, B., Wasserman, G. A., Pollitt, E., & Carter, J. A. (2007). Child development: Risk factors for adverse outcomes in developing countries. *The Lancet, 369*(9556), 145-157. doi: 10.1016/S0140-6736(07)60076-2

Wang, L. W., Wang, S. T., & Huang, C. C. (2008). Preterm infants of educated mothers have better outcome. *Acta Paediatrica, 97*(5), 568-573. doi: 10.1111/j.1651-2227.2008.00738.x

Wasserman, G. A., Liu, X., Parvez, F., Ahsan, H., Levy, D., Factor-Litvak, P., . . . Graziano, J. H. (2006). Water manganese exposure and children's intellectual function in Araihazar, Bangladesh. *Environmental Health Perspectives, 114*(1), 124-129. doi: 10.1289/ehp.8030

Watanabe, K., Flores, R., Fujiwara, J., & Tran, L. T. H. (2005). Early childhood development interventions and cognitive development of young children in rural Vietnam. *The Journal of Nutrition, 135*(8), 1918-1925. doi: 10.1016/j.ecresq.2009.11.001

Watson, D. L., & Emery, C. (2009). From rhetoric to reality: The problematic nature and assessment of children and young people's social and emotional learning. *British Educational Research Journal, 36*(5), 767-786. doi: 10.1080/01411920903159424

Wechsler, D. (1991). *WISC-III: Wechsler Intelligence Scale for Children*. San Antonio, TX: Psychological Corporation

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV)*. San Antonio, TX: The Psychological Corporation.

Wicherts, J. M., Dolan, C. V., & van der Maas, H. L. J. (2010). A systematic literature review of the average IQ of sub-Saharan Africans. *Intelligence, 38*(1), 1-20. doi: 10.1016/j.intell.2009.05.002

Williams, B., Brown, T., & Onsman, A. (2012). Exploratory factor analysis: A five-step guide for novices. *Australasian Journal of Paramedicine, 8*(3), 1-13.

Appendix A

Enrolment Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 2: Enrolment Form – ENF

Form completion date | Field worker | Child VTS ID | Child ACDIS DSID

Y Y Y Y M M D D

1. Mother's details

Surname | Maiden name | Date of birth
Y Y Y Y M M D D

First name | Second name | VTS ID (if applicable) | ACDIS DSID (if applicable)

2. Child's details

Surname | Date of birth | Gender: O Male   O Female
Y Y Y Y M M D D

Is this child a twin?   O Yes O No

First name | Second name

If yes,   O Twin 1   O Twin 2

3. Tracking information
Physical address

BSID No.

Phone number | Alternative number

Contact – Surname (known person at home) | Contact – First name

Isigodi | Local area name

Head of the homestead– Surname | Head of the homestead – First name

Nearest shop | Directions to reach home (e.g. roads, rivers, school, etc).

Description of household (including colour)

Appendix B

Ethical Clearance

UNIVERSITY OF ™
KWAZULU-NATAL

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YAKWAZULU-NATALI
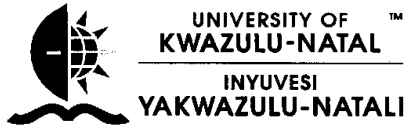
10 October 2012

Dr. R Bland
Africa Centre for Health and Population Studies
Mtubatuba
3935

Dear Dr Bland

PROTOCOL: The effect of an exclusive breastfeeding support intervention on subsequent development of children in the context of HIV. REF: BF184/12

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application.

The study was provisionally approved by a quorate meeting of BREC on 12 June 2012 pending appropriate responses to queries raised. Your responses dated 24 July 2012 to queries raised on 19 July 2012 have been noted by the Biomedical Research Ethics Committee at a quorate meeting on 09 October 2012. **All questionnaires etc must be submitted to BREC for approval before they are used.** The conditions have now been met and the study is given full ethics approval and may begin as from 10 October 2012.

This approval is valid for one year from **10 October 2012.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx. BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

Professor D Wassenaar (Chair)
Biomedical Research Ethics Committee
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 2384 **Facsimile:** +27 (0)31 260 4609 **Email:** brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx
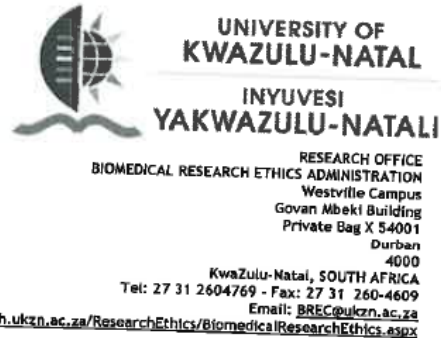Founding Campuses: ■ Edgewood   ■ Howard College   ■ Medical School   ■ Pietermaritzburg   ■ Westville

INSPIRING GREATNESS

Appendix C

Recertification

20 December 2013

Dr. R Bland
Africa Centre for Health and Population Studies
Mtubatuba
3935

Dear Dr Bland

PROTOCOL: The effect of an exclusive breastfeeding support intervention on subsequent development of children in the context of HIV. REF: BF184/12

RECERTIFICATION APPLICATION APPROVAL NOTICE

Approved: 10 October 2013
Expiration of Ethical Approval: 09 October 2014

I wish to advise you that your application for Recertification received on 09 October 2013   for the above protocol has been noted and approved by the Biomedical Research Ethics Committee (BREC) at a meeting that took place on **12 November 2013 (meeting not quorate) and ratified at a full meeting on 10 December 2013** for another approval period. The start and end dates of this period are indicated above.

BREC has noted Ms Joanie Mitchell's (Student no.: 15655369) Masters study as part of the above study.

If any modifications or adverse events occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written BREC approval for the change.

Yours sincerely

Mrs A Marimuthu
Senior Administrator: Biomedical Research Ethics

Appendix D

Socio-Demographic Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 3: Socio-Demographic Form – SDF

Form completion date	Field worker	Study ID
Y Y Y Y M M D D	☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐

1. Child's details

a. How many living biological children does the mother have (including index child)?   ☐☐

b. How many dead biological children does the mother have? (do not include miscarriages)   ☐☐

Birth order of index child (e.g. 2 of 4)   ☐ of ☐

Instruction: List all biological siblings (living or dead), starting with the oldest sibling (do not include index child)   O NA

Name	Year of birth	Current school grade*	Name	Year of birth	Current school grade*
1.	Y Y Y Y		11.	Y Y Y Y	
2.	Y Y Y Y		12.	Y Y Y Y	
3.	Y Y Y Y		13.	Y Y Y Y	
4.	Y Y Y Y		14.	Y Y Y Y	
5.	Y Y Y Y		15.	Y Y Y Y	
6.	Y Y Y Y		16.	Y Y Y Y	
7.	Y Y Y Y		17.	Y Y Y Y	
8.	Y Y Y Y		18.	Y Y Y Y	
9.	Y Y Y Y		19.	Y Y Y Y	
10.	Y Y Y Y		20.	Y Y Y Y	

* If not at school write N

* If don't know write U

* If died write D

2. Father and mother's details

a. Is the child's father still alive?   O Yes   O No   O Don't know   If no or don't know, go to q2d

b. Is the mother still in a relationship with him?   O Yes   O No

c. Does he provide for the child financially?   O Yes   O No

d. If the mother is not in a relationship with child's father, is she   O Single   O With new partner

e. Which man is most involved with this child?

O Biological father   O Mother's current partner   O Other   O None   If other, specify:_____

3. Caregiver's details

a. Does the child live with his/ her mother?   O Yes   O No

If No, what age was the child when the mother started living apart from the child? ☐☐ child age   (then skip to q3c)

b. Is the mother at home with the child every night?   O Yes   O No   O Don't know

If No, how many days per month is the mother at home with the child at night? ☐☐

c. Does the child live with his/ her biological father?   O Yes   O No

d. Who is considered the current **primary** caregiver of the child?   O Mother   O Other

If other, what is the relationship of the current primary caregiver to the child?

O Father   O Paternal grandmother   O Maternal grandmother   O Step mother   O Step father

O Cousin   O Uncle   O Aunt   O Paid nanny   O Other

If other, specify:_____   Estimated age of the caregiver ☐☐ years

e. Does somebody receive a child grant for this child?   O Yes   O No

If yes, who is it?   O Mother   O Primary caregiver (other than mother)   O Other   If other, specify:_____

f. Who is responsible for feeding the child most of the time?   O Mother   O Primary caregiver (other than mother)

O Other   If other, specify:_____

4. Educational details: mother and caregiver

What is the highest educational level completed by the mother?

O None   O Some primary   O Primary completed

O Grade 10 (Std 8)   O Matriculation   O Post matriculation

If the primary caregiver is not the mother, what is the highest educational level completed by the primary caregiver?

O None   O Some primary   O Primary completed

O Grade 10 (Std 8)   O Matriculation   O Post matriculation

5. Living arrangements

Answer the following questions regarding the head of the homestead

a. Gender of the head   O Male   O Female   Age in years ☐☐

b. What is the relationship of the head of the homestead to the child's mother?

O Mother herself   O Husband/partner   O Mother's father   O Mother's mother   O Husband/ partner's father

O Husband/ partner's mother   O Other   If other, specify:_____

Answer the following questions regarding members of the household

c. How many resident adults (i.e. >18 years) are there in this household? ☐☐

d. How many non-resident adults (i.e. > 18 years) are there in this household? ☐☐

e. How many resident children (i.e. ≤ 18 years) are there in this household? ☐☐

f. How many non-resident children (i.e. ≤ 18 years) are there in this household? ☐☐

g. Are there other households in this homestead?   O Yes   O No   If yes, how many? ☐☐

h. If, yes are there any adults (i.e. >18 years) from other households in the homestead involved in the care of this child?

(i.e. watching, feeding, playing with and helping with homework)   O Yes   O No

Appendix E

Child's School Information Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 10: Child's School Information Form – CSIF(B)

Form completion date | Field worker | Study ID
Y Y Y Y M M D D

a. Does your child attend school?   O Yes   O No   If no, go to qc

b. If yes, name of current school:_____   Current grade: ☐

c. Please list below all crèches and schools your child has attended since they were born until now:

Name of crèche*/school	Grade	Year

d. How many days of school did your child miss during the last calendar year? i.e. January to December of previous year ☐ days

O Don't know

e. If you were to walk to the primary school nearest to your home, how long would it take in minutes? ☐

* Include crèche if attended at least 3 times per week

Appendix F

Pregnancy, Delivery and Postnatal Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 5: Pregnancy, Delivery and Postnatal Form – PDPF

Form completion date   Field worker   Study ID

| Y | Y | Y | Y | M | M | D | D |

Pregnancy and delivery: DSS children only

The following questions relate to the pregnancy and delivery of the study child

1. Did the mother attend an antenatal clinic for this pregnancy?   O Yes   O No

If yes, was the clinic in the Hlabisa sub-district?   O Yes   O No

2. What was the name of the clinic? _____

3. Approximately how many antenatal care visits did the mother make during this pregnancy? [ ]   O Don't know

4. Where was the child born?   O Hlabisa Hospital

O Clinic in Hlabisa sub-district   Name:_____

O Other hospital   Name: _____

O Clinic outside Hlabisa sub-district Name:_____

O Home   O Don't know   O Other   If other, specify: _____

5. What was the mode of delivery?   O Vaginal   O Forceps/ Vacuum   O Caesarian   O Other, specify_____

6. What was the birth weight of the baby?   [ ] . [ ] kg

7. Gestation of baby   [ ] weeks

8. What was the birth head circumference of the baby?   [ ] . [ ] cm

9. Was the baby admitted to the neonatal nursery after delivery? O Yes   O No If yes for how many days approximately? [ ]

10. Which clinic did the mother attend for post-natal and child health visits?

O Clinic in Hlabisa sub-district   Name:_____

O Clinic outside Hlabisa sub-district Name: _____

Infant feeding: VTS and DSS Children

1. Did the mother ever breastfeed her baby?   O Yes   O No   O Don't know   If yes, go to q2   If no, stop the questionnaire

2. Did the mother breastfeed the baby within the first hour after birth?   O Yes   O No   O Don't know

3. In the first week how did the mother feed her baby?   O Breast milk only   O Mixed feed   O Formula milk only

4. After the first week how did she feed her baby?   O Breast milk only   O Mixed feed   O Formula milk only

If **breast milk** only, go to q5   If **mixed** feed, go to q6   If **formula milk** only, stop the questionnaire here

5. For how long did she give breast milk only? [ ] (months)

6. When did she stop breastfeeding altogether? [ ] (months)

Appendix G

Child Anthropometry Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 16: Child Anthropometry form – AF

Form completion date | Field worker | Study ID
Y Y Y Y M M D D

1. Child

Weight 1	⬚⬚.⬚ kg	Weight 2	⬚⬚.⬚ kg
Height 1	⬚⬚⬚.⬚ cms	Height 2	⬚⬚⬚.⬚ cms
MUAC 1	⬚⬚⬚.⬚ cms	MUAC 2	⬚⬚⬚.⬚ cms
Body fat 1	⬚⬚⬚.⬚ %	Body fat 2	⬚⬚⬚.⬚ %
Head circumference	⬚⬚⬚.⬚ cm	Head circumference	⬚⬚⬚.⬚ cm

Appendix H

Child's Medical Information Form

Africa Centre   **Siyakhula Project (Saving Brains)**

Form 7: Child's Medical Information Form - CMIF (A)

Form completion date	Field worker	Study ID
Y Y Y Y M M D D	☐☐☐☐	☐☐☐☐☐☐

1. Study Child's hospitalization details

a. Has the child ever been hospitalized overnight since birth? (probe about injuries) O Yes O No O Don't know

If yes, how many times? ☐☐   If no or don't know, go to q1b

1st admission (year) ☐☐☐☐   Diagnosis:_____

Length of stay   O< 7 days   O ≥ 7 days   O Don't know

2nd admission (year) ☐☐☐☐   Diagnosis:_____

Length of stay   O< 7 days   O ≥ 7 days   O Don't know

3rd admission (year) ☐☐☐☐   Diagnosis:_____

Length of stay   O< 7 days   O ≥ 7 days   O Don't know

4th admission (year) ☐☐☐☐   Diagnosis:_____

Length of stay   O< 7 days   O ≥ 7 days   O Don't know

5th admission (year) ☐☐☐☐   Diagnosis:_____

Length of stay   O< 7 days   O ≥ 7 days   O Don't know

b. Has the child ever been diagnosed with TB?   O Yes   O No   O Don't know   If no or don't know, skip to 1c

If yes, when did treatment start? ☐☐☐☐

c. Is the child on any chronic medication?   O Yes   O No   If yes, for what condition? (do not include TB)

O Epilepsy   O   Asthma   O Other   If other, specify:_____

2. Immunization

Age of child		Please tick vaccinations received. Use RTHC and Maternal recall						
At birth	(a) BCG	O Yes	O No	O Don't know	(b) OPV	O Yes	O No	O Don't know
6 weeks	(a) DTaP-IPV.HiB (1)	O Yes	O No	O Don't know	(b) Hep B (1) Hepatitis B vaccine	O Yes	O No	O Don't know
10 weeks	(a) DTaP-IPV.HiB (2)	O Yes	O No	O Don't know	(b) Hep B (2) Hepatitis B vaccine	O Yes	O No	O Don't know
14 weeks	(a) DTaP-IPV.HiB (3)	O Yes	O No	O Don't know	(b) Hep B (3) Hepatitis B vaccine	O Yes	O No	O Don't know
9 months	(a) Measles vaccine (1)	O Yes	O No	O Don't know				
18 months	(a) DTaP-IPV.HiB (4)	O Yes	O No	O Don't know	(b) Measles vaccine (2)	O Yes	O No	O Don't know
6 years	(a) Td vaccine	O Yes	O No	O Don't know				

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Appendix I

Intercorrelations between Observed Variables in Model 4

Table I1

Intercorrelations between Observed Variables used in Model 4

Subtests	1	2	3	4	5	6	7	8
1. Atlantis	1.00							
2. Atlantis Delayed	.48	1.00						
3. Number Recall	.30	.17	1.00					
4. Word Order	.30	.15	.52	1.00				
5. Rover	.30	.20	.22	.24	1.00			
6. Block Counting	.16	.10	.27	.19	.33	1.00		
7. Story Completion	.36	.27	.34	.31	.33	.26	1.00	
8. Pattern Reasoning	.32	.27	.33	.26	.41	.42	.45	1.00