The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

University of Cape Town

The Relationship between Socioeconomic Status and Neuropsychological Performance in 7- to 10-year-old South African Children

Fransien Schoeman – SCHFRA012

A dissertation submitted in partial fulfilment of the requirements for the award of the degree of Master of Arts (MA) in Psychological Research

Faculty of Humanities
University of Cape Town
2011

University of Cape Town

COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature: ___________________________________ Date: __________________

ACKOWLEDGEMENTS

Dr. Kevin G.F. Thomas, University of Cape Town: The supervisor of this project. I cannot thank him enough for his expertise, guidance, time, and effort on this project.

Ms. Leigh Schrieff, University of Cape Town: I would like to thank her for her time, effort and encouragement throughout this project.

The principals, teachers, and administration staff of the participating schools: I thank them for their hospitality and goodwill during the times I spent there.

The participants and their parents: Sincere thanks for their willingness to participate and enabling me to do my research.

Scholarships: KW Johnston Bequest, University Research Scholarship, Postgraduate Entrance Level Scholarship, and Claude Leon Foundation Merit Scholarship. I thank all the funders who have supported this project.

My parents, family and friends: I thank them in deep appreciation for their unconditional support and patience.

University of Cape Town

TABLE OF CONTENTS

ACKNOWLEDGEMENT 2

TABLE OF CONTENTS 3

LIST OF TABLES 7

ABSTRACT 9

INTRODUCTION 11

Cross-cultural Neuropsychology 12

Culture and neuropsychological performance 12

Culture as a variable in neuropsychological testing 14

Components of Socioeconomic Status 15

Components contributing to SES 16

Parental education 16

Parental/family income 17

Parental employment and occupation 18

Proximal factors related to SES 19

Home environment 19

Collective SES 19

School environment and quality of education 20

Neuropsychological Assessment of Children 23

Development of the Cognitive Domains of Interest 28

Childhood attention 28

Childhood memory 31

Childhood executive functioning 32

The Influence of SES on the Cognitive Domains of Interest 35

Influence of SES variation on attentional abilities 35

Influence of SES variation on memory functioning 37

University of Cape Town

Influence of SES variation on executive functioning 38

Specific Aims and Objectives 40

METHODS 42

Research Design and Setting 42

Participants 42

Measures 45

Demographic questionnaire 46

General intellectual functioning 49

Attention 50

Memory 52

Executive functioning 54

Procedure 55

Ethical Considerations 56

Data Analysis: Scoring procedures 56

Full Scale IQ, comprising of Performance IQ and Verbal IQ 57

Selective/focused attention 57

Sustained attention 57

Attentional control/switching 57

Sustained-divided attention 57

Simple attentional capacity and working memory 58

Verbal memory 58

Visual Memory 58

Executive functioning 59

Data Analysis: Statistical procedures 59

Between-groups comparisons of demographic characteristics 60

Between-groups comparisons of neuropsychological performance 60

Neuropsychological battery: Scoring and deriving composite scores 60

Multiple regression: Composite domain scores 65

Post-hoc multiple regression: Neuropsychological subtest scores 65

Comparison between the South African sample and the published norms 65

University of Cape Town

RESULTS 66

Objective 1 66

ANOVA and ANCOVA results for 7- and 8-year-olds 66

NEPSY-II Inhibition-Inhibition Completion Time 70

NEPSY-II Inhibition-Switching Completion Time 70

TEA-Ch Creature Counting Time 71

WASI Vocabulary 71

ANOVA and ANCOVA results for 9- and 10-year-olds 71

CMS Dot Locations Delayed Recall 76

CMS Stories Delayed Recognition 76

CMS Numbers Forward 77

NEPSY-II Design Fluency 77

TEA-Ch Creature Counting Total Correct 77

RCF Immediate Recall 78

Objective 2 78

Multiple regression analyses of 7- and 8-year-old data 78

Descriptive statistics for domain scores 78

Regression results 78

Multiple regression analyses of 9- and 10-year-old data 81

Descriptive statistics for domains scores 81

Regression results 81

Post-hoc regression models for individual test outcome measures 83

Objective 3 90

Normative comparisons for 7-year-olds 90

Normative comparisons for 8-year-olds 92

Normative comparisons for 9-year-olds 95

Normative comparisons for 10-year-olds 97

Objective 4 99

DISCUSSION 106

Objective 1: Between SES-group comparisons of neuropsychological

University of Cape Town

performance 107
Objective 2: Predicting neuropsychological performance using SES group membership alongside other demographic variables 113
Objective 3: Comparisons to published normative data 115
    7-year-olds 115
    8-year-olds 117
    9-year-olds 118
    10-year-olds 120
    Discussion of overall Objective 3 findings 121
Real-World Significance and Practical Application of Findings 126
    Practical application: Objective 4 – preliminary normative data 129
Other Findings of Interest 131
Limitations and Directions for Future Research 133

REFERENCES 135

APPENDIX A: Demographic Questionnaire and Asset Index 155
APPENDIX B: Parent/Guardian's Informed Consent Form 157
APPENDIX C: Assent Form for Participants 161
APPENDIX D: Example of Feedback Report 162

University of Cape Town

LIST OF TABLES

Table 1. *Demographic Characteristics of Participating Schools* 43

Table 2. *Demographic Characteristics of the Sample* 44

Table 3. *Neuropsychological Test Battery Used in the Current Study* 46

Table 4. *Demographic Questionnaire and Asset Index Data* 48

Table 5. *Neuropsychological Performance within Composite Domains* 62

Table 6. *ANCOVA Assumptions for the Neuropsychological Test Battery (7- and 8-year-olds)* 67

Table 7. *ANCOVA Results for the Neuropsychological Test Battery (7- and 8-year-olds)* 69

Table 8. *ANCOVA Assumptions for the Neuropsychological Test Battery (9- and 10-year-olds)* 73

Table 9. *ANCOVA Results for the Neuropsychological Test Battery (9- and 10-year-olds)* 75

Table 10. *Neuropsychological Test Performance by Domain: Primary Regression Results for 7- and 8-year-olds* 80

Table 11. *Neuropsychological Test Performance by Domain: Primary Regression Results for 9- and 10-year-olds* 82

Table 12. *Post-hoc Regression Model Results for 9- and 10-year-olds:*

University of Cape Town

Individual Outcome Measures in the Domain Attention, Concentration and Working Memory 85

Table 13. *Post-hoc Regression Analysis: CMS Numbers Forward* 87

Table 14. *Post-hoc Regression Analysis: TEA-Ch Sky Search Time per Target* 88

Table 15. *Post-hoc Regression Analysis: TEA-Ch Sky Search Attention Score* 89

Table 16. *Normative Comparisons: Results from one-sample t-tests for 7-year-olds* 91

Table 17. *Normative Comparisons: Results from one-sample t-tests for 8-year-olds* 93

Table 18. *Normative Comparisons: Results from one-sample t-tests for 9-year-olds* 96

Table 19. *Normative Comparisons: Results from one-sample t-tests for 10-year-olds* 98

Table 20. *Normative Data for 7- to 10-year-old Children from a High-SES Background* 100

Table 21. *Normative Data for 7- to 10-year-old Children from a Medium-SES Background* 102

Table 22. *Normative Data for 7- to 10-year-old Children from a Low-SES Background* 104

University of Cape Town

ABSTRACT

Socioeconomic status (SES) plays a significant role in neuropsychological performance, with several empirical research studies reporting that low-SES children score more poorly on cognitive tasks than do high-SES children. However, in South Africa there is a lack of local research focusing specifically on SES and children's neuropsychological performance. In terms of neuropsychological performance in children, the contributing factors to SES (e.g. parental education and employment) as well as the more proximal factors related to SES (e.g. collective SES, quality of schooling etc.) are important. Given the range of potential influences on brain development, it is possible that the SES gradient in cognitive achievement might have a broad and uniform neurocognitive basis, affecting all components of the developing brain to a roughly equal degree, although some components may be more sensitive to SES than others. Various studies are consistent in showing that high-SES children perform better than low-SES children (even when IQ is statistically controlled). However, cognitive ability is not depressed across the board among low-SES children. Rather, abilities have been linked to specific neurocognitive systems are disproportionately affected. The aim of the current study, therefore, was to investigate the relationship between SES and neuropsychological performance in a sample of South African children (divided into three SES-based groups) between the ages of 7- and 10-years old, with specific focus on the domains of attention, memory, and executive functioning. In addition, I aimed to provide preliminary normative data, stratified by age and SES, for the test battery used in this study.

Between SES-group comparisons indicated significant differences between the three SES-groups, in favour of the high-SES group. For 7- and 8-year-olds differences occurred on tests of inhibition, switching and sustained attention, all in addition to processing speed; and expressive language. For 9- and 10-year-olds differences occurred on tests of delayed visual recall, delayed verbal recognition, simple attention and concentration, non-verbal fluency, as well as sustained attention and switching. SES group membership was a significant contributor to variation in performance on tests of attention and concentration in 9- and 10-year-olds. Compared to the published normative data, in general, the high-SES children (in all four age groups) performed similar or better than the standardization samples, the medium-SES children performed similarly

University of Cape Town

or poorer than the standardization samples, and the low-SES children performed significantly poorer than the standardization samples. The findings of this study are consistent with previous findings which suggest that high-SES children outperform their age peers from lower-SES backgrounds on cognitive tasks, and that SES is an important factor to consider in neuropsychological assessment.

Keywords: Socioeconomic status (SES), neuropsychological performance, children, South Africa, attention, memory, executive functioning, norms.

.

University of Cape Town

Introduction

The relationship between socioeconomic status (SES) and neuropsychological performance is a frequent topic of discussion, debate, and research. However, in South Africa there is a lack of local research focusing specifically on the relationship between SES and children's neuropsychological performance. The wide range of SES in South Africa implies not only a wide range of occupations and associated income determining families' access to resources, but also implies a wide range of quality of schooling and education, which in turn influences performance on cognitive tasks. Regarding clinical or real-world significance, this study is a step in the direction of gathering data in order to standardize norms for children in three SES groups (classified as low-, medium-, and high-SES) which will enable clinicians to assess for SES before intuitively interpreting data according to generalized assumptions about children from these SES groups.

Socioeconomic status (SES) plays a significant role in neuropsychological performance, with several empirical research studies reporting that low-SES children score more poorly on cognitive tasks than do high-SES children (Ardila, 1995; Bjorklund & Weiss, 1985; Bowey, 1995; Hackman & Farah, 2009; Kishiyama, Boyce, Jimenez, Perry & Knight, 2008; Magnuson & Duncan, 2006; Walker, Petrill, & Plomin, 2005). Defining SES is difficult, however, due to the variety of factors researchers focus on when studying this topic. Magnuson and Duncan (2006) indicate that educational, financial, and social resources, as well as more macro-level factors such as culture and worldviews, are often grouped under the collective term 'socioeconomic status.' They argue, however, that more proximal factors, particularly family and childrearing environments, are more likely to be the critical link between a family's SES and a child's wellbeing. The emphasis in defining SES should therefore be on gradients in social and economic resources, rather than on cultural underpinnings of categorical social classes. They highlight four key components of parental SES that are particularly relevant for the child's wellbeing: income, education, family structure, and neighbourhood conditions.

In a manner similar to the argument made by Magnuson and Duncan (2006), Myer, Stein, Grimsud, Seedat, and Williams (2008) state that SES is usually defined as, or investigated using, (a) estimated household income, (b) years of participant education, and (c) participant employment. Myer, Ehrlich, and Susser (2004) argue that these traditional markers of SES may not adequately capture variation in socioeconomic position in developing country settings where

University of Cape Town

there is a substantial economy and resource sharing is common (particularly in rural areas where bartering of goods and services may act in the place of income-based wealth). In an attempt to improve on this situation, Myer et al. (2008) developed a 17-item asset index that asked about (a) household ownership of appliances (e.g., refrigerator, microwave, television, etc.), (b) other household resources (e.g., telephone, automobile, flush toilet, etc.), and (c) financial activities in which participants engaged (e.g., shopping at a supermarket, having an account at a retail store, etc.). In this study, SES is defined following those parameters.

Cross-cultural Neuropsychology

Culture and neuropsychological performance. SES is, of course, not unique in its significant relationship to neuropsychological performance: Cultural influences on cognitive performance have also been widely researched and commented upon (see, e.g., Ardila, 1995; Cattell, 1940; Cohen, R.A., 1969; Eviatar, 2000; Greenfield, 1997; Manly, J. J., 2008; Rosselli & Ardila, 2003; Shuttleworth-Edwards, Donnelly et al., 2004; Shuttleworth-Edwards, Kemp et al., 2004). Nell (1999a) discusses the pioneering study of cross-cultural neuropsychology: Luria's 1931 expedition to Uzbekistan. Luria undertook this trip in order to explore ideas related to Vygotsky's theory of cortical development through mediation of social experience and Durkheim's suggestion that it is in society that the mind originates. His expectations were confirmed when he found that different groups of Uzbek peasants performed simple intellectual tasks in different ways according to their level of modernization: The least modernized group performed tasks at the most concrete and basic level, whereas those with some formal schooling or training managed to reason more abstractly.

More than a half century later, Gilbert (1986) replicated Luria's findings, this time investigating cognitive function in a sample of rural South Africans in KwaZulu-Natal. Gilbert selected his sample (five groups of five participants), all born and raised in the study area, to correspond to the five groups that Luria had identified in his study: (1) the "poor" were subsistence farmers or casual labourers with little or no formal education or urban experience; (2) the "farmers" had no formal training in agriculture but were capable of producing at a higher level than the subsistence farmers; (3) the "entrepreneurs" were shop owners and businessmen; (4) the "community workers" were active in community-based projects but with no formal qualifications; and (5) the "professionals" were teachers and nurses who had completed their

University of Cape Town

studies away from home and returned to the area as carriers of contemporary knowledge and experiences. Levels of formal schooling varied between an average of 1 year for the “poor” group and approximately 12 years for the “professionals”. A grouping task and a categorization task was administered to the participants in order to determine if, like Luria’s participants, different levels of modernization were related to different approaches to cognitive tasks. Their approaches and responses to the task were documented carefully.

Gilbert’s “poor” group, like Luria’s, generally reasoned concretely on both the grouping and categorization tasks; the “farmers” performed similarly to the “entrepreneurs” on the grouping task, showing more flexibility than the “poor” group, and on the categorization task agreed on some of the suggested abstract categorizations. The “entrepreneurs” showed a similar flexible grouping style to the “professionals” but on the categorization task not all of the participants were able to consistently reason in terms of categories and veered between abstract and situational reasoning. The “community workers” resembled the “professionals” in their classification style. The “professionals” did not consistently employ abstract reasoning – though they did so more so than the other groups – but rather a combination of concrete and categorical reasoning in both tasks.

More recent studies from all over the world (e.g., Ardila, 1995; Nell, 1999a; Teng & Manly, 2005) confirm the assertions originally made by Luria and later on agreed on by Gilbert: Cognitive abilities generally assessed through neuropsychological assessment depend on learning, training, and exposure to Western education. Furthermore, there is no universal set of cognitive skills because different life circumstances require different adaptive skills in order to survive in a given environment; for example, abstract reasoning as a skill is of more importance for survival in the realm of academia than it is in doing general labour on a farm.

Neuropsychologists concerned with cross-cultural assessment have therefore become invested in devising attempts to test in a culture-free manner, by means of using relevant and appropriate assessment tools and, equally important, considering the relevance and appropriateness of the normative data used (Teng & Manly, 2005). The importance of the latter is illustrated by S. J. Anderson (2001) in a local study that examined the prevalence of neuropsychological impairment as indicated by poor performance on neuropsychological tasks. A battery of well-known and commonly used tests was administered to a sample of neurologically intact English-speaking individuals of European descent. Compared to the

University of Cape Town

internationally-published norms, 25% of participants were classified as "impaired" despite being cognitively sound. In another South African study, Skuy, Schutte, Fridjhon, and O'Carroll (2000) found that the use of published norms was not accurate in measuring the neuropsychological performance of a sample of urban Black African high school learners. Similarly, Zindi (1994) found that white children from London far outperformed an age-matched group of black working-class Zimbabwean children on the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974).

Culture as a variable in neuropsychological testing. Despite its known relationship with, and effect on neuropsychological performance, culture as a variable poses more difficulty in the stratification of normative data than variables such as SES, educational level/years of education, and even quality of schooling, due to its qualitative nature. SES, for example, can be classified in groups such as low or high, educational level can be classified in terms of years of formal education, and so on. Culture, on the other hand, is defined and operationalised as an individual's membership in a cultural group (e.g., their national culture) which defines the values they adopt and implement. These values are influenced and modified by membership in professional, ethnic, religious, and various other social groups – each with its own specialised culture and value set. Therefore, individuals vary greatly in the degree to which they implement values dictated by a single cultural group (such as their national culture). Also, an individual's culture is therefore not permanent or unchangeable (Straub, Loch, Evaristo, Karahanna, & Strite, 2002).

Rapid globalization and increased mobility of individuals has led to significant culture shifts in terms of previously disadvantaged populations making the transition towards Westernization, which inevitably leads to conceptual shifts (in terms of selection, administration, and interpretation of neuropsychological/cognitive tests) in the field of psychometric testing (Shuttleworth-Edwards, Kemp, et al., 2004). The implications of these cultural shifts have led to the idea that people within a certain race, ethnicity, or culture can no longer be assumed to be homogenous with regard to neuropsychological/cognitive performance. Also, it should be kept in mind that when discussing cross-cultural neuropsychology the clinician is not excluded from the increasing diversity of the population of which he/she forms part:

> [N]europsychologists must be responsive to the rapidly changing and diverse nature of the population by taking into account cultural, linguistic and educational background of

University of Cape Town

> the people we assess in all aspects of our practice, including not only the measures and normative standards that we use, but also the languages in which we are competent to assess, the educational materials we provide, and the recommendations we make (Manly, J. J., 2008, p. 180).

This variation within groups has also brought about new considerations in cross-cultural research, with the emphasis of grouping falling less on race and ethnicity as a determinant of culture, but rather following a more universalist approach that cuts across racial divisions and instead stratifies data in terms of, for instance, level and quality of education, or degree of acculturation (Manly et al., 2000; Shuttleworth-Edwards, Kemp, et al., 2004; Skuy et al., 2001). The accuracy of neuropsychological assessment and diagnosis in ethnically or linguistically different populations will therefore be improved by refining measures within, as well as the overall approach to, neuropsychological assessment in the contexts of racial and ethnic, cultural, and linguistic diversity. This changed approach will also enlighten overarching questions about valid measurement of cognitive ability, regardless of diversity matters (Brickman, Cabo, & Manly, 2006).

In terms of a South African context with its broadly diverse population, numerous ethnicities, 11 official languages, vastly dissimilar socioeconomic classes, unequal access to a variety of resources including health care and educational opportunities, "culture" is a most complex term to isolate and define. This study therefore set out to take in account the "regular" demographic variables (e.g., age, language, sex, etc.) as well as educational level and education quality, but to focus on SES due to its ability to be divided into clear, definable, and characteristic groups – allowing for stratification of normative data according to SES. In clinical practice, preliminary norms such as those presented in this paper will enable clinicians to make informed decisions when it comes to choosing appropriate norms for assessment of an individual or a group, rather than making assumptions based on experience and intuition and applying these to internationally published norms.

Components of Socioeconomic Status

The nature of SES itself answers the questions how and why a sociological construct, SES, might be associated with brain function (Farah et al., 2006). Traditionally, researchers have used family income as measure of SES, an approach that is justified in that that variable accounts

University of Cape Town

for the greatest amount of variance in the construct. SES measures that combine two or more indicators account for more variance than single indicators, however (Bradley & Corwyn, 2002). Although SES is generally estimated by measuring and defining it as above, it encompasses far more than these simple indices, including associated differences in physical and mental health and in psychosocial and physical/biological aspects of the environment. Important psychosocial factors include the presence of both parents in the home, parental stress and depression, cognitive stimulation, caregiver sensitivity and responsiveness to the child, caregiver affect (emotional warmth or rejection of the child), and exposure to violence. Physical/biological factors include nutrition, environmental exposure to pollutants, and infectious diseases. Any of these is, in principle, capable of influencing brain development and function (Adler et al., 1994; Evans, 2004; Walker et al., 2005). In addition, some variance in an individual's SES has been attributed to genetic factors, which could also be manifest in the brain (Lichtenstein & Pederson, 1997).

For the purposes of this study I will elaborate only on the components that contribute to SES that are included in the asset index I used (i.e. parental education, family income, parental employment status, and parental occupation). I will also discuss proximal factors related to SES such as the home environment, collective SES, school environment, and quality of education.

Components contributing to SES.

Parental education. Parents' level of completed formal education may influence children's wellbeing by shaping parent-child interactions; also, parenting differences as a result of parental education are considered very consequential in explaining why children of less-educated parents perform more poorly on measures of cognitive development than children of more highly educated parents. More specifically, compared to less educated parents, parents who have acquired more formal schooling tend to provide a more cognitively stimulating home learning environment and have a more verbal and supportive teaching style (Harris, Terrel, & Allen, 1999). Parental education has also been found to be a stronger predictor of child intellectual attainment and cognitive development than family income (Mercy & Steelman, 1982).

With regard to the question of which parent's education level (maternal or paternal) is a better indicator of childhood intellectual attainment and years of schooling, there are conflicting and inconclusive results. Some studies (e.g., Crook, 1995; Duncan & Magnuson, 2003; Mercy & Steelman, 1982) suggest that maternal education is a stronger predictor, while others (e.g.,

University of Cape Town

Behrman & Rosenzweig, 2002; Bjorklund, Lindahl, & Plug, 2006; Comber & Keeves, 1973) suggest paternal education is a stronger predictor, and still others (e.g., Kalmijn, 1994; Scarr & Weinberg, 1978) report no difference in predictive strength. Nonetheless, it is commonly agreed that parental education is strongly associated with the child's cognitive development.

Parental/family income. Family income has substantial but decidedly selective associations with children's attainment and achievements (Duncan & Magnuson, 2003). The selective nature of effects include the following: (a) family income has much larger associations with measures of children's ability and achievement than with measures of behaviour, mental health, and physical health; (b) family economic conditions in early childhood appear to be more important for shaping ability and achievement than do economic conditions during adolescence; and (c) the association between income and achievement appeared to be non-linear, with the biggest impacts at the lower levels of income (Davis-Kean, 2005; Klebanov, Brooks-Gunn, Chase-Lansdale, & Gordon, 1997; Morris, Gennetian, Duncan, & Huston, 2009; Van der Berg & Burger, 2002).

With regard to the relationship between family income and schooling, family income and economic position, especially in early childhood, has much stronger associations with achievement and ability-related outcomes than with measures of health and behaviour, due to the importance of school-readiness in determining the subsequent course of schooling (Duncan, Yeung, Brooks-Gunn, & Smith, 1998). Income poverty has a strong association with a low level of preschool ability, which is associated with low test scores later in childhood as well as grade failure, school disengagement, and dropping out of school, even when controls for family characteristics such as maternal schooling, household structure, and welfare receipt are included. A reason for this might be that preschool ability sets the stage for children's transition into the formal school system. Therefore, children who have not learned skills such as colour naming, sorting, counting, letters, and the names of everyday objects, are at a disadvantage compared with children who have mastered these skills (Duncan et al., 1998). In terms of completed schooling, family income has a larger impact for children in low-income families than for those in high-income families for a few reasons: Older low-income children may be required to obtain jobs in order to contribute financially to the household instead of completing formal schooling, children from low-income families may lack role models in the form of people who have completed their formal schooling, and there may not be the necessary support (financially,

University of Cape Town

academically and emotionally) to complete formal schooling. High parental income has also been found to facilitate entry into tertiary academic institutions as these high-income parents are more likely able to provide funds for further studies or have knowledge and resources necessary to obtain these funds, for example applying for bursaries or loans – all of which low-income families are unable to provide for their children (Brooks-Gunn, Guo, & Furstenburg, 1993; Guo, Brooks-Gunn & Harris, 1996).

Parental employment and occupation. In a manner similar to that for parental education, findings regarding the relative importance of mother's and father's employment status have been inconclusive. Some studies have concluded that the father's occupational status outweighs that of the mother (Crook, 1995; Keeves & Saha, 1992; Korrup, Ganzeboom, & Van Der Lippe, 2002; Marks, 2008), whereas others report that mother's occupational status has a more substantive effect on schooling and academic attainment (Beyer, 1995; Kalmijn, 1994; Korrup et al., 2002).

Characteristics of parents' jobs, along with the level of parental education, influence children primarily through the way the home learning environment is established and structured. For instance, mothers who work in occupations with a variety of tasks and problem-solving opportunities appear to provide more warmth and support and a greater number of stimulating materials, resulting in their children manifesting more advanced verbal competence (Parcel & Menaghan, 1990).

Parenting- and child-rearing styles have been found to be influenced by the characteristics and level of prestige of parents' jobs, which in turn affect children's academic achievement (Luster, Rhoades & Haas, 1989). Therefore, parents with low-prestige jobs (i.e., those featuring low autonomy, routinised tasks, and little opportunity for substantively complex work) or working-class parents who are used to occupations characterised by a power hierarchy where adherence to rules and obedience to superiors are required differ in terms of parenting style from parents with high-prestige jobs or middle-class parents, whose workplace tends to allow greater self-determination and where responsibility and decision-making is commonplace (Duncan & Magnuson, 2003; Kohn, 1963; Turner, J. H., 1970). In terms of parenting style, then, low-prestige or working-class parents tend to be more controlling and directive and less autonomy-supportive than middle-class parents; they are less likely to than middle-class parents to help children in problem-solving situations by asking questions and gently guiding the child in the right direction in order for them to find the correct answer rather than providing the solution;

University of Cape Town

in other words, they are less likely to communicate confidence that the child can master certain challenges without assistance, thus enhancing the child's feelings of mastery and motivation in learning situations. In a study on the relationship between maternal employment and children's academic performance, Beyer (1995) concluded that it is not the mother's employment status per se that plays a role in the child's academic performance, but rather that it is the parenting style as affected by her employment status that will, in turn, affect the child's academic performance.

Proximal factors related to SES.

Home environment. Quality of home environment – its opportunities for learning, the warmth of mother-child interactions, and the physical condition of the home – accounts for a substantial portion of the powerful effects of family income on cognitive outcomes. For instance, Smith, Brooks-Gunn, and Klebanov (1997) showed that differences in the home environments of high- and low-income children explained close to half of the effects of income on the cognitive development of pre-school children, and between one-quarter and one-third of the effect of income on the academic achievement of elementary school children.

With regard to the physical condition of the home, the degree of crowding in the home and the number of siblings present is associated with the relation between SES and child cognitive and language competence via the stimulation found in the home. The distress and distractions accompanying crowding in the house can, for example, result in fewer exchanges, or exchanges of poor quality, between parent and child. One potential mechanism underlying these associations is that more siblings in the family results in less allocation of time and attention to each child (Bradley, Corwyn, Burchinal, McAdoo, & Garcia Coll, 2001). Low-SES parents are less likely to purchase reading and learning materials for their children, less likely to take their children to educational and cultural events, and less likely to regulate the amount of television their children watch, all of which contribute to poor academic achievement, school failure (even in early grades) and behavioural problems (Battin-Pearson et al., 2000). Not only are opportunities for home learning advantaged or low-SES environments less than in high-SES environments, low-SES children are also less likely to benefit from the provision of learning experiences in the home (Klebanov et al., 1997).

Collective SES. Researchers generally acknowledge that SES operates at multiple levels to affect well-being (Adler, Marmot, McEwen, & Sterwart, 1999; Leventhal & Brooks-Gunn, 2000). For children, it is important to consider community-level SES because there is evidence

University of Cape Town

that neighbourhood of residence is associated with health, achievement, and behavioural outcomes, even after controlling for individual parental income and education (Baum, Garafalo, &Yali, 1999; Leventhal & Brooks-Gunn, 2000). One potential mechanism underlying this relationship is the fact that neighbourhood of residence is strongly predictive of the individual's likelihood of being exposed to violence and to environmental hazards, and of access to recreational and institutional resources (Bradley & Corwyn, 2002).

Living in a high-SES neighbourhood during early childhood and adolescence impacts most positively on school readiness and school achievement (and, more specifically, on IQ, verbal ability, and reading recognition) because of the presence of neighbourhood resources such as learning, social, and recreational activities, and high-quality childcare and schools (Leventhal & Brooks-Gunn, 2000). In their extensive review of research on the effects of neighbourhood residence on child and adolescent well-being, Leventhal and Brooks-Gunn (2000) conclude that high neighbourhood SES contributes to high school achievement and educational attainment, and that low neighbourhood SES increases the likelihood of deviant and problem behaviour.

School environment and quality of education. General academic achievement is influenced by all of the abovementioned factors because it is in the school environment where developed skills (problem-solving, recall, classification, etc.) are applied, and also where difficulties in their application are most readily noticeable. Additionally, however, one study (Walker et al., 2005) showed that school characteristics (e.g., class size, presence of free school meals, authorized or unauthorized absences, percent of students classified as ethnic minority, student-teacher ratio, etc.) also have a significant association with academic achievement. The same study showed that when school characteristics were statistically controlled, the correlation of SES with academic achievement showed a modest decrease in comparison to the substantial reduction in correlation when SES was controlled. It can therefore be argued that SES is not exclusively responsible for the difficulties in skills application – SES has a broader influence on a child's learning environment than do school characteristics, as it affects the home environment (as discussed above) as well as the school environment.

School environments, as impacted by SES, in turn impact on the quality and level of education received by the learner. Quality and level of education, in turn, have an important impact on neuropsychological test performance (Cavé & Grieve, 2009; Levav, Bartko, French, & Mirsky, 1999; Manly et al., 2000; Ostrosky-Solís, Ardila, & Rosselli, 1999; Shuttleworth-

University of Cape Town

Edwards, Kemp et al., 2004; Shuttleworth-Jordan, 1996). However, level and quality of education have uneven effects on neuropsychological performance: Results showed sensitivity in certain functions (attentional-executive functions, selective- and sustained attention and orientation, attentional-working memory and place- and person orientation) but not in others (contextual-executive memory and verbal memory) (Gómez-Pérez & Ostrosky-Solís, 2006; Levav et al., 1999; Ostrosky-Solís et al., 1999) and in studies that compare the impact of level and quality of schooling, quality of education proved to have a more extensive effect on neuropsychological performance than did level of education (Cavé & Grieve, 2009; Nell, 1999b; Shuttleworth-Edwards, Kemp et al., 2004).

In South Africa, of course, there are vast socioeconomic and educational disparities among various sectors of the population. It is therefore surprising that there is not more literature focusing on the ways in which school environment and quality of education might affect cognitive abilities and neuropsychological test performance. The literature that does exist report findings that poor quality of education is associated with lowering of both Verbal and Performance IQ on the Wechsler Adult Intelligence Scale – Third Revision (WAIS-III; Wechsler, 1997) (Shuttleworth-Edwards, Kemp et al., 2004); similarly, quality of education has been found to have substantial effects on WAIS-III test performance within the Black Southern African population (Shuttleworth-Edwards, Donnelly et al., 2004). Also, quality of education has been found to be related to performance on neuropsychological tests of executive functioning in a sample of South African high school learners (Cavé & Grieve, 2009).

University of Cape Town

Nell (1999b) discusses quality of school and education in relation to test-wiseness, and argues that level of education alone is a crude indicator of test-wiseness because it says nothing about those aspects of school quality that are taken for granted in Western settings. *Test-wiseness* refers to the feelings that participants experience when undertaking a test, i.e., that:

> [Y]ou are highly motivated or keyed up, a little nervous, and ready (with not a little trepidation) to meet the challenge. In consequence, when the test session begins, you concentrate intensely, don't chat to the examiner (even in a one-to-one situation), and take it for granted even without being told that you have to work as fast and accurately as you can (p. 129).

The components of test-wiseness that Nell (1999b) emphasizes are typical classroom-type skills such as fluent reading, automatised knowledge of the alphabet, good pencil control and

familiarity with copying tasks – all acquired through exposure to a (Western) formal education system. He further argues that quality of education is partially dependent on physical school quality, i.e., whether the necessary resources are accessible to learners. The accessibility of such resources, of course, depends on the demographics and socioeconomic position of the school, which corresponds to the demographics and SES of the learners. Van der Berg (2009) commented that "schools intensify the effect of SES on achievement – equity of resources is an inadequate tool to achieve equity of outcomes" (p. 6). Therefore the variability in performance as a result of the disparities in quality of education in South Africa can not be eradicated by simply improving physical school quality and ensuring that all schools receive the same resources.

In conjunction with quality of school and education, teacher attitudes and expectations may also be part of a complex set of mediators linking behaviour and school performance via learning material and experiences. According to McLoyd (1998), teachers tend to perceive low-SES learners less positively, both in terms of their academic and self-regulatory skills. Teachers provide poor children with less positive attention and less reinforcement for good performance. If children, both prior to school entry and during their school years, have less experience with cognitively stimulating materials and experiences at home, they are more likely to fulfil teachers' negative stereotypes. Over time, the frustrations connected with school failure and negative exchanges with teachers are likely to increase acting out behaviours (or depression for some children). It also increases the likelihood that children will affiliate with deviant peers.

In a recent presentation, Van der Berg (2009) discussed the poor performance of South African learners on standardized tests that are internationally benchmarked: the TIMMS (Trends in International Mathematics and Science Study; Reddy, 2005), the PIRLS (Progress in International Reading Literacy Study; Mullis, Martin, Kennedy & Foy, 2007), and the SACMEQ (Southern African Consortium for Monitoring Educational Quality; Van der Berg & Louw, 2006). Data from these tests indicated a high variance in performance patterns in South Africa between learners in historically advantaged compared to historically disadvantaged areas, with a steep gradient curve between poorer and wealthier communities. Similar findings were reported for medium of instruction and language of testing, and no school tested in an African language was able to reach the required international benchmark.

According to Van der Berg (2009), there is a need to increase the proportion of the population that has access to high-quality education; he suggests that this aim can be achieved by

University of Cape Town

improving the quality of education within the schools catering for the majority of the population. Therefore, the key challenge lies in improving the quantity and quality of effective schools.

Before describing the development during childhood of the cognitive domains focused on in this study and elaborating on the role of SES in test performance within those domains, it is useful to briefly discuss models, applications, and the process of neuropsychological assessment.

Neuropsychological Assessment of Children

The goals of neuropsychological assessment and applications of clinical neuropsychology are agreed upon throughout the literature (Anderson, Northam, Hendy, & Wrennal, 2001; Lezak, Howieson & Loring, 2004; Mitrushina, Boone, & D'Elia, 1999). One of these goals and applications is to provide information with regard to the integrity of the central nervous system (CNS). Neuropsychological assessment of individuals with intact or uncompromised CNS enables the definition of baseline performance of a specified population which can either (a) serve as normative data, or (b) be used for longitudinal comparisons with follow-up data, which in turn, is applicable and useful in medical diagnoses and treatment decisions involving cognitive dysfunction. A second goal and application is the identification of neurobehavioural/cognitive strengths and weaknesses in terms of functional status. This identification enables clinicians to select or establish appropriate rehabilitative techniques and interventions focusing either on a patient's strengths and their development and role in compensation for lost functions, or on weaknesses and their remediation. A third goal and application revolves around monitoring. This monitoring can be monitoring of recovery or deterioration, of response to treatment and subsequent prediction of future recovery, of the extent and nature of deficits, or of the highest level of functioning to be achieved upon recovery. Such monitoring can, in the case of deterioration post-injury, provide diagnostic and prognostic information.

With specific reference to neuropsychological assessment of children, Anderson, Northam et al. (2001) point out that in limiting assessment to intellectual evaluation – with test procedures based mainly on "multidetermined activities" (p. 377) – the clinician fails to directly assess underlying functional abilities such as attention and information-processing capabilities. Despite the frequency of neuropsychological dysfunction, it is likely to go undetected on pure intellectual evaluation due to the insensitivity of these tests to its subtle nature and presentation. Therefore, the choice of assessment tools should reflect adequate knowledge of theory of

University of Cape Town

neuropsychological development and dysfunction. Evaluation of functional abilities (e.g. educational skills, behaviour etc.) and adaptive abilities provide interesting and useful information regarding the child's ability to apply neurobehavioural skills to real-world contexts, as it is often there where the clearest demonstration of dysfunction lies (Anderson, Northam et al., 2001).

The foundation of interpretation of neuropsychological assessment is the model of assessment utilized by the clinician. The various models discussed in the literature include three main approaches: (a) a fixed battery approach, (b) a flexible battery approach, and (c) an intermediate position; as well as four alternative approaches: (d) eclectic batteries, (e) functional evaluation, (f) process approach, and (g) a pragmatic approach (see e.g., Anderson, Northam et al. 2001; Baron, 2004; Mitrushina et al., 1999; Strauss, Sherman, & Spreen, 2006). Fixed battery approaches involve utilizing a comprehensive battery of tests designed to assess various cognitive domains, and administering them to all participants/patients, regardless of the referral question, in a standardized manner according to a specified procedure. An example of how such an approach would be used in child neuropsychological assessment is in the retrospective analysis of test data for research purposes: The battery is administered in a standardized manner to all children, enabling straightforward comparison of individual children or patient groups. Such an approach usually meets the necessary criteria for the provision of normative, age-related data.

University of Cape Town

Flexible battery, or qualitative, approaches tend to describe and focus more on cognitive styles and the nature of deficits in relation to brain function. These approaches are patient-centered in that the particular set of tests used varies from one patient to the next as guided by the unique nature of the presenting deficits and the referral question. Although such approaches are descriptively helpful, they prove to be challenging in the assessment of children where developmental factors, individual variation, influence of past experience, and education play major roles in neuropsychological test performance. For instance, a few words written by a 7-year-old might reveal certain qualitative features that might be evidence of brain pathology (e.g., left-right confusion as evidenced by letter reversals); however, these might be developmentally appropriate and should therefore be interpreted alongside quantitative data on age expectations.

An intermediate position involves using the flexible battery approach in a modified fashion: The test battery is tailored in such a way that homogenous groups of people/patients are

routinely given a specific set of tests. For example, the battery used in the current study includes tests of all the cognitive domains most likely to be compromised as a result of pediatric traumatic brain injury.

Certain clinicians prefer to use eclectic/idiosyncratic batteries developed by themselves and their peers based on their personal theoretical perspective. This strategy implies that these tests do not include traditional psychometric methods, but rather make use of parts and factors of various different techniques in order to answer questions of particular interest to the individual clinician.

Functional evaluation has come to the foreground in recent years, with numerous tests (e.g. the TEA-Ch (Manly, Robertson, Anderson, & Nimmo-Smith, 1999) and the Rivermead Test of Behavioural Memory for Children (Wilson, Ivani-Chalian, & Aldrich, 1991) developed in attempts to make the test situation as close to real-life situations as possible. The rationale here is that such assessment accounts for factors such as personality, motivation, and individual cognitive style – all of which influences test performance. Additional sources such as collateral interviews, behavioural observations in applied settings, questionnaires and rating scales, etc. are employed in order to overcome the limitations of the artificial test situation in which the above factors are usually poorly accounted for.

The process approach is a variant of the flexible battery approach that explores the manner in which the testee attained a test score and how they succeeded or failed at a task qualitatively (Lezak et al., 2004; Strauss et al., 2006). The testee's strategy is carefully observed during each task and errors or unusual approaches are questioned or the task is readministered with modified materials or adjusted instructions to shed light on the nature of the specific deficit that underlies the poor performance. Criticism of this approach includes its lack of normative data, lack of psychometric foundation (e.g., in terms of test reliability and validity), as well as the complication it brings for readministration of tests. Research has been conducted on an equivalent approach which aims to quantify the process of problem-solving, which might contribute to more meticulous detection and accurate characterization of neuropsychological deficits (Strauss et al., 2006).

Baron (2004) describes the pragmatic approach which she has developed and uses. The focus of this approach is to identify the strengths of the child in order to understand the observed weaknesses. The order and use of tests or subtests are determined by the clinician as the

University of Cape Town

assessment progresses; in other words, a continuous application to test a fluid train of thought instead of administering a full battery of tests in an incoherent order in terms of the domains or abilities that the test is supposed to measure.

According to a 1999 survey of practices and beliefs of 422 clinical neuropsychologists in the United States, the flexible battery approach was rated favourite, with endorsement rates of approximately 70% (Sweet, Moberg, & Suchy, 2000). Clinicians and researchers alike agree, however, that no single assessment model can, in isolation, supply all the necessary information to understand a presenting problem and explain a child's neuropsychological/neurobehavioural performance. Simply put, it is necessary to use a combination of models and approaches; one might, for instance, administer the appropriate standardized psychometric tests in a conventional fashion, all the while meticulously observing the quality of the child's responses. Psychometric assessment provides information with respect to the child's developmental level and possible deviations for age expectations. It also provides information about the "normality" of the child's cognitive status, and helps to identify strengths and weaknesses within cognitive domains. It also allows comparisons between individuals as well as across diagnostic groups, and enables building of extensive databases for research purposes. Qualitative observations and enquiry, on the other hand, inform the clinician about the difficulties with which the child is faced in terms of his/her own real-life situation – all of which impact on the child's drive, motivation, and personality (Anderson, Northam et al. 2001; Mitrushina et al., 1999; Strauss et al., 2006).

The assessment process begins with the administration of tests and continues with the interpretation of data derived from those tests and from the administration session itself. The selection of the most appropriate tests alone does not guarantee accurate understanding or explanation of the participant/patient's cognitive profile (Mitrushina et al., 1999). For instance, using an appropriate set of normative data is imperative for accurate interpretation of the assessed performance. Following the selection of appropriate norms, each raw test score is compared to the distribution of performance scores on the same test obtained by the chosen normative sample with similar demographic characteristics. This comparison then allows the clinician to determine in which range the testee performed relative to the standardization sample.

This step, however, is challenging for the clinician: The standardization samples upon which available published norms are based cannot be applied invariably to each patient or to each research study sample, yet if norms are going to be used profitably the standardization

University of Cape Town

sample should match the characteristics of the testee/s as closely as possible – it is well known that neuropsychological performance is related to age, years of education, intelligence level and, occasionally, sex – and the test administration and scoring procedures (procedure variables) should be identical for the standardization sample and the current testee/s (Mitrushina et al., 1999).

This problem of finding appropriate normative data and so making accurate interpretations is particularly acute in developing world countries such as South Africa. The importance of locally researched, South African-based norms is clear. As S. J. Anderson (2001) suggests, interpretative validity can be maximized by using population-specific normative data.

Assessment of cognitive functions of healthy local populations provides the frame of reference that enables understanding of neurological disorders in populations who have experienced brain damage. In addition, it also enables accurate differential diagnoses by applying norms that are relevant to the assessed group; for example, when assessing the effects of traumatic brain injury (TBI), appropriate norms relevant to this specific group should be applied. In the local South African setting, foreign norms (i.e., the published norms) for neuropsychological tests continue to be used unconditionally as a result of the lack of suitable locally-collected alternatives. It is relatively common practice in South Africa for clinicians to rely on a narrow interpretation of test scores when formulating a neuropsychological diagnostic conclusion. This situation is true especially for, but is not limited to, relatively inexperienced clinicians with limited knowledge of neuropsychological practice. With the use of the published norms clinicians also tend to intuitively adjust the obtained scores according to their anecdotal clinical knowledge and experience, which is problematic in that there is no consensus or empirical proof that such an approach indicates the deficits the testee presents with in an accurate and appropriate manner (Anderson, S. J., 2001; Gómez-Pérez & Ostrosky-Solís, 2006; Skuy et al., 2001).

It is exactly this lack of locally appropriate norms that prompted the current study, but with specific reference to and for application in the assessment of TBI in individual South African children. Practical implications of local norms for commonly-used tests include enabling clinicians to compare and interpret data to normative samples that represent the testee and his/her personal characteristics (i.e., SES, grade/level of education, etc), and thus relying less on their intuitive judgment. The use of such norms will therefore inform the feedback which the clinician

University of Cape Town

will report – be it as a consultation in a hospital set-up or as medico-legal testimony in a court case.

The next section discusses the cognitive domains relevant to this study, particularly focusing on the development of these domains throughout childhood. I focus specifically on the 7-10 age range as it is the range on which this study focused.

Development of the Cognitive Domains of Interest

The domains selected for investigation in this study are those included in Cowan's (1988, 1995) model of development of information-processing abilities. This model integrates the processes related to specific brain structures with neural and neurobehavioural function; hence, it can be understood as an integrative information-processing system, which incorporates four components: attention, memory, output, and central executive (Anderson, Northam et al., 2001). Cowan suggests that these components work together in this way: A child must firstly be able to attend to information (*attention*), then register, encode, and store it (*memory*), after which it can be retrieved and output (*output*). The *central executive* has links with all aspects of this process/system, and is primarily responsible for directing the focus of attention and formulating strategies for efficient performance.

The sections that follow will describe the development through childhood (specifically between the ages of 7 and 10 years) and the function/s of each of these components, i.e. attention, memory and executive functioning. Due to the involvement of the frontal lobes in the execution of cognitive tasks and its close relationship with attentional abilities, it is difficult to discuss attention and executive functioning separately as they are not mutually exclusive. But, for the sake of discussing childhood development of the cognitive domains of interest, specific abilities were assigned to either attention or executive functioning. Discussion of the development of five components of attention includes sustained attention/vigilance, selective/focused attention, attentional switching/cognitive flexibility, sustained-divided attention, and working memory. The four aspects of executive functioning investigated in this study and discussed below are inhibition, generativity (non-verbal fluency), planning and organization, and abstract reasoning (verbal and non-verbal).

Childhood attention. The first component in Cowan's model is attention, i.e. that process which enables the child to attend to the relevant information before the subsequent steps

University of Cape Town

of information-processing can occur. In the literature, attention is generally understood and defined as multiple different processes through an integrated neural system (which involves input from various brain structures) enabling the individual to become receptive to stimuli and subsequently begin to process internal or external information whether incoming or already attended to (Anderson, Northam et al., 2001; Parasuraman & Greenwood, 1998). Various models of attentional systems describe the dynamic interaction between the components of attention/attentional processing, e.g. Luria's (1973) model of two attentional systems, Posner's (1978) similar dual-system model of attention, and Mirsky and colleagues' multi-component model of attention (Mirsky, Anthony, Duncan, Ahearn, & Kelman, 1991; Mirsky, 1996). Four of Mirsky et al.'s (1991) five components will be discussed in the light of the development of attentional skills over age.

The first element of attention, as described by Mirsky et al. (1991), is *sustained attention* or *vigilance*, which is the ability to maintain attention over an extended period of time. Developmental trends show that sustained attention develops from 5-6 years to 11-12 years, with rapid development and improvement in performance up to age 9, after which development reaches a plateau in some indices of performance (Betts, McKay, Maruff, & Anderson, 2006; Manly et al., 2001). This reaching of a plateau in development after 8-9 years occurs due to a functional reorganization that takes place over the 1-2 years of rapid development before children reach 11-12 years, when the plateau becomes clearly evident (Kirk, 1985; Klenberg, Korkman, Lahti-Nuutilla, 2001). McKay, Halperin, Schwartz, and Sharma (1994) and Anderson, Northam et al. (2001) report similar findings of relatively stable development over childhood with a developmental spurt around age 11.

Selective/focused attention is the ability to concentrate attentional resources on a specific task and to ignore distracting stimuli or to identify relevant stimuli and respond to these despite the presence of background distraction (Anderson, Northam et al., 2001; Klimkeit, Mattingley, Sheppard, Farrow, & Bradshaw, 2004). Unlike sustained attention, selective/focused attention appears to mature relatively early, with 6-year-olds achieving adult-level performance on tasks that tap these abilities (McKay et al., 1994). However, Anderson, Northam et al. (2001) tested selective/focused attention in the visual and auditory modalities and report a gradual increment throughout childhood in both modalities, with younger children performing significantly more poorly than older children and taking longer to complete tasks. A plateau is reached at

University of Cape Town

approximately 10 years when the discrepancy becomes less evident. Klimkeit et al. (2004) report similar findings, with 8-year-olds making more inattentive and distractibility errors than do 10-12 year-olds.

Attentional switching/cognitive flexibility is defined as the ability to flexibly and efficiently shift attention from one cognitive set to another, frequently acting according to rules that are contrary to the other cognitive set (Davidson, Amso, Cruess Anderson, & Diamond, 2006). Switching has been reported to be much more challenging than consistent inhibition in a steady state or than retaining and manipulating a number of items in mind, and also shows a considerably longer developmental progression, with 13-year-olds still not performing at adult levels on certain tasks with measures of reaction speed and accuracy (Davidson et al., 2006). Conversely Crone, Ridderinkhof, Worm, Somsen, and Van der Molen (2004) found that by age 10 years children are capable of adult-level responses. Their measure was, however, quite simple, in that switching requirements were reduced for these children to achieve this level of performance. Another interesting finding of this study was that it appeared as though maturation of rule switching occurred earlier than that of rule maintenance, indicating that these two abilities reflect different developmental trajectories.

Mirsky et al.'s models do not include divided attention as a component, although other researchers (e.g., Della Sala, Baddeley, Papagno, & Spinnler, 1995; Savage, Cornish, Manly, & Hollis, 2006) regard it as an integral component of attention. *Divided attention* is the ability to attend to two tasks or stimuli that occur simultaneously (Anderson, Northam et al., 2001). In their development of normative data for the TEA-Ch, Anderson, Northam et al. (2001) found that from the age of 9 years children had less difficulty to complete more complex tasks which could suggest a developmental spurt in these divided attention skills at approximately 9 years.

Working memory refers to the ability hold information in mind, mentally manipulate that information, and act according to it (Davidson et al., 2006). Baddeley (1986) argued that working memory is the temporary retention of an item of information with the purpose of solving a problem or for a mental operation. The ability to simply hold information in mind – without any added requirement of manipulating it or exercising inhibition – has been reported to develop early in childhood, with robustness even in preschool children, and with little improvement over age (Diamond, 1995). Verbal working memory test performance has been found to mature between the ages of 10 and 12 years (Welsh, 2002), while visual working

University of Cape Town

memory appears to reach maturity beyond 12 years (Anderson, Northam et al., 2001; Klenberg et al., 2001; Lin, Chen, Yang, Hsiao & Tien, 2000). One study has, however, reported functional gains in the efficiency of working memory capacity between 15 and 19 years and again between 20 and 29 years (De Luca et al., 2003).

Childhood memory. In order to explain memory as the process of registering, encoding, storing and retrieving information, many models have been proposed. Some models focus on modality-specific systems, i.e. verbal and non-verbal memory (e.g. McCarthy & Warrington, 1994); or on more interactive approaches, i.e. investigating certain aspects of memory in a certain domains such as short-term visual memory (e.g., Della Sala, Gray, Baddeley, Allamano & Wilson, 1999); or on the differentiation between a number of types of memory such as declarative/explicit memory (i.e., tasks that require the individual to intentionally or consciously recall previous experiences or information) versus procedural / implicit memory (i.e., memory tasks that demonstrate learning via some behavioural measure that does not require explicit recollection of the event of learning or recollecting any facts, for example a skilled activity like playing a musical instrument) (Schacter, Chiu, & Ochsner, 1993; Nelson,1995).

There is a variation in developmental trajectories of particular aspects of memory, therefore the development of memory as a domain is, perhaps, best explained in the light of these aspects. Developmental spurts have been found to coincide with physical growth spurts or maturational changes in cerebral areas; these spurts involve myelination of nerve fibres, resulting in faster transmission of information (Case, 1992; Thatcher, 1992). The prolonged development of the frontal lobes (well into adolescence, and even into early adulthood) also plays a role in terms of the organization of information processing (Baddeley, 1990).

In terms of general performance on memory tasks, younger children (up to approximately 8 years of age) perform consistently poorer than older children on various tasks (Anderson & Lajoie, 1996; Brainerd & Reyna, 2001; Gathercole, 1998). For instance, studies show that, relative to older children, these younger children have: (a) shorter immediate memory spans – preschool children have the capacity to hold three to four pieces of information compared to five or six pieces of information that is expected of 9-year-olds and seven pieces of information in adolescence (Luciana & Nelson, 1998); (b) less efficient learning skills and poorer delayed recall in tasks of story recall, word list learning and recall and visuo-spatial information (Anderson & Lajoie, 1996), and (c) more restricted use of memory strategies, less benefit of familiarity with a

University of Cape Town

task, poorer spontaneous retrieval of information, and flatter learning curves (Merriman, Azmita & Perlmutter, 1988; Siegler, 1991). Developmental transitions seem to occur from 8 to 9 years (i.e. 9- to 11-year-olds perform better than 7- and 8-year-olds), and again at around the age of 12 years (i.e. children older than 12 years exhibit improved capacity and ability for controlling memory and learning, and also show improved organization of information for more effective processing (Anderson & Lajoie, 1996).

Childhood executive functioning. The executive functions are represented by the *central executive* component of Cowan's information-processing system. The purpose of this component, as noted before, is directing attention, monitoring activity, coordinating and integrating information and activity, choosing between alternatives, making decisions, and executing temporally structured action (Anderson, Northam et al., 2001; Fuster, 2002). Executive skills can be distinguished from cognitive skills in that they act more generally and impact on all aspects of behaviour, whereas cognitive skills may be interpreted as domain-specific. Consequently, the integrity of executive functions is required for appropriate and socially responsible behaviour (Lezak et al., 2004).

The development of executive functions as a result of the development and physical maturation over age of the frontal lobe regions is agreed upon and extensively reported on in the literature (see, e.g., Garon, Bryson, & Smith, 2008; Jurado & Rosselli, 2007; Paus, 2005; Romine & Reynolds, 2005). In terms of physical development, prefrontal grey matter appears to increase volumetrically after birth, and reaches a maximum at some stage between the ages of 4 and 12 years, after which it gradually decreases (Giedd et al., 1999). Accompanying the increase in gray matter is a reduction in synaptic density due to the selective specialisation that is the basis of the formation of cognitive networks in the cerebral cortex (Edelman, 1987). Prefrontal white matter, on the other hand, increases in volume through childhood and adolescence and into young adulthood (Sowell, Delis, Stiles, & Jernigan, 2001). This increase in white matter volume in the frontal lobe is attributable to the myelination of cortico-cortical axons, which make up approximately 95% of the extrinsic connectivity throughout the neocortex (outer layer of the cerebral hemispheres) (Fuster, 2002). This physical development continues through late adolescence and into early adulthood, whereas the other cortical regions mature at an earlier stage.

University of Cape Town

Considering the role of prefrontal networks in cognitive functions leads to the assumption that the development of those networks underlies the development of highly integrative cognitive functions, for example language, that continue to develop into adulthood (Fuster, 2002). The multiple stages of increase and progression in performance on frontal-mediated tasks occurs with different functions maturing in different ways, at different times; the greatest period of development and increases in performance early in middle childhood (between 5 and 8 years), becoming more moderate towards the end of middle childhood (8 to 12 years), increasing at a slower rate during adolescence, and nearing adult levels between adolescence and early adulthood (17 to early 20s), depending on task demands. The greatest period of development of planning, verbal fluency, design fluency, and inhibition of perseveration, occurred between the ages 5 to 8 years; notable increases across all frontal functions occurred between 8 and 11 years of age. Between 11 and 14 years there was a slight increase in performance in inhibition of perseveration, with no increase in such performance thereafter. Until 17 years and into early adulthood there is continued development of planning and verbal fluency (Anderson, V. A., Anderson, P., Northam, Jacobs & Catroppa, 2001; Fuster, 2002; Korkman, Kemp, & Kirk, 2001; Romine & Reynolds, 2005; Welsh, Pennington, & Groisser, 1991).

The four components of executive functioning investigated in this study will be discussed next; they are inhibition, generativity/non-verbal fluency, planning and organization, and abstract reasoning (verbal and non-verbal).

Davidson et al. (2006) define *inhibition* as that process which provides us a measure of control over our attention and action; i.e. the ability to inhibit attention to distracters (which makes selective and sustained attention possible, as discussed above), and the ability to inhibit a strong behavioural inclination (which makes change possible and is also important in social politeness). Several studies have shown that response inhibition and decreased disinhibited behaviour occur between the ages of 8 and 13 years, providing sufficient support for the relatively early maturation of inhibitory abilities compared to that of other executive functioning skills (e.g., development of working memory and strategic planning continue well into adolescence; Brocki & Bholin, 2004; Klimkeit et al., 2004; Lehto, Juujarvi, Kooistra & Pulkkinen, 2003). As support for this notion of early maturation of inhibitory abilities, Davidson et al. (2006) found that the younger the children, the harder it was for them to inhibit prepotent

University of Cape Town

responses. Children at every age, without exception and up to 13 years of age, demonstrated that inhibition was sufficiently difficult to negatively influence their performance.

Generativity can be defined as the ability to spontaneously generate novel ideas or behaviours. It is often measured by tasks that require the individual to generate numerous responses to a single cue or stimulus (Turner, M. A., 1999). The ability to generate words or designs according to specific criteria appears to increase and improve with age; there is rapid development of this ability during middle childhood (i.e., 9- to 10-year-old children perform better than 7- and 8-year-olds) and more gradual progression in late childhood and early adolescence (Anderson, Northam et al., 2001).

With regard to *planning and organization*, empirical studies have shown that these skills improve with the development and maturation of the frontal lobes. For instance, Cohen, Ricci, Kibby, and Edmonds (2000) reported that the development of clock drawing abilities paralleled age-related increases in executive functioning skills, supporting empirical observations of multistage frontal lobe development (Dilworth, Greenberg, & Kusché, 2004). Cohen and colleagues found an upward progression in clock construction from 6 to 12 years, similar upward progression in the ability to equally space the numbers around the clock face from 6 to 11 years, and also similar upward progression in terms of the ability to record time by the hour, half-hour, and the minute from the ages of 6 to 8 years. In other words, clock construction and the concept of time are developing as the individual matures: 6-year-olds have a basic conceptualisation of a clock, 7-year-olds are able to successfully tell the time using an analogue clock, 8-year-olds have the ability to set the time correctly and to plan well enough so as not to neglect entire quadrants during the construction of a clock face (the kind of planning that 6-year-olds do not have), and 10-year-olds are able to construct a clock face correctly (although number positioning/spacing errors are typically present).

Abstract reasoning follows a similar developmental trajectory to the components discussed previously (i.e. there is increasing skill with age until a plateau in late adolescence). For instance, young children show the ability for some deductive and inductive reasoning, while the skill of reasoning only appears to become fully functional after early adolescence (Galotti, 1989). Age-related changes in children's performance on analogical reasoning[1] tasks have been

[1] Analogy is defined as drawing from a basis to a target where the basis and target are both defined as sets of relations (Gentner, 1983).

University of Cape Town

linked to three developmental mechanisms: Increased domain knowledge, a relational shift, and increased working memory capacity in order to manipulate relations (Richland, Morrison, & Hollyoak, 2004). As children age their knowledge of relations increase, hence their increased ability for analogical reasoning (Goswami & Brown, 1989). Children's ability to reason on the basis of relational features rather than perceptual distracters corresponds with the development of response inhibition and analogical reasoning follows accordingly (Diamond, Kirkham, & Amso, 2002). Working memory has been proposed to play a role in analogical reasoning in that young children process and maintain a smaller number of units of information than older children, and therefore have more difficulty when required to reason in terms of relations between three or more objects or concepts (Andrews, Halford, Bunch, Bowden, & Jones, 2003; Halford, 1993).

The Influence of SES on the Cognitive Domains of Interest

Given the range of potential influences on brain development, it is possible that the SES gradient in cognitive achievement might have a broad and uniform neurocognitive basis, affecting all components of the developing brain to a roughly equal degree, although some components may be more sensitive to SES than others (Farah et al., 2006). Results from different studies that attempted to investigate this question (these are reviewed in more detail below) are consistent in showing that high-SES children perform better than low-SES children, even when IQ is statistically controlled. However, as demonstrated clearly by Farah et al. (2006), childhood poverty does have reasonably specific neurocognitive correlates; that is, cognitive ability is not depressed across the board among low-SES children. Rather, abilities that have been linked to specific neurocognitive systems are disproportionately affected.

Of course, the observed SES-related differences in neuropsychological test performance across individuals and groups are not exclusively associated with variability in external factors such as resources, opportunities, or quality of education; internal cognitive processes and observable brain structures clearly play key roles in such performance. The role of these external factors is, however, significant in accounting for at least part of the variance across SES groups.

In the next three sections I will discuss the influence of SES variation on the domains of interest of the current study.

Influence of SES variation on attentional abilities. Low-SES children present with difficulties in aspects of attention as early as the first year of life through early adolescence,

University of Cape Town

including tasks that require filtering distracting information (selective attention), managing response conflict (cognitive control), and regulating behaviour (Farah et al., 2006; Lipina, Martelli, Vuelta, & Colombo, 2005). The early ages are highlighted as the time when attentional abilities appear most compromised when low-SES children's performance is compared to their high-SES peers (Lupien, King, Meaney, & McEwen, 2001). Low-SES infants between 6 and 14 months of age perform more poorly on tasks associated with later executive functioning skills than high-SES infants of the same age. These early differences have been suggested to be a precursor to later difficulties in executive functioning, selective attention and attentional control/switching (particularly in the filtering of distracting stimuli), as well as having an impact on the early stages of perceptual processing, which subsequently impact on the development of other skills such as language and reading in children from low-SES backgrounds (Lipina et al., 2005; Stevens, Lauinger & Neville, 2009).

In his findings concerning what he termed "executive attention" (i.e., the ability to resolve response conflict), Mezzacappa (2004) reported that on overall performance as well as task-specific measures, socioeconomically advantaged children performed significantly better than their socioeconomically disadvantaged peers. These findings are consistent with the literature concerning SES and early cognitive development, which supports the notion that the environment in which the child grows up not only profoundly impacts on his/her level of global functioning, school readiness and school achievement, but also impacts on more basic processes such as executive attention.

The consequences of SES disparities in working memory and cognitive control may be substantial, given recent research showing relations between these systems and general fluid intelligence (Farah et al., 2006; Gray & Thompson, 2004; Hackman & Farah, 2009). In contrast, Engel, Santos, and Gathercole (2008), found no significant difference in performance between low-SES and high-SES children on tasks of working memory (digits backward and a counting recall task). However, the authors reported that the small sample size and not sufficiently high statistical power are believed to have contributed these findings and it is likely that significant group differences would have emerged for this measure with a larger sample size – therefore supporting the results reported by Farah and colleagues indicating that SES indeed impacts significantly on working memory.

University of Cape Town

Influence of SES variation on memory functioning. As mentioned earlier, SES appears to have different influences at different stages of childhood and does not affect different neurocognitive systems uniformly. Similarly, it has a non-uniform influence on different aspects of individual neurocognitive systems, such as memory. It also seems that memory is one of the domains that is affected to a lesser extent by SES than other cognitive domains, such as language and executive functioning (Noble, Norman, & Farah, 2005).

Hackman and Farah (2009) and Farah et al. (2006) reported a significant relationship between SES and performance on tasks of long-term memory and delayed recognition during the first years of school until middle school. These findings are not, however, consistent across the literature. For instance, Lupien et al. (2001) found no significant relationship between SES and memory in a sample of children between 6 and 16 years of age. The primary focus of this study, however, was on measuring salivary cortisol levels in low-SES and high-SES children from different age groups in order to measure whether SES differences in salivary cortisol exist and if these differences vary according to age. A secondary aim was to measure the relationship between salivary cortisol levels and cognitive functioning (memory, attention and language) in this population, as well as possible changes in this relation as a function of age. Declarative memory was assessed by a free recall test which required participants to assign gender to 15 line drawings of animals after which the participants were immediately required to freely recall all the animals that were presented in any order; a 30-minute delayed recall trial was also administered. Nondeclarative memory was assessed by a verbal fluency task in which the participants had to name as many animals as they could in a period of 45 seconds. These results should therefore be interpreted in the light of the fact that this study was not primarily aimed at measuring memory performance as a function of SES and only two aspects of memory were assessed on tasks of relatively low complexity.

Studies have suggested that SES does not directly influence recall, but rather that the classification styles children use in sort and recall tasks are influenced by SES. For instance, Jensen and Frederikson (1973) found differences between high- and low-SES children when they were prompted to organize lists according to taxonomic groups: Low-SES children recalled significantly less than did high-SES children, a result suggesting that differences in free-recall performance are most apparent when children are predisposed to semantically organize lists (as high-SES children are apparently more apt to do). These researchers argue that low-SES children

University of Cape Town

are less familiar with the adult-defined taxonomic categories that are found in middle-SES and high-SES homes as a result of parents' education level.

Influence of SES variation on executive functioning. Several different strands of evidence point to executive functions being particularly vulnerable to variations in SES. Firstly, and as noted above, from a neuroanatomical perspective the prefrontal regions of the brain (i.e., those that support executive functioning) undergo prolonged postnatal development (Casey, Giedd, & Thomas, 2000; Fuster, 2002). Additionally, the functional connectivity of these regions with other brain regions also increases throughout adolescence (Fuster, 2002; Paus, 2005). Therefore, there is maximal opportunity for different life experiences associated with lower and higher SES to influence the neural characteristics of the prefrontal cortex. Secondly, regions within the prefrontal cortex have been associated with 'general intelligence' of the kind measured by IQ tests (Gray & Thompson, 2004), and IQ is robustly associated with SES (see, e.g., Smith et al., 1997). Thirdly, numerous empirical studies have shown that several discrete aspects of executive/prefrontal functioning are associated with variation in SES. For instance, Miller, Benson, and Johnson (2003) showed that increasing SES is associated with an increasing tendency to resist impulses and to delay gratification (characteristics associated with optimal prefrontal function). Mezzacappa (2004) assessed the sociodemographic correlates of performance on Posner's Attention Network Task (a task designed to evaluate alerting, orienting, and executive attention) and found that the ability to resolve response conflict displayed a strong positive association with SES. Noble et al. (2005) confirmed these findings, showing that executive functioning was poorer in low-SES than in middle-SES preschool children; specifically, they found statistically significant differences in performance on tasks of inhibition and on a false alarm task, where the low-SES children made more false alarm errors than did the medium-SES children. Kishiyama et al. (2008) reported their behavioural and electrophysiological results to be indicative of the fact that factors associated with social inequalities contribute to altered function of the prefrontal cortex in low-SES children.

Furthermore, SES differences occur in the relations children use to form categories: Bjorklund and Weiss (1985) noted that low-SES children make the shift from complementary classification (e.g., being aware of the fact that dogs, cats, and horses are alike because they all have four legs and a tail) to taxonomic classification (e.g., knowing that dogs, cats and horses are all "animals") later than do children from middle- and high-SES homes. They also point out that

University of Cape Town

if there is no match between the knowledge structures of low-SES children and the learning material they are given, greater cognitive effort is required in order to complete tasks successfully. Low-SES children therefore often perform more poorly on neuropsychological and academic tasks purely because their knowledge structures differ from their high-SES peers (with highly educated parents) and their "middle-class, college-educated teacher[s]" (p. 127).

However, Rosselli and Ardila (2003) argue that children of parents with low levels of education and low SES cannot be assumed to be somehow *deprived* of knowledge or skills; it is more accurate to assume that they have developed *different* types of learning than people with higher levels of education. Waber, Carlson, Mann, Merola, and Moylan (1984) similarly found that children employ different cognitive styles in problem-solving situations according to their different SES backgrounds. These researchers conducted tests to examine the efficiency of processing stimuli presented to the right visual field-left cerebral hemisphere (RVH-LH) and left visual field-right cerebral hemisphere (LVF-RH) of children from high- and low-SES backgrounds. Results showed marked differences: High-SES children showed LH advantage more than did low-SES children. The authors argue that these group differences reflect SES-related variation in the nature of information processing in the two hemispheres: High-SES children prefer a more analytic approach in problem-solving (associated with the LH), whereas low-SES children use more global processes (associated with the RH).

University of Cape Town

Specific Aims and Objectives

The major aim of this study was to investigate the relationship between SES and neuropsychological performance in a sample of South African children. To obtain a more nuanced description of this relationship, I took into account other demographic factors such as quality of education (as indicated by SES level), years of formal education, age, sex, and race.

A second aim of this study was to use the obtained data to provide preliminary normative for South African children, aged 7 to 10 years of age, from different socioeconomic backgrounds. One specific use for this set of normative data has already been established: It will be used as part of a larger research programme investigating pediatric traumatic brain injury (pTBI) in the Western Cape (i.e., the typically developing individuals who participated in this study will be used as the standardization sample against which pTBI children will be gauged).

As noted earlier, the rationale for the current study stems from the lack of local research into the relationship between SES and neuropsychological test performance. The wide SES range present in contemporary South Africa is associated with a wide range of quality of schooling and education, which influences performance on cognitive tasks. Regarding clinical or real-world significance, this study is a step in the direction of gathering data in order to standardize norms for the three SES groups (as defined in the Methods section below) or South African children as a collective, but also to inform clinicians of those aspects that distinguish these children from the (generally US) normative populations; they will thus be able to assess for SES before intuitively interpreting test data according to generalized assumptions about children from these SES groups.

The domains under investigation in this study (attention, memory, and executive functioning) were specifically selected due to the devastating impact pTBI has on each one of them. Anderson, Northam et al. (2001) and Lowther and Mayfield (2004), discuss memory impairment in children as substantial because the day-to-day tasks in childhood revolve around learning and the acquisition of knowledge, and perfecting these newly acquired skills. This process is interfered with when TBI occurs; hence, development at an age-appropriate rate is unsuccessful. With regard to attentional skills, after TBI children's deficits tend to be more global – persisting past the acute phase of injury – whereas adults tend to present with specific psychomotor slowing. The implications of attention deficits following pTBI can be summarized as twofold: not only does the initial injury and associated cognitive impairment negatively

University of Cape Town

influence the child's attentional abilities, but there may also be ongoing impact on cerebral development together with an inability to acquire new skills; these may, in turn, lead to increasing delays in knowledge and skills, resulting in failure in developing and differentiating cognitive and attentional abilities (Anderson, Northam et al., 2001; McKay et al., 1994). With regard to executive functioning research is rather sparse; however, studies have shown that younger age at injury is associated with poorer executive functioning, and in particular slower response speed (Anderson, Northam et al., 2001; Levin & Hanten, 2005).

Naturally, across all of the relevant domains children who have acquired moderate to severe brain injuries perform more poorly and are more significantly impaired than children with mild injuries (for a review, see Schretlen & Shapiro, 2003).

In summary, the objectives of this study were to:

(a) compare, across the domains of attention, memory and executive functioning, the performance of low-, medium-, and high-SES South African children within two age bands (7- and 8-year-olds and 9- and 10-year-olds);

(b) investigate whether SES group membership impacted more on attention, memory, and executive function performance of the children than did IQ, level of formal education, age, sex, and race;

(c) compare the performance of low-, medium-, and high-SES South African children to the published norms for a set of standardized and widely used neuropsychological tests of attention, memory, and executive functioning; and

(d) provide preliminary normative data, stratified by age and SES, for 7- to 10-year-old children in the Western Cape.

University of Cape Town

METHODS

Research Design and Setting

The current study used a cross-sectional descriptive design to (a) compare across the domains of attention, memory and executive functioning the performance of low-, medium- and high-SES South African children in two age bands (7- and 8-year-olds and 9- and 10-year-olds), (b) investigate whether SES-group membership, more than IQ, level of education, age, sex and race, was a significant predictor of performance in the cognitive domains of interest in this South African sample of typically developing children, (c) to compare the performance of low-, medium-, and high-SES South African children to the published norms for the standardized test battery that was used, and (d) provide preliminary normative data stratified by age and SES for 7- to 10-year old children in the Western Cape. The study took place in the city of Cape Town and a nearby suburb.

University of Cape Town

Participants

Participants were recruited from three urban primary schools in the Western Cape (two in Cape Town and one in Kuilsrivier); children from one school were classified as emerging from a low-SES background, those from another were classified as emerging from a medium-SES background, and those from the third were classified as emerging from a high-SES background. To define SES in relation to which school an individual attended, I used some of the parameters Van der Berg and Burger (2002) used in their study investigating SES and educational performance in Western Cape schools. They referred to very poor (i.e., very low-SES schools) as those where school fees (at the time of their study, i.e., 1997-2000) were below R30 per child per annum; similarly, poor schools were those with fees of R100 per child per annum. According to Van der Berg and Burger, top academic achievements such as A-aggregates and university exemptions occur very rarely in schools at the bottom rung of the socioeconomic ladder; instead, A-aggregates are concentrated in schools with fees of above R1 000 per year, “to which few poor children have access” (p.11). Therefore, I selected schools according to annual school fees, grade range, total teachers and learners, pupil-teacher ratio as well as the number of other educational resources, such as computer rooms and libraries (see Table 1).

Table 1
Demographic Characteristics of Participating Schools

	Low SES	Medium SES	High SES
Per learner annual school fee	R512.50	R3 500	R30 333.33
Grade range	Grade R-7	Grade R-7	Grade 1-6
Total learners	531	595	305
Total teachers	15	25	32
Pupil-teacher ratio	35.4 : 1	23.8 : 1	9.5 : 1
Number of computer rooms	1	1	1
Number of libraries	0	0	1

Inclusion criteria specified that children were 7 to 10 years of age, fluent in English (even if it was not their home language), and had a parent or legal guardian who would consent to their participation and complete a demographic questionnaire. Exclusion criteria included diagnoses of ADHD, epilepsy, learning disability, head injury, or mental retardation. This information was obtained from parents (the consent form stipulated the exclusion criteria, and also noted that children who had been diagnosed with any of the above-named conditions would not be considered as participants in the study) and from the class teacher's personal feedback.

The final sample consisted of 116 children between the ages of 7 and 10 years, in Grades 1 to 5, all fluent in English, and all fitting the parameters of the inclusion/exclusion criteria stated above. Table 2 presents a complete set of demographic information for the participants, broken down by SES group. No participants withdrew from the study after enrolment, and there were no incomplete neuropsychological data sets.

I conducted numerous statistical analyses to check whether there were between-group differences on any of the major sociodemographic variables reported in Table 2. With regard to the sex distribution across groups, there were no statistically significant differences (boys: $\chi^2(2) = 0.034$, $p = .983$; girls: $\chi^2(2) = 0.138$, $p = .933$). To investigate possible differences in the average age of the three groups, a series of one-way ANOVAs was performed – on the sample as a whole and for each of the two age bands – with group membership as the independent variable (a between-subjects factor). For the sample as a whole, the assumptions of normality of the distribution and homogeneity of variances (as shown by Levene's test, $F(2, 113) = 0.07$, $p = .933$) were upheld. ANOVA showed that the factor of group membership was not statistically significant, $F(2, 113) = 0.88$, $p = .916$. For both age bands, the assumption of homogeneity

University of Cape Town

Table 2
Demographic Characteristics of the Sample

	SES		
	Low (n = 37)	Medium (n = 39)	High (n = 40)
Sex			
Male:Female	19:18	19:20	20:20
Age (years)			
Total sample	8.41 (0.04)	8.36 (0.05)	8.39 (0.05)
7-8-year-olds	7.37 (0.02)	7.36 (0.02)	7.38 (0.02)
9-10-year-olds	9.35 (0.02)	9.36 (0.02)	9.34 (0.05)
Years of education			
Total sample	3 (0.05)	3.05 (0.93)	3.25 (0.98)
7-8-year-olds	2 (0.02)	1.95 (0.69)	2.42 (0.69)
9-10-year-olds	3.85 (0.02)	4.15 (0.93)	4 (0.45)
Race			
Coloured	20	35	1
Black	17	1	0
White	0	3	39
Home language			
English	17	35	40
Afrikaans	1	1	0
English & Afrikaans	2	2	0
Xhosa	15	1	0
Zulu	2	0	0

Note. For the variables *Age* and *Years of Education*, data presented are means, with standard deviations in parentheses.

University of Cape Town

of variance was upheld, and in both cases group membership was not statistically significant (7- and 8-year-olds: Levene's test, $F(2, 53) = 0.030$, $p = .970$; ANOVA, $F(2, 53) = 0.019$, $p = .981$; 9- and 10-year-olds: Levene's test, $F(2, 57) = 0.025$, $p = .976$; ANOVA, $F(2, 57) = 0.048$, $p = .953$). The three groups were thus successfully matched for age.

With regard to years of education, a one-way ANOVA was performed to determine whether there were any between-group differences in terms of average years of education. The assumption of homogeneity of variance was not upheld (Levene's test, $F(2, 113) = 4.304$, $p = .016$), but because there were approximately equal numbers of participants in each group and because ANOVA is "relatively robust with respect to violations" (Howell, 2004, p. 359), the analyses were carried out despite this violation. The ANOVA showed that the factor of group membership was not significant, $F(2, 113) = 0.492$, $p = .613$; therefore the three groups were successfully matched for years of education.

With regard to race, there were statistically significant between-group differences in the distribution across the three groups (Coloured: $\chi^2(2) = 31.107$, $p < .001$; Black: $\chi^2(1) = 14.222$, $p < .001$; White: $\chi^2(1) = 30.857$, $p < .001$). These between-group differences were considered in the regression analyses that were performed.

With regard to home language, I used Fisher's exact test to investigate possible between-group differences in the distribution across the three groups. I used this statistical test because 9 cells (60%) had expected values of less than 5, and therefore a chi-square analysis was not recommended. There were statistically significant between-group differences for home language, Fisher's exact test = 39.758, $p < .001$. These differences were not, however, anticipated to have any effect on further statistical analyses as all participants were fluent in English and had English as their medium of educational instruction.

Measures

The test battery used in this study was a combination of subtests from standardized neuropsychological measures that have been developed and normed in the United States, the United Kingdom, and Australia. Table 3 presents a summary description of the battery.

University of Cape Town

Table 3
Neuropsychological Test Battery Used in the Current Study

Test	Subtest	Cognitive domain assessed
WASI		
PIQ	Block Design	General intellectual functioning (non-verbal)
	Matrix Reasoning	General intellectual functioning (non-verbal)
VIQ	Vocabulary	General intellectual functioning (verbal)
	Similarities	General intellectual functioning (verbal)
FSIQ		General intellectual functioning (total)
CMS	Stories	Memory (verbal)
	Word Lists	Memory (verbal)
	Dot Locations	Memory (visual)
RCF	3-min immediate recall	Memory (visual)
	30-min delayed recall	Memory (visual)
TEA-Ch	Sky Search	Attention (selective/focused)
	Score!	Attention (sustained)
	Creature Counting	Attention (attentional control/switching)
	Sky Search DT	Attention (sustained-divided)
CMS	Numbers Forward	Attention (simple)
CMS	Numbers Backward	Working memory
NEPSY-II	Clocks	Executive functioning (planning and organization)
	Design Fluency	Executive functioning (generativity)
	Inhibition	Executive functioning (inhibition and switching)

Note. WASI = Wechsler Abbreviated Scale of Intelligence; PIQ = Performance IQ; VIQ = Verbal IQ; FSIQ = Full-Scale IQ; CMS = Children's Memory Scale; ROCF = Rey-Osterrieth Complex Figure; TEA-Ch = Test of Everyday Attention for Children.

Demographic questionnaire. I used this questionnaire to derive further information about participants' SES level. As shown in Appendix A, the questionnaire follows Myer et al. (2008) in asking about neighbourhood and type of dwelling, as well as parents' occupation, income level, and level of education. Myer et al. (2004) reported that in developing country settings where there is a substantial informal economy and resource sharing is common (for example, in rural areas where income-based wealth may well be replaced by bartering for goods and services), these traditional markers of SES may not adequately capture variation in socioeconomic position. Therefore an asset index, reflecting individual and household wealth, was used in addition to these more traditional markers. This asset index demonstrated excellent reliability

University of Cape Town

(Cronbach's $\alpha = 0.92$). An aggregate asset score was used to categorize asset ownership into three categories: 0-5 (low), 6-12 (medium), and 13-17 (high) (Myer et al., 2008).

In all three groups of participants the response rate was low with regard to the demographic questionnaire. The information that could be obtained from the demographic questionnaires that were returned is summarized in Table 4 (see Appendix A for the complete demographic questionnaire and asset index), and analyses of those data are presented below.

Household income. Because 14 cells (77.8% of the data) had expected values of less than 5, Fisher's exact test was used to analyse between-group differences with regard to this variable. There were statistically significant between-groups differences, Fisher's exact test = 26.999, p <.001. This result was expected given that the three groups of participants were selected to differ in terms of SES and that household income is a key component of SES.

Parental education. Parental education was analysed for both fathers' and mothers' levels of formal education. Due to the fact that 8 cells (66.7% of the data) for father's level of education and 7 cells (58.3% of the data) for mother's education had expected values less than 5, Fisher's exact test was used to analyse between-groups differences with regard to this variable. There were statistically significant between-groups differences in both cases (Fathers: Fishers exact test = 17.502, p =.004; Mothers: Fisher's exact test = 19.581, p <.001). Again, this result was expected given that the three groups of participants were selected to differ in terms of SES, and that parents' level of formal education is a key contributor to SES.

Parental employment. The employment status of both fathers and mothers were analysed separately. Fisher's exact test was used because 24 cells (88.9% of the data) for father's employment had expected values of less than 5, and because 25 cells (92.6% of the data) for mother's employment had expected values of less than 5. Again, there were statistically significant between-groups differences in both cases (Fathers: Fishers exact test = 25.287, p =.006; Mothers: Fisher's exact test = 31.106, p <.001). Once again, this result was expected and that parental employment is a key contributor to SES.

Material and financial resources (asset index). There were also statistically significant between-group differences, as measured by Fisher's exact test, on this variable, Fisher's exact test = 10.249, p =.012). This form of statistical analysis was conducted rather than a chi-square analysis because 6 cells (66.7% of the data) had expected counts of less than 5.

University of Cape Town

Table 4
Demographic Questionnaire and Asset Index Data

	SES		
	Low (*n* = 16)	Medium (*n* = 21)	High (*n* = 13)
Household income (per year)			
R0	3	0	0
R1 - R5 000	4	1	0
R5 001 - R25 000	5	7	0
R25 001 - R100 000	1	1	2
R100 001 +	1	10	11
Unknown/incomplete	2	2	0
Parental education[a] (Father:Mother)			
0 years	0:0	0:0	0:0
1-6 years	0:0	0:0	0:0
7 years	0:0	0:0	0:0
8-11 years	5:6	4:4	0:0
12 years	6:6	9:7	2:3
13+ years	1:1	6:10	10:10
Unknown/incomplete	4:3	2:0	1:0
Parental employment[b] (Father:Mother)			
Higher executives, major professionals	0:0	0:0	5:3
Business managers of medium businesses, lesser professions	0:0	2:0	0:1
Administrative personnel, managers, minor professionals, owners/proprietors of small businesses	6:2	8:7	6:6
Clerical and sales, technicians, small businesses	2:1	4:10	0:1
Skilled manual (with training)	1:0	5:0	0:0
Semi-skilled	2:2	0:0	0:0
Unskilled, unemployed	2:3	0:0	1:1
Homemaker	0:2	0:2	0:1
Student, no occupation	1:4	0:2	0:0
Unknown/incomplete	2:2	2:0	1:0
Material & financial resources[c] (Asset Index)			
0-5 assets	2	0	0
6-12 assets	6	5	0
13-17 assets	8	16	13

Note. The *n* for each group indicates the number of demographic questionnaires that were returned. [a] Highest level achieved. [b] Hollingshead occupational index categories. [c]Aggregate asset scores.

University of Cape Town

Once again, this result was expected given that (a) the three groups of participants were selected to differ in terms of SES, and (b) the asset index was developed to provide a valid measure of SES in developing-world contexts.

General intellectual functioning. I used the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) to measure general intellectual functioning. This instrument was designed for use in individuals aged 6-89 years and was standardized and normed in the United States.

Only one published South African study (Thornton et al., 2008) has used this measure. That study, however, substituted the original WASI Vocabulary subtest with the Human Science Research Council South African standardization of the Vocabulary subtest from the Wechsler Adult Intelligence Scale – 3rd version (WAIS-III, Wechsler, 1997; Claassen, Krynauw, Paterson & Mathe, 2001). There are no other published research studies using the complete WASI in a South African or in a paediatric population. However, Hemp (1989) successfully used the closely related Wechsler Intelligence Scale for Children - Revised (WISC-R; Wechsler, 1974) in a study of South African children with TBI. Studies investigating the relationship between the WASI and the WISC have shown that WASI subtests are statistically significantly correlated with the corresponding WISC subtests, and that therefore the subtests and IQ scales of the WASI measure constructs similar to those measured by their WISC counterparts (Wechsler, 1999).

For the purposes of this study, WASI Full Scale IQ (FSIQ; a weighted combination of Verbal and Performance IQ scores) was used as an estimate of general intellectual functioning. In some cross-cultural studies, Performance IQ (PIQ) is viewed as a better estimate of general intellectual functioning than Verbal IQ (VIQ) or FSIQ because it does not rely on language abilities. In this study, however, an inclusion criterion for all participants was that they be fluent in English, and so this language factor was not a problem.

The two WASI subtests that comprise the PIQ measure are *Block Design* and *Matrix Reasoning*. The *Block Design* subtest measures perceptual organization, spatial visualization, visual-motor coordination, and abstract conceptualization. It requires the participant to replicate 13 modeled or printed two-dimensional geometric patterns within a specified time limit using two-coloured cubes. The *Matrix Reasoning* subtest, which measures nonverbal fluid reasoning, requires the participant to indicate the missing piece from a choice of five possibilities to complete a series of 35 incomplete gridded patterns. Performance on this subtest is indicative of

University of Cape Town

the participant's ability to mentally manipulate and perceive relationships among abstract symbols (Wechsler, 1999).

The two WASI subtests that comprise the VIQ measure are *Vocabulary* and *Similarities*. The *Vocabulary* subtest, which consists of 42 items, measures language development and word knowledge by asking the participant to name 4 simple pictures (items 1-4) or supply a definition or explanation of a word presented orally and visually (items 5-42). This subtest is also a comprehensive measure of crystallized and general intelligence (*g*; Wechsler, 1999). The *Similarities* subtest consists of 26 items. For items 1-4, the participant is presented with a picture of three common objects in a row at the top of the page, and pictures of four response possibilities in a row at the bottom of the page from which the participant has to choose the option that most closely matches the set of three target objects at the top of the page. For items 5-26, the participant is orally presented with a pair of words (objects, e.g. grapes and strawberries, or concepts, e.g., love and hate). This subtest measures verbal concept formation and categorical reasoning by requiring the participant to explain what a given pair of words has in common.

According to the WASI administration and scoring manual, test-retest reliability coefficients range from .86 to .93 for Vocabulary, from .81 to .91 for Similarities, from .86 to .93 for Block Design and from .86 to .96 for Matrix Reasoning. Reliability coefficients range from .92 to .95 for both VIQ and PIQ. A systematic content analysis and a review of parallel items of similar subtests of other Wechsler batteries ensured content validity. Construct validity is supported by the intercorrelations of scores on the WASI subtests and other IQ tests, and by the results of factor analyses that showed a two-factor model (two Verbal subtests and two Performance subtests) demonstrates best fit for the data from the normative children's sample (6 to 16 years), the normative adult sample (17 to 89 years), the total normative sample, and across all six normative age bands (6-9, 10-13, 14-16, 17-34, 35-69, and 70-89) (Wechsler, 1999).

Attention. The Test of Everyday Attention for Children (TEA-Ch; Manly et al., 1999) measures selective attention, sustained attention, and divided attention. It also measures participants' ability to switch attention from one activity to another. This instrument was developed, normed, and standardized in Australia for children and adolescents between the ages of 6 and 16 years. The complete battery consists of nine subtests, but for the purposes of this study, the brief screening version of the TEA-Ch (i.e., the version that includes only the first four subtests of the battery) was used. There are no published research studies using this instrument

University of Cape Town

with South African populations. The TEA-Ch has, however, been used extensively for both research and clinical purposes in English-speaking populations in the United Kingdom, the US and Australia (e.g. Bellgrove et al., 2005; Heaton et al., 2002; Manly et al., 2001).

The TEA-Ch *Sky Search* subtest assesses selective and focused attention. In the first part of the task, the participant is required to find as many "target" spaceships as possible on a sheet filled with similar distractor ships. In the second part of the task, the participant is required to mark, as quickly as possible, all of the "target" spaceships on a page containing only those targets (the targets are distributed randomly on the page). A measure of the child's ability to make a selection that is relatively free from the influence of motor slowness is reflected by the score obtained by subtracting the score on part 1 from that on part 2.

The TEA-Ch *Score!* subtest assesses sustained attention. Specifically, it tests the participant's ability to sustain his/her own attention by keeping a count of the number of "scoring" sounds heard on a soundtrack, as if he/she is keeping score on a computer game. Long intervals between the sounds and the fact that the child simply has to count the amount of sounds makes this task seem very simple; indeed, it is, and it does very little to grab the child's attention. Hence, it is suitable in assessing the child's ability to sustain attention.

The TEA-Ch *Creature Counting* subtest assesses attentional control/switching. The participant is required to repeatedly switch between two relatively simple activities (counting upwards and counting downwards). The participant is required to count aliens in their burrow, with occasional arrows indicating when to change the direction in which he/she is counting. Time taken and accuracy are scored.

The *Sky Search Dual Task (DT)* subtest assesses sustained-divided attention. The participant is required to combine the first two tasks of finding "target" spaceships (as in *Sky Search*) while simultaneously keeping a count of scoring sounds heard on a soundtrack (as in *Score!*).

Reliability of the nine subtests of the complete battery is reportedly high, with coefficients ranging from .57 to .87, and with strong inter-correlations. Validity, too, is good, with high regression coefficients with CFI (Comparative Fit Index) = .937; NFI (Normed Fit Index) = .913; and NNFI (Non-Normed Fit Index) = .96, all well above the fit index value of .90 (Manly et al., 1999). Therefore, as indicated by these statistics, the three main constructs

University of Cape Town

measured by the TEA-Ch (i.e., selective attention, attentional control/switching, and sustained attention) form a good fit for observed patterns of performance.

I used the *CMS Numbers Forward* subtest to assess simple attentional capacity. On this subtest, the participant is required to repeat random digit sequences of graduated length in the same sequence as read out loud by the examiner.

I used the *CMS Numbers Backward* subtest as a measure of working memory ability. On this subtest, the participant is required to repeat random digit sequences of graduated length in the reverse order of that read out loud by the examiner.

Memory. I used subtests from the Children's Memory Scale (CMS; Cohen, M. J., 1997) to assess the auditory/verbal learning and memory abilities of the participants. This battery was standardized and normed in the US for children and adolescents between the ages of 5 and 16 years. There are no published research studies using this instrument with South African populations but it is increasingly popular in clinical practice and research in South Africa. The CMS is used relatively frequently in research studies abroad; for instance, Vella et al. (2007) describe its use in a British child brain injury research programme.

The *CMS Stories* subtest assesses the ability to recall meaningful and semantically related verbal material. For the immediate recall portion, the participant listens to two stories told by the examiner, and is then required to retell the stories from memory. For the 25-30 minute delayed recall portion, the participant has to retell the two stories. A delayed recognition trial comprises 15 factual questions regarding each of the two stories; each question is answered by simple "yes" or "no" responses.

The *CMS Word Lists* subtest assesses the ability to learn a list of unrelated words over four learning trials. For the immediate recall portion, the participant listens to the initial presentation of the list by the examiner, after which he/she has to recall as many words as possible. For the following three trials the participant is reminded only of those words he/she forgot and is asked to recall as many words as he/she can remember after the reminder. Following these four trials, a distractor list is presented once, after which the participant has to recall as many of the new words as possible. It is then required that the participant recall the first list once more, without a reminder of those words. For the 25-30 minute delayed recall portion, the participant is asked to recall as many of the words from the first list as he/she can remember.

University of Cape Town

Finally, the participant has to complete a recognition task, indicating which of a list of words read out loud by the examiner were contained in the original list.

The *CMS Dot Locations* subtest assesses the ability to learn the spatial locations of an array of dots over three learning trials. For the immediate recall portion, the participant is presented with a picture of the array of dots for 5 seconds, after which he/she has to recall the arrangement on a grid with plastic chips; this administration is repeated three times. Then a distractor array is displayed; the participant has to represent that array as before. After completing that task, the participant is asked to again recall the first dot array. For the 25-30 minute delayed recall portion, the participant is required to recall the initial array.

The test developer reports that reliability coefficients for the core subtests of the battery range from .61 to .93 and from .65 to .93 for the supplemental subtests. Regarding content validity, the CMS appears to provide comprehensive assessment of memory and learning abilities in children aged 5 to 16 years. The method of establishing content validity commenced with expert revision of a trial version of the battery during which some subtests were eliminated based on factors such as redundancy, ease of administration and scoring, as well as "child-friendliness". The remaining subtests were re-evaluated in a national standardization tryout where some subtests were eliminated based on content, bias, and psychometric properties. The structure and construct validity of the remaining subtests were supported by Pearson correlation coefficients which ranged from .06 to .96 across all ages. Regarding criterion-related validity, *t*-test analyses within studies of special groups (epilepsy, TBI, and brain tumours) indicated that participants drawn from clinical populations performed more poorly than demographically-matched controls on CMS indexes.

The 3-min immediate and 30-min delayed recall trials of the *Rey-Osterrieth Complex Figure* test (RCF; Osterrieth, 1944) were used to assess a more complex figural form of visual memory. This test has been normed and standardized in many countries and for age groups ranging from 6 to 89 years (Mitrushina et al., 1999). For the purposes of this study I used E. M. Taylor's (1959) scoring criteria (as reproduced in Strauss et al., 2006). On both of these trials, the participant was asked to reproduce, as accurately as possible, the complex figure that he/she had drawn earlier.

University of Cape Town

Demsky, Carone, Burns, & Sellers (2000) examined the RCF test's validity for children of 6- to 11-years of age and found that neither race nor sex was significantly related to the test. They also reported better performance with increasing age.

Executive functioning. I used subtests from the NEPSY-II (Korkman, Kirk, & Kemp, 2007) to measure performance in this domain. This instrument was normed and standardized in the United States for children and adolescents aged 7 to 16 years.

With regard to cross-cultural use of this instrument, Mulenga, Ahonen, and Aro (2001) used the original NEPSY in a pilot study performed to correlate the performance of Zambian children with that of American children. They found that the US-normed NEPSY is to some degree insensitive to language and cultural factors, making it ideal to use in a South African context. There are, however, no published research studies using either the NEPSY or the NEPSY-II with South African populations, even though the instrument is becoming more commonly used in clinical practice. The NEPSY and NEPSY-II are favoured research instruments in the United States (see, e.g. O'Brien et al., 2004; Riccio, Avila & Ash, 2010).

The NEPSY-II *Clocks* subtest primarily assesses planning and organization. In the first part of the task, the participant is required to draw, over several trials, the face of a clock and to then add the hands following either instructions from the examiner or the model from a digital clock. In the second part of the task, the participant is required to read, over several trials, the time on clocks either with or without numbers. In the third part of the task, the participant is required to copy two clock drawings.

The NEPSY-II *Design Fluency* subtest assesses behavioural productivity. The participant is required to generate unique designs by connecting up to five dots, presented in two arrays: structured (symmetric arrangement of five dots) and random (asymmetric arrangement of five dots). The participant draws as many designs as he/she can on each array within a specific time limit (60 seconds for each array).

The NEPSY-II *Inhibition* subtest assesses the ability to inhibit automatic responses in favour of novel responses and the ability to switch between response types. The test comprises three conditions: *Naming*, *Inhibition*, and *Switching*. In *Naming* the participant looks at a series of black and white shapes (circles and squares) and arrows (pointing either up or down), and is required to name either the shape or the direction of the arrow; in *Inhibition* he/she is required to give the alternate response, depending on the colour of the shape or direction of the arrow – for

University of Cape Town

instance, the participant will say "up" when he sees a "down" arrow, and vice-versa, and will say "circle" for "square", and vice-versa; in *Switching* participants are required to say, for example, the arrow's correct direction when it is white, but the opposite direction when it is black, i.e., for a white "down" arrow the participant will say "down", but for a black "down" arrow he/she will say "up", and similarly for the squares and circles.

The NEPSY-II test developers report that reliability of the subtests of this battery was measured by means of inter-rater and interscores agreement, subtest internal consistency, and test-retest stability. The test's stability across time and age groups is supported by the range of stability coefficients from .62 to .89. Content validity and the effectiveness of the NEPSY-II in distinguishing between healthy children and those with known neurodevelopmental disorders (including learning disabilities, attention deficit/hyperactivity disorder, TBI, autistic disorders, and speech and learning impairment) were obtained and established from data of the performance of normally developing children as well as from clinical studies. Concurrent validity studies with other measures and clinical group studies established construct validity (Korkman et al., 2007).

University of Cape Town

Procedure

Once permission was obtained from the Western Cape Education Department to proceed with the study, I contacted principals of schools for which permission had been granted via telephone and scheduled meetings in order to explain the objectives, aims, and procedure of the study. Once the principals had granted permission, the informed consent form (Appendix B) and the demographic questionnaire (Appendix A) were distributed to potential participants. Participants were randomly selected from the pool of consent forms on which parents actively consented to their child's participation and that were returned to the school.

All participants were individually tested. Testing consisted of two sessions of 60-90 minutes each. All sessions were held at the participant's school, in a room that was specifically allocated for testing purposes and that was quiet and without distractions. Testing took place during school hours. Taking academic time into consideration, testing sessions were scheduled to cause as little disruption as possible, i.e., they tended to take place during "non-academic" periods (e.g., assembly, sport, etc.) or after hours if the school had an after-care service.

At the start of the first session, the participants were given an assent form (see Appendix C) to read and sign. Additionally, I verbally explained the aims of the study and the testing procedure; their voluntary participation was reiterated, and I also reminded them that they could take a break whenever they needed to, and that they could withdraw from the study at any time. Any questions the participant had about the study or about his/her participation were dealt with before test administration began. At the end of the second session participants were thanked for their participation in and contribution to the study, any questions that arose throughout the sessions were addressed, and they were assured of their anonymity and confidentiality.

Ethical Considerations

Permission to conduct research in schools was obtained from the Western Cape Education Department and informed consent was obtained from participants' parents. Additionally, participants read (or had read to them) an assent form, which they subsequently signed. Before testing began, I reiterated to them that their participation was voluntary, that they were allowed to withdraw at any time, and that they could take a break whenever they wanted during the testing session. After the second session was completed participants had the opportunity to ask questions and their anonymity and confidentiality were confirmed.

With help from my supervisor, I provided feedback on the participants' performance to schools and parents regarding the children's performance on the test battery (see Appendix D). No participants showed any personal, psychological, or learning problem during the testing sessions. If any of these problems were evident the relevant teacher or school psychologist would have been informed.

University of Cape Town

Data Analysis: Scoring procedures

For the WASI, CMS, NEPSY-II, and TEA-Ch, scoring procedures were followed as set out in the administration manuals of each battery. The RCF was scored following E. M. Taylor's (1959) criteria (as reproduced in Strauss et al. 2006); these scores were compared to normative data provided by Anderson et al. (1997, 2001; as cited in Strauss et al., 2006).

To help the reader understand exactly what each outcome variable entails and the nature of some of the independent variables employed in the statistical analyses that follow, I now

provide a brief explanation of the scoring procedures, as well as which scores were generated by each test.

Full Scale IQ, comprising of Performance IQ and Verbal IQ. Age-adjusted scaled scores for each of the WASI Block Design and Matrix Reasoning subtests were combined in order to reflect the child's general non-verbal abilities via the PIQ. Similarly, the age-adjusted scaled scores for WASI Vocabulary and Similarities subtests were combined; this combination reflects the child's general verbal abilities via the VIQ score. The combination of the PIQ and VIQ index scores resulted in the FSIQ, which reflects the child's level of general intellectual functioning.

Selective/focused attention. To assess the ability to focus attention on the task at hand, I calculated the following age-adjusted scaled scores: (a) the TEA-Ch *Sky Search Targets score*, which was the number of correctly identified targets found on the first target sheet including distractor targets, (b) the *Sky Search Time per Target score*, which was the total time taken (in seconds) divided by the number of correctly identified targets found on the first target sheet (Sky Search Targets score), (c) and the *Sky Search Attention score*, derived from subtracting the Sky Search Motor Control Time per Target Score (the total time taken divided by the number of targets found on the second (motor control) stimulus sheet) from Sky Search Time per Target score.

Sustained attention. I calculated age-adjusted scaled scores representing the child's accuracy in counting relevant sounds and assessing the ability to maintain attention over time on the TEA-Ch Score! subtest by adding all the correct items on the scoring sheet.

Attentional control/switching. To assess the ability to maintain attention and switch appropriately when specified, I calculated the following age-adjusted scaled scores: the TEA-Ch *Creature Counting Total Correct score* and *Creature Counting Timing* scores. The Creature Counting Total Correct score was calculated by adding the total correct responses (i.e., the number that the child reached at the end of the series of aliens he/she counted). The Creature Counting Timing score was calculated by dividing the total time (in seconds) taken to complete the seven counting trials by the total amount of switches for correct items (i.e., the trials where the child reached the correct final number).

Sustained-divided attention. To assess the ability to simultaneously sustain and divide attention between two competing stimuli, I calculated age-adjusted scaled scores representing the

University of Cape Town

accuracy of the child's ability to count the relevant sounds on the soundtrack while simultaneously identifying the correct targets on the TEA-Ch DT target sheet. This *Sky Search DT Decrement* score was calculated by subtracting the Sky Search Time per Target score (on the Sky Search subtest) from the Weighted Time per Target score on the Sky Search DT subtest.

Simple attentional capacity and working memory. To assess simple attentional capacity as well as more complex working memory ability, I calculated age-adjusted scaled scores for CMS *Numbers Forward*, and *Numbers Backward*. The Numbers Forward score was calculated by the number of correctly repeated strings of digits in the same order as the examiner; similarly the Numbers Backward score was obtained from the number of correctly reversed digit-strings.

Verbal memory. I calculated age-adjusted scaled scores for CMS *Stories Immediate Recall*, *Stories Delayed Recall*, and *Stories Delayed Recognition* to assess the child's ability to encode, store and recall meaningful and semantically related complex verbal material. The Stories Immediate Recall and Delayed Recall scores were calculated by adding the total amount of facts recalled correctly in both stories on each trial. The Stories Delayed Recognition score was calculated by adding the number of correct responses to questions about facts from both stories.

I also calculated age-adjusted scaled scores for CMS *Word Lists Learning*, *Word Lists Delayed Recall*, and *Word Lists Delayed Recognition* to assess the child's ability to learn, store, and retrieve a list of unrelated words (i.e., simple verbal information). The Word Lists Learning score was calculated by adding the number of correct responses over the four learning trials. The Word Lists Delayed Recall score was obtained by adding the number of correct responses on the 25-minute delayed recall trial. Lastly, the Word Lists Delayed Recognition score was calculated by adding all the correct responses on the recognition task that followed immediately after the delayed recall trial.

Visual memory. To assess the ability to encode, store, and retrieve simple visually-presented information, I calculated age-adjusted scaled scores for the CMS *Dot Locations Learning*, *Dot Locations Total*, and *Dot Locations Delayed Recall* tasks. The Dot Locations Learning score was calculated by adding the number of correct responses over the three learning trials. The addition of the 5-minute delayed recall score resulted in the Dot Locations Total score. The Dot Locations Delayed Recall score was calculated by adding the number of correct responses on the 25-minute delayed recall trial.

University of Cape Town

To assess the ability to encode, store, and retrieve more complex figural information, I scored the RCF 3-minute- and 30-minute delayed scores using E.M. Taylor's (1959) criteria (as reproduced in Strauss et al., 2006) and used these raw scores in my final data analyses.

Executive functioning. To assess multiple aspects of executive functioning, including planning and organization, cognitive flexibility and behavioural productivity, and inhibitory control and the ability to inhibit automatic responses, I calculated age-adjusted scaled scores for each of the NEPSY-II subtests in the battery. For planning and organization abilities I calculated the *Clocks Total* score which was a combination of scores from the four tasks contained within the subtest: (a) presentation, location, and accuracy of the numbers, contour, hands and centre; (b) presentation and accuracy of the hands to complete given clock drawings; (c) providing the time as read from two clocks with numbers and two clocks without; and (d) presentation, location, and accuracy of two clocks that were copied exactly from two stimulus clocks. The *Design Fluency* score was calculated by adding the number of correct designs on the structured and random array design sheets in order to assess the ability to use flexible cognitive processes to produce novel designs. Lastly, the scores of the *Inhibition* subtest were calculated. The *Inhibition-Naming Combined* scaled score and the *Inhibition-Naming Completion Time* scaled score were obtained to ensure that poor performance was not due to language difficulties. Inhibitory control was measured by the *Inhibition-Inhibition Combined* scaled score and the *Inhibition-Inhibition Completion Time* scaled score. Similarly, the *Inhibition-Switching Combined* scaled score and the *Inhibition-Switching Completion Time* scaled scores represented the child's ability to show cognitive flexibility in switching between different response types. The Combined scaled score for all these Inhibition subtest integrated the total errors percentile rank with the Completion Time scaled score; Completion Time scaled scores were calculated by adding the completion times for the two response sets (shapes and arrows). The Total Errors scaled score was calculated by adding all uncorrected and self-corrected errors across all trials.

Data Analysis: Statistical procedures

Data were checked and cleaned before actual analyses were performed. The raw scores obtained on the various measures were converted to age-appropriate scaled scores following conventional procedures outlined in the various test manuals. Descriptive statistics were compiled using Statistica 9.0 (StatSoft, 2009); these were used to explore the data in order to

University of Cape Town

establish any existing trends and to allow for the testing of assumptions that must be upheld for further inferential statistical analysis. Inferential statistics were conducted using the same statistical software package. All statistical analyses used an alpha level of p =.05 for the threshold of statistical significance. Effect size estimates were reported, where appropriate, as these estimates allow for assessment of the real-world significance of group differences.

Between-groups comparisons of demographic characteristics. To assess for differences between the three groups in terms of demographic variables other than SES, one-way analyses of variance were conducted on continuous variables (age and years of education), and chi-square (χ^2) analyses were conducted on categorical variables (sex, race, home language, and asset index information). Where more than 20% of the data had expected values smaller than 5, Fisher's exact test was used for analysis of categorical variables.

Between-groups comparison of neuropsychological performance. This series of statistical analyses were performed to assess for differences in neuropsychological performance across the three groups. Due to the fact that three groups differed significantly in terms of IQ, analysis of covariance (ANCOVA) was conducted in order to determine how the three groups performed when IQ was controlled for. Once all the assumptions for inferential statistical analyses were met, all the subscores were analysed (scaled scores were used) across the two age-bands (7- and 8-year-olds and 9- and 10-year-olds) within the three groups. Adjusted means are reported.

In the instances where significant group differences were indicated after controlling for IQ, post-hoc pairwise comparisons of the adjusted means were conducted via Tukey's Honest Significant Difference (HSD) test. To reduce the chances of Type I error, the α level was adjusted according to Bonferroni-type adjustment (α =.05/amount of pairwise comparisons, in this case α =.05/3 =.017).

Neuropsychological test battery: Scoring and deriving composite scores. Due to the size of the complete test battery (33 dependent variables) and the sample (N = 116), a hybrid method using composite scores was used to reduce the number of dependent variables (see Medina et al., 2007, for a complete description of this statistical technique). Measures were grouped into composite domains according to established categorizations and theoretical assumptions (Lezak et al., 2004), as well as the results of reliability analyses (Cronbach's α coefficients), for each composite domain. Each individual neuropsychological variable was converted into a Z score

University of Cape Town

based on the entire sample of children ($N = 116$). The individual measure Z scores were then averaged to form a final composite Z score for each domain. By means of a standardized Cronbach's α calculated for each composite domain, the individual measures were confirmed to be significantly correlated. Table 5 presents information about the various domains and their descriptive statistics.

University of Cape Town

Table 5

Neuropsychological Performance within Composite Domains

	7- and 8-year-olds (*n* = 56)						9- and 10-year-olds (*n* = 60)					
	High SES (*n* = 20)		Medium SES (*n* = 19)		Low SES (*n* = 17)		High-SES (*n* = 21)		Medium SES (*n* = 19)		Low-SES (*n* = 20)	
	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)
Attention, Concentration and Working Memory (α = 0.530)	**-0.12 – 1.80**	**0.49 (0.45)**	**-1.16 – 1.23**	**-0.17 (0.54)**	**-1.29 – 0.20**	**-0.38 (0.36)**	**-0.49 – 1.09**	**0.45 (0.44)**	**-1.63 – 0.56**	**-0.11 (0.51)**	**-1.47 – 0.49**	**-0.36 (0.52)**
CMS Numbers												
Forward	4-7	0.59 (0.86)	4-6	-0.19 (1.03)	4-6	-0.43 (0.84)	4-8	0.52 (0.74)	4-7	-0.42 (0.96)	4-8	-0.15 (1.07)
Backward	3-5	0.56 (0.97)	3-5	-0.38 (1.22)	2-4	-0.38 (0.76)	3-6	0.58 (0.95)	2-6	-0.01 (0.92)	2-4	-0.60 (0.77)
TEA-Ch Sky Search												
Targets	4-14	0.35 (1.07)	4-14	-0.22 (0.95)	6-14	-0.13 (0.92)	6-13	0.11 (0.99)	8-13	0.14 (0.85)	4-13	-0.24 (1.14)
Time per Target	5-19	0.74 (1.07)	4-11	-0.04 (0.67)	1-7	-0.78 (0.55)	3-16	0.65 (1.00)	1-11	-0.08 (0.74)	1-9	-0.60 (0.82)
Attention score	4-12	0.39 (0.80)	4-12	-0.03 (0.75)	1-16	-0.40 (1.30)	3-15	0.57 (1.01)	1-12	-0.10 (0.81)	1-10	-0.50 (0.88)
TEA-Ch Score!	5-15	0.30 (0.95)	3-15	-0.09 (1.09)	3-15	-0.23 (0.92)	4-14	0.29 (0.91)	3-14	-0.07 (1.07)	4-14	-0.24 (0.99)
TEA-Ch Sky Search DT	1-13	0.32 (0.85)	1-18	-0.22 (0.92)	1-19	-0.10 (1.19)	1-13	0.18 (0.64)	1-13	-0.12 (0.78)	1-19	-0.07 (1.43)
Visual Memory (α = 0.770)	**-1.00 – 1.20**	**0.22 (0.61)**	**-1.68 – 1.32**	**0.04 (0.75)**	**-1.77 – 0.85**	**-0.29 (0.79)**	**-0.60 – 1.43**	**0.13 (0.52)**	**-0.87 – 1.25**	**0.24 (0.58)**	**-1.95 – 1.48**	**-0.37 (0.87)**
CMS Dot Locations												
Learning	5-14	0.40 (0.82)	3-14	-0.18 (1.03)	3-14	-0.23 (1.06)	8-16	0.27 (0.67)	4-16	0.09 (1.14)	3-16	-0.37 (1.08)
Total	5-15	0.42 (0.83)	4-15	-0.17 (1.03)	4-15	-0.27 (1.04)	8-16	0.27 (0.67)	4-16	0.09 (1.14)	3-16	-0.37 (1.08)
Delayed Recall	9-13	0.34 (0.77)	7-13	0.01 (0.97)	7-13	-0.40 (1.16)	7-14	0.42 (0.73)	5-14	0.13 (1.03)	4-14	-0.56 (1.00)
RCF												
Immediate recall	2.5-24	0.001 (1.13)	3.5-25	0.23 (0.92)	3.5-20.5	-0.27 (0.93)	4-24	-1.87 (1.41)	8-30	-1.22 (2.39)	6-29	-1.55 (2.23)
Delayed recall	1.5-24.5	-0.07 (1.04)	3-27	0.31 (0.98)	2.5-20	-0.29 (0.92)	3-29	-1.95 (2.16)	8.5-29	-1.08 (2.16)	6.5-31	-1.40 (2.48)
Verbal Story Memory (α = 0.837)	**-1.64 – 1.71**	**0.21 (0.97)**	**-1.30 – 1.50**	**0.17 (0.71)**	**-1.81 – 0.74**	**-0.45 (0.80)**	**-1.27 – 1.66**	**0.52 (0.82)**	**-1.58 – 1.49**	**-0.06 (0.79)**	**-1.59 – 0.62**	**-0.48 (0.69)**
CMS Stories												

University of Cape Town

	7- and 8-year-olds (n = 56)						9- and 10-year-olds (n = 60)					
	High SES (n = 20)		Medium SES (n = 19)		Low SES (n = 17)		High-SES (n = 21)		Medium SES (n = 19)		Low-SES (n = 20)	
	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)
Immediate Recall	5-16	0.13 (1.10)	7-19	0.31 (1.00)	6-12	-0.51 (0.70)	5-17	0.48 (0.91)	2-15	0.01 (1.07)	4-12	-0.51 (0.79)
Delayed Recall	4-19	0.18 (1.23)	7-17	0.12 (0.92)	6-14	-0.34 (0.75)	5-15	0.35 (0.90)	5-15	0.14 (1.02)	4-13	-0.50 (0.92)
Del. Recognition	7-17	0.35 (0.82)	5-14	0.09 (0.73)	1-15	-0.50 (1.28)	6-18	0.72 (1.05)	4-14	-0.33 (0.75)	4-13	-0.44 (0.72)
Verbal List Memory (α = 0.773)	**-1.38 – 2.05**	**0.33 (0.82)**	**-1.14 – 1.30**	**-0.04 (0.76)**	**-1.50 – 0.91**	**-0.32 (0.79)**	**-0.81 – 1.90**	**0.19 (0.61)**	**-1.21 – 1.25**	**0.14 (0.79)**	**-2.29 – 1.41**	**-0.34 (0.96)**
CMS Words												
Learning	5-15	0.50 (1.04)	6-14	-0.03 (1.00)	5-12	-0.53 (0.71)	8-17	0.29 (0.80)	8-15	-0.03 (0.90)	8-15	-0.29 (1.22)
Delayed Recall	8-17	0.19 (1.00)	8-16	-0.04 (1.15)	7-14	-0.16 (0.88)	8-16	0.05 (0.82)	6-15	0.23 (1.02)	6-16	-0.27 (1.33)
Del. Recognition	5-13	0.32 (0.88)	5-13	-0.06 (0.76)	2-13	-0.29 (1.29)	5-14	0.24 (0.85)	4-14	0.22 (0.85)	3-14	-0.46 (1.15)
Inhibition (α = 0.818)	**-1.19 – 2.01**	**0.41 (0.73)**	**-1.84 – 1.48**	**-0.26 (0.92)**	**-2.36 – 1.54**	**-0.15 (0.98)**	**-0.76 – 1.62**	**0.55 (0.70)**	**-2.00 – 1.51**	**-0.13 (1.04)**	**-1.68 – 0.94**	**-0.52 (0.78)**
NEPSY Inhibition												
Inh. Comp. Time	6-15	0.51 (0.76)	5-13	-0.45 (0.88)	3-15	-0.04 (1.15)	6-16	0.49 (0.90)	4-16	-0.14 (1.14)	6-13	-0.39 (0.75)
Inhibition Combined	5-15	0.30 (0.83)	2-14	-0.07 (1.08)	1-14	-0.26 (1.04)	7-15	0.60 (0.65)	2-14	-0.12 (1.06)	2-14	-0.65 (1.03)
Switching (α = 0.779)	**-0.39 – 1.71**	**0.63 (0.55)**	**-1.11 – 0.90**	**-0.29 (0.57)**	**-1.92 – 0.86**	**-0.35 (0.66)**	**-0.29 – 1.25**	**0.64 (0.42)**	**-1.49 – 1.38**	**-0.16 (0.68)**	**-1.66 – 0.40**	**-0.53 (0.54)**
NEPSY Inhibition												
Switching Comp. Time	5-15	0.69 (0.75)	1-11	-0.57 (0.86)	1-13	-0.11 (0.97)	7-17	0.69 (0.70)	5-14	-0.18 (0.93)	4-13	-0.56 (0.93)
Switching Combined	6-16	0.61 (0.83)	1-14	-0.22 (0.91)	1-12	-0.43 (0.99)	7-15	0.70 (0.65)	2-15	0.10 (1.01)	2-10	-0.83 (0.64)
Total Errors	5-17	0.41 (0.85)	1-15	0.09 (0.85)	1-15	-0.56 (1.11)	7-14	0.71 (0.46)	2-16	0.17 (0.94)	1-9	-0.91 (0.76)
TEA-Ch Creature Counting												
Total Correct	8-15	0.46 (0.88)	10-12	-0.30 (0.37)	5-15	-0.16 (1.42)	8-14	0.47 (0.89)	6-11	-0.70 (0.70)	7-14	0.18 (1.01)
Time	7-13	0.96 (0.49)	1-11	-0.48 (0.93)	1-8	-0.51 (0.69)	5-17	0.65 (0.81)	1-13	-0.16 (0.85)	1-10	-0.53 (0.97)

University of Cape Town

	7- and 8-year-olds (*n* = 56)						9- and 10-year-olds (*n* = 60)					
	High SES (*n* = 20)		Medium SES (*n* = 19)		Low SES (*n* = 17)		High-SES (*n* = 21)		Medium SES (*n* = 19)		Low-SES (*n* = 20)	
	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)
Planning, Organization and Abstract Reasoning (α = 0.698)	**-0.78 - 2.02**	**0.33 (0.78)**	**-1.43 - 1.37**	**0.07 (0.76)**	**-1.28 - 0.68**	**-0.45 (0.55)**	**-1.75 - 1.26**	**0.19 (0.80)**	**-0.84 - 1.30**	**0.26 (0.62)**	**-1.33 - 0.41**	**-0.44 (0.46)**
NEPSY Clocks Total	6-18	0.53 (0.83)	6-14	-0.08 (1.03)	1-15	-0.50 (0.90)	7-19	0.34 (0.90)	6-18	0.19 (1.00)	4-17	-0.53 (0.91)
WASI												
Block Design	7-18	0.70 (1.08)	7-16	-0.05 (0.82)	6-11	-0.73 (0.41)	7-17	0.53 (1.03)	6-15	0.24 (0.90)	6-10	-0.79 (0.44)
Matrix Reasoning	6-15	0.59 (1.00)	5-14	-0.30 (0.85)	4-13	-0.30 (0.91)	5-14	0.40 (0.83)	5-14	0.002 (1.00)	3-14	-0.43 (1.03)
Similarities	10-15	0.61 (0.86)	9-15	-0.02 (0.91)	7-13	-0.67 (0.85)	9-16	0.77 (0.75)	8-15	0.10 (0.70)	5-11	-0.91 (0.71)
Generativity	**-1.32 – 2.54**	**0.58 (1.10)**	**-2.29 – 0.93**	**-0.05 (0.74)**	**-1.64 – 1.57**	**-0.58 (0.81)**	**-1.23 – 1.84**	**0.51 (0.94)**	**-1.23 – 1.46**	**0.06 (0.81)**	**-2.38 – 1.07**	**-0.59 (0.95)**
NEPSY Design Fluency	4-16	0.58 (1.10)	1-11	-0.05 (0.74)	3-13	-0.58 (0.81)	6-14	0.51 (0.94)	6-13	0.06 (0.81)	3-12	-0.59 (0.95)
Expressive Language (α = 0.756)	**-0.87 – 1.51**	**0.63 (0.58)**	**-1.28 – 1.34**	**-0.10 (0.70)**	**-2.07 – 0.89**	**-0.59 (0.77)**	**0.23 – 2.03**	**1.01 (0.51)**	**0.12 – 1.45**	**0.75 (0.36)**	**-0.55 – 1.08**	**0.23 (0.41)**
NEPSY Inhibition												
Naming Comp. Score	5-14	0.66 (0.72)	4-11	-0.32 (0.78)	1-14	-0.36 (1.16)	6-16	0.57 (0.89)	5-13	-0.26 (0.83)	2-15	-0.35 (1.03)
Naming Combined	4-15	0.35 (0.86)	2-14	0.09 (1.08)	1-10	-0.50 (0.89)	5-16	0.40 (1.05)	5-14	-0.04 (0.74)	1-15	-0.39 (1.04)
WASI Vocabulary	8-18	0.87 (0.84)	6-13	-0.07 (0.67)	3-9	-0.90 (0.59)	7-16	0.62 (0.82)	5-15	0.29 (0.89)	3-10	-0.93 (0.48)

Note. CMS = Children's Memory Scale; TEA-Ch = Test of Everyday Attention for Children; ROCF = Rey-Osterrieth Complex Figure; WASI = Wechsler Abbreviated Scale of Intelligence. Data presented are *Z* scores (converted *Z* scores based on the whole sample, *N* = 116) for composite domain categories, and scaled scores (SS) for most individual test measures. Raw scores are presented for the following individual test measures: CMS Numbers Forward, CMS Numbers Backward, RCF Immediate Recall, and RCF Delayed Recall. The raw/scaled scores presented are the average performance of each group's participants and the standard deviation of their performance in parentheses. These raw and scaled scores are provided for descriptive purposes; they were also used in the statistical analysis, as were the *Z* scores. Cronbach's α is reported as a measure of composite domain reliability. All *Z* scores were formatted so that all measures were scored in the same direction (with the higher the score, the better the participant's performance).

University of Cape Town

Multiple regression: Composite domain scores. After confirming that all assumptions underlying regression analyses had been met, I conducted a series of regression analyses to determine to what extent SES group status predicted performance on each composite domain, after controlling for IQ-, grade-, sex-, and race differences. Throughout these analyses, neuropsychological domain score was the outcome variable, with IQ, grade, sex, race and SES group entered separately as predictor variables (Step 1: FSIQ; Step 2: Grade = 1, 2, 3, 4, 5; Step 3: Sex = males, females; Step 4: Race = black, white, coloured; Step 5: SES group = medium vs. high and medium vs. low). Where SES group significantly predicted performance in a specific domain, post-hoc regression analyses of the subtests/scores within the composite domain were performed.

Post-hoc multiple regression: Neuropsychological subtest scores. Significantly predicted performance within a composite domain was followed by regression analysis to determine on which of the individual subtests/scores performance was predicted by SES group after controlling for grade. In order to reduce Type I error, Bonferroni adjustments were performed to calculate domain-specific α levels (α =.05/number of subtests or scores within a composite domain). By not adjusting the α level and using α =.05, the overall Type I error may be inflated by as much as 2 to 6 times the nominal α level, depending on the number of predictors in the model and the number of predictors that have a non-zero correlation with the response. As a result, one or more variables could be identified as "significant" predictors of performance which in actual fact is not the case and therefore these variables are not needed in the regression model as they account for a negligible amount of unique variance in performance. Therefore, by adjusting the overall α level for a composite domain according to the Bonferroni adjustment approach, only those variables that truly predict performance are identified and included in the regression model (Mundfrom, Perrett, Schaffer, Piccone, & Roozeboom, 2006).

Comparison between the South African sample and the published norms. Single sample *t*-tests were used to determine how the South African sample (each of the three SES groups separately), within each age group (i.e., 7-, 8-, 9-, and 10-year-olds separately), performed compared to the published test norms. Age-adjusted scaled scores were used for the TEA-Ch, CMS, and NEPSY-II, and *Z* scores for the RCF.

University of Cape Town

RESULTS

Objective 1

My first objective was to compare, across the domains of attention, memory, and executive functioning, the performance of low-, medium-, and high-SES South African children within two age bands (7- and 8-year-olds, and 9- and 10-year-olds).

ANOVA and ANCOVA results for 7- and 8-year-olds. In order to determine whether the groups were matched for IQ, one-way ANOVA was performed on the WASI IQ scores, with group membership being the between-subjects factor. The assumption of normality of the data distribution was upheld for all three IQ measures (i.e., FSIQ, VIQ, and PIQ). The assumption of homogeneity of variances was also upheld for all three measures, Levene's test for FSIQ, $F(2, 53) = 2.313$, $p = .109$; VIQ, $F(2, 53) = 2.170$, $p = .124$; and PIQ, $F(2, 53) = 1.281$, $p = .286$.

The subsequent series of one-way ANOVAs showed that there was a statistically significant between-groups effect of group membership in terms of FSIQ ($F(2, 53) = 22.768$, $p < .001$), VIQ ($F(2, 53) = 22.446$, $p < .001$), and PIQ ($F(2, 53) = 16.166$, $p < .001$). These results therefore indicate that the three groups were not successfully matched for IQ and that thus IQ needed to be added to the between-groups analysis as a covariate.

Hence, I conducted a series of one-way ANCOVAs, each featuring (a) SES as an independent variable with three levels (high, medium and low), (b) an individual neuropsychological test score as the dependent variable, and (c) WASI FSIQ as the covariate. Because ANCOVA appears robust to the violation of the assumptions of homogeneity of variance and homogeneity of regression when group sizes are equal (see Hamilton, 1977, and Rheinheimer & Penfield, 2001), cases were removed at random in order to render equal groups ($n = 17$ for each of the three SES groups). With these equal-sized groups in place, the assumptions for ANCOVA were met: there was normal distribution of the data, observations were independent, the covariate was linearly related to the dependent measure (Pearson's correlation coefficient), there was homogeneity of variance (as established by Levene's test), and the regression slopes were homogeneous (see Table 6).

University of Cape Town

Table 6

ANCOVA Assumptions for the Neuropsychological Test Battery (7- and 8-year-olds)

	Pearson's Correlation	Levene's Test		Homogeneity of Regression	
Outcome variable	*r*	*F*	*P*	*F*	*p*
TEA-Ch Sky Search					
Targets	0.343	0.254	.777	0.137	.872
Time per target	0.600	1.265	.291	0.006	.994
Attention score	0.246	0.420	.659	2.750	.075
TEA-Ch Score!	0.452	0.594	.556	2.781	.073
TEA-Ch Creature					
Total correct	0.521	14.84	< .001***	7.936	.001**
Time	0.577	2.266	.115	1.917	.159
TEA-Ch Sky Search DT	0.192	1.003	.374	2.135	.110
CMS Numbers					
Forward	0.424	0.407	.668	0.124	.884
Backward	0.473	0.709	.497	1.846	.170
CMS Words					
Learning	0.490	0.573	.568	0.122	.885
Delayed recall	0.143	0.726	.489	0.355	.703
Delayed recognition	0.334	4.332	.019*	2.724	.076
CMS Stories					
Immediate recall	0.401	1.362	.266	0.151	.860
Delayed recall	0.395	1.915	.159	0.475	.625
Delayed recognition	0.432	5.049	.010*	1.224	.304
CMS Dot Locations					
Learning	0.366	5.124	.010*	1.247	.297
Total	0.389	4.270	.020*	1.450	.245
Delayed recall	0.193	1.827	.172	0.988	.380
RCF					
Immediate recall	0.373	0.277	.759	3.245	.050
Delayed recall	0.291	0.195	.824	0.777	.466
NEPSY-II					
Clocks	0.639	0.462	.633	2.546	.090
Design Fluency	0.551	1.442	.247	0.716	.494
Inhibition - Naming					
Completion time	0.538	1.660	.201	0.855	.432
Combined	0.457	0.902	.413	1.133	.331

University of Cape Town

Outcome variable	Pearson's Correlation	Levene's Test		Homogeneity of Regression	
	r	*F*	*P*	*F*	*p*
Inhibition - Inhibition					
Completion time	0.510	1.66	.201	2.446	.098
Combined	0.413	0.468	.629	1.70	.195
Inhibition - Switching					
Completion time	0.530	0.535	.589	0.700	.502
Combined	0.604	0.231	.794	0.713	.496
Inhibition total errors	0.489	0.729	.488	2.065	.139
WASI					
Vocabulary	0.915	1.057	.355	0.008	.992
Similarities	0.782	0.155	.857	0.058	.943
Block Design	0.800	8.627	< .001***	0.493	.164
Matrix Reasoning	0.722	0.294	.747	2.004	.147

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001

As Table 7 shows, four of the series of ANCOVAs revealed statistically significant between-group differences. The four dependent variables in question were: NEPSY Inhibition-Inhibition Completion Time, NEPSY Inhibition-Switching Completion Time, TEA-Ch Creature Counting Time, and WASI Vocabulary. Details for post-hoc analyses for data from each of these variables are presented below.

University of Cape Town

Table 7

ANCOVA Results for the Neuropsychological Test Battery (7- and 8-year-olds)

	ANCOVA			Adjusted Means		
Outcome variable	$F(2, 47)$	p	Adjusted R^2	High-SES	Medium-SES	Low-SES
TEA-Ch Sky Search						
Targets	1.074	.350	0.102	10.00	8.75	9.90
Time per target	3.009	.059	0.396	7.76	6.86	5.09
Attention score	0.840	.438	0.035	7.92	7.10	6.16
TEA-Ch Score!	0.182	.833	0.160	7.84	8.23	8.76
TEA-Ch Creature Counting						
Total correct	1.078	.349	0.259	12.26	11.78	12.84
Time	8.810	< .001***	0.484	8.69	4.26	4.70
TEA-Ch Sky Search DT	0.919	.406	0.014	6.85	4.14	5.31
CMS Numbers						
Forward	1.839	.170	0.191	11.08	9.34	8.58
Backward	0.348	.708	0.185	10.07	9.20	9.20
CMS Words						
Learning	0.897	.415	0.221	10.42	10.04	9.13
Delayed recall	0.268	.766	0.030	11.02	10.55	10.08
Delayed recognition	0.075	.928	0.058	9.02	8.57	8.53
CMS Stories						
Immediate recall	2.257	.116	0.185	10.08	11.97	10.25
Delayed recall	0.440	.647	0.119	10.72	11.81	11.18
Delayed recognition	0.559	.576	0.156	10.05	10.24	9.01
CMS Dot Locations						
Learning	1.176	.317	0.122	11.85	9.90	10.43
Total	1.054	.357	0.136	12.68	10.75	11.17
Delayed recall	1.408	.255	0.034	11.82	11.17	10.49
RCF						
Immediate recall	1.650	.203	0.145	9.87	13.64	12.40
Delayed recall	2.171	.125	0.108	8.86	13.27	11.05
NEPSY-II						
Clocks	0.019	.981	0.371	8.43	8.65	8.51
Design Fluency	0.408	.668	0.272	8.38	8.22	7.41
Inhibition - Naming						
Completion time	2.434	.099	0.135	8.87	6.86	7.86
Combined	0.857	.431	0.188	7.90	8.76	7.28
Inhibition – Inhibition						
Completion time	3.516	.038*	0.315	9.29	8.55	10.69
Combined	0.502	.609	0.136	7.85	9.09	9.01
Inhibition – Switching						

University of Cape Town

Outcome variable	ANCOVA			Adjusted Means		
	$F(2, 47)$	p	Adjusted R^2	High-SES	Medium-SES	Low-SES
Completion time	5.926	.005**	0.389	9.02	6.38	8.77
Combined	0.215	.807	0.331	8.13	7.50	7.84
Inhibition total errors	1.193	.312	0.230	8.01	9.24	7.33
WASI						
Vocabulary	3.593	.035*	0.850	9.88	9.54	8.46
Similarities	1.121	.335	0.606	11.45	12.04	11.63
Block Design	0.679	.512	0.628	10.45	10.59	9.73
Matrix Reasoning	1.603	.212	0.523	8.87	9.02	10.35

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001

University of Cape Town

NEPSY Inhibition-Inhibition Completion Time. SES group membership accounted for 13% of the variance in performance on this outcome variable when IQ was controlled for. The mean completion time adjusted for IQ differences were calculated across the three SES groups. The low-SES group had the largest adjusted mean, followed by the high-SES group, and the medium-SES group had the smallest adjusted mean. Post-hoc analysis (Tukey's HSD) was conducted to evaluate the pairwise differences among the adjusted means; Bonferroni corrections were used to control for Type I errors across the three pairwise comparisons. At the adjusted α level (p =.017), there was a statistically significant difference between the performance of the low- and medium-SES groups (p =.003). This effect was in the opposite direction to that predicted, however, with participants in the low-SES group performing significantly better than those in the medium-SES group when adjusting for IQ. That is to say, low-SES participants displayed the ability to complete a task requiring inhibitory control of natural responses in significantly less time than medium-SES participants.

NEPSY Inhibition-Switching Completion Time. SES group membership accounted for 20% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means for completion time were calculated across the three SES groups after controlling for IQ. The high-SES group performed the best, low-SES group performed more poorly than that, with the poorest performance in the medium-SES group. Post-hoc analysis (Tukey's HSD with Bonferroni adjustment identical to what is described above) of the adjusted means suggested that there were statistically significant differences in performance between the high-SES group and the medium-SES group (p <.001), and between the high-SES group and the low-

SES group (p =.007). These data therefore indicate that, when controlling for IQ, high-SES participants were consistently faster than both low- and medium-SES participants in completing a task that required the cognitive flexibility to switch between different response types.

TEA-Ch Creature Counting Time. SES group membership accounted for 27% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means for the three groups were calculated after controlling for IQ, and indicated that the high-SES group clearly performed much better than the medium- and low-SES groups, with the low-SES group performing slightly better than the medium-SES group. Post-hoc pairwise comparisons using identical methods to those described above showed that there were statistically significant differences between the high-SES group and the medium-SES group (p <.001) and between the high-SES group and the low-SES group (p <.001). These data therefore indicate that, when controlling for IQ, high-SES participants were able to complete, in significantly less time than medium- and low-SES participants, a task that required maintaining attention and switching appropriately when specified.

WASI Vocabulary. SES group membership accounted for 13% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means were calculated for the three groups after controlling for IQ, indicating that the high-SES group had the largest adjusted mean, followed by the medium-SES group, and lastly the low-SES group. Post-hoc pairwise comparisons using identical methods to those described above showed that there were statistically significant differences between the high-SES group and the medium-SES group (p <001), between the high-SES group and the low-SES group (p <.001), and between the medium-SES group and the low-SES group (p <.001). These data therefore indicate that, when controlling for overall IQ, high-SES participants performed better on a test of language development and word knowledge than medium-SES participants, who in turn performed better than low-SES participants.

ANOVA and ANCOVA results for 9- and 10-year-olds. In order to determine whether the groups were matched for IQ, one-way ANOVA was performed on the WASI IQ scores, with group membership being the between-subjects factor. The assumption of normality of the data distribution was upheld for all three IQ measures (i.e., FSIQ, VIQ, and PIQ). The assumption of

University of Cape Town

homogeneity of variances was upheld for all three measures, Levene's test for FSIQ, $F(2, 57) = 1.868$, $p = .164$; VIQ, $F(2, 57) = 2.577$, $p = .085$; and PIQ, $F(2, 57) = 1.813$, $p = .172$.

The subsequent series of one-way ANOVAs showed that there was a statistically significant between-groups effect of group membership in terms of FSIQ, $F(2, 57) = 31.751$, $p < .001$; VIQ, $F(2, 57) = 26.907$, $p < .001$; and PIQ, $F(2, 57) = 12.824$, $p < .001$. These results therefore indicate that the three groups were not successfully matched for IQ and that thus IQ needed to be added to the between-groups analysis as a covariate.

Hence, I conducted a series of one-way ANCOVAs, each featuring (a) SES as independent variable with three levels (high, medium, and low), (b) an individual neuropsychological test score as the dependent variable, and (c) WASI FSIQ as the covariate. Because ANCOVA appears robust to the violation of the assumptions of homogeneity of variance and homogeneity of regression when group sizes are equal (see Hamilton, 1977, and Rheinheimer and Penfield, 2001), cases were removed at random in order to render equal groups ($n = 19$ for each of the three SES groups). With these equal-sized groups in place, the assumptions for ANCOVA were met: there was normal distribution of the data, observations were independent, the covariate was linearly related to the dependent measure (Pearson's correlation coefficient), there was homogeneity of variance (as established by Levene's test), and the regression slopes were homogeneous (see Table 8).

University of Cape Town

Table 8

ANCOVA Assumptions for the Neuropsychological Test Battery (9- and 10-year-olds)

	Pearson's Correlation	Levene's Test		Homogeneity of Regression	
Outcome variable	*R*	*F*	*p*	*F*	*P*
TEA-Ch Sky Search					
Targets	0.204	0.672	.515	1.541	.224
Time per target	0.619	0.489	.616	0.079	.924
Attention score	0.604	0.109	.897	0.202	.818
TEA-Ch Score!	0.249	0.182	.834	0.223	.801
TEA-Ch Creature					
Total correct	0.038	2.677	.078	2.804	.070
Time	0.433	0.929	.401	2.494	.093
TEA-Ch Sky Search DT	0.062	7.993	< .001***	2.774	.072
CMS Numbers					
Forward	0.233	0.995	.376	0.155	.857
Backward	0.386	0.765	.470	0.471	.627
CMS Words					
Learning	0.342	2.195	.121	1.110	.338
Delayed recall	0.248	2.334	.107	3.778	.030*
Delayed recognition	0.281	2.042	.140	1.847	.168
CMS Stories					
Immediate recall	0.437	0.372	.691	2.075	.136
Delayed recall	0.441	0.034	.967	1.372	.263
Delayed recognition	0.207	4.160	.021	1.685	.196
CMS Dot Locations					
Learning	0.260	3.927	030*	0.722	.491
Total	0.257	4.187	.020*	0.716	.494
Delayed recall	0.343	1.067	.351	2.170	.125
RCF					
Immediate recall	0.318	0.301	.742	0.320	.728
Delayed recall	0.265	0.211	.810	0.048	.953
NEPSY-II					
Clocks	0.444	0.034	.967	0.256	.775
Design Fluency	0.273	0.200	.819	0.347	.709
Inhibition – Naming					
Completion time	0.449	0.192	.826	1.442	.246
Combined	0.356	1.158	.322	0.436	.649

University of Cape Town

Outcome variable	Pearson's Correlation	Levene's Test		Homogeneity of Regression	
	R	*F*	*p*	*F*	*P*
Inhibition – Inhibition					
Completion time	0.473	1.526	.227	0.534	.598
Combined	0.476	4.397	.017*	1.268	.290
Inhibition – Switching					
Completion time	0.502	2.939	.062	0.354	.704
Combined	0.696	2.075	.136	1.256	.293
Inhibition total errors	0.717	5.571	.006**	1.349	.269
WASI					
Vocabulary	0.853	2.390	.101	0.931	.401
Similarities	0.816	0.059	.943	1.007	.373
Block Design	0.768	11.11	<.001***	0.950	.394
Matrix Reasoning	0.658	0.285	.753	2.472	.094

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001.

University of Cape Town

As Table 9 shows, six of the series of ANCOVAs revealed statistically significant between-group differences. The seven dependent variables in question were: CMS Dot Locations Delayed Recall, CMS Stories Delayed Recognition, CMS Numbers Forward, NEPSY-II Design Fluency, TEA-Ch Creature Counting total correct, and RCF Immediate Recall. Details for post-hoc analyses for data from each of these variables are presented below.

Table 9

ANCOVA Results for the Neuropsychological Test Battery (9- and 10-year-olds)

	ANCOVA			Adjusted Means		
Outcome Variable	*F*(2, 47)	*p*	Adjusted R²	High-SES	Medium-SES	Low-SES
TEA-Ch Sky Search						
Targets	0.281	.756	0.002	10.66	11.11	10.60
Time per target	1.652	.201	0.386	7.34	5.96	5.91
Attention score	1.105	.339	0.355	7.62	6.43	7.00
TEA-Ch Score!	0.446	.643	0.025	10.04	8.92	9.36
TEA-Ch Creature Counting						
Total correct	8.943	<.001***	0.211	12.26	9.66	11.61
Time	3.131	.052	0.232	8.71	6.52	5.93
TEA-Ch Sky Search DT	0.297	.745	0.041	8.44	7.36	8.16
CMS Numbers						
Forward	3.327	.044	0.112	11.05	8.91	10.36
Backward	3.116	.053	0.195	12.17	10.39	8.76
CMS Words						
Learning	0.369	.693	0.080	11.25	10.56	10.78
Delayed recall	0.313	.733	0.020	11.07	11.69	11.13
Delayed recognition	1.027	.365	0.063	10.26	10.54	8.89
CMS Stories						
Immediate recall	1.322	.275	0.186	10.45	9.04	8.51
Delayed recall	0.315	.732	0.159	10.06	9.70	9.08
Delayed recognition	8.114	<.001***	0.226	11.92	8.22	7.39
CMS Dot Locations						
Learning	1.123	.333	0.055	11.95	11.32	9.63
Total	1.401	.255	0.063	12.28	11.66	9.96
Delayed recall	3.736	.030	0.183	12.56	11.52	9.34
RCF						
Immediate recall	3.241	.047*	0.153	12.48	17.40	16.25
Delayed recall	2.885	.065	0.114	12.55	17.47	16.96
NEPSY-II						
Clocks	0.271	.764	0.160	12.84	12.93	11.91
Design Fluency	3.396	.041*	0.133	10.36	9.40	7.55
Inhibition – Naming						
Completion time	2.273	.113	0.223	10.52	8.87	10.34
Combined	0.405	.669	0.091	9.65	8.64	8.88
Inhibition - Inhibition						
Completion time	0.988	.379	0.209	10.41	9.54	10.69
Combined	1.321	.276	0.222	10.40	8.75	8.78
Inhibition – Switching						

University of Cape Town

Outcome Variable	ANCOVA $F(2, 47)$	p	Adjusted R^2	Adjusted Means High-SES	Medium-SES	Low-SES
Completion time	2.901	.064	0.288	11.14	9.29	9.47
Combined	1.800	.175	0.490	9.59	8.51	7.48
Inhibition total errors	2.851	.067	0.536	9.37	8.33	6.56
WASI						
Vocabulary	1.043	.359	0.722	9.38	9.69	8.77
Similarities	2.502	.092	0.677	11.74	10.97	10.30
Block Design	0.520	.597	0.575	9.81	9.95	9.13
Matrix Reasoning	2.803	.070	0.458	8.58	8.81	10.66

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001.

University of Cape Town

CMS Dot Locations Delayed Recall. SES group membership accounted for 6% of the variance on this outcome variable when IQ was controlled for. The adjusted means were calculated after controlling for IQ Indicating that the high-SES group had the largest adjusted mean, followed by the medium-SES group, and lastly the low-SES group. Post-hoc analysis (Tukey's HSD) indicated that with Bonferroni corrected α level (p =.017), the high-SES group performed significantly better than the low-SES group (p <.001). The difference between the low- and medium-SES groups was also statistically significant at the conventional level but not at the Bonferroni-corrected level (p =.031). In other words, when IQ was controlled for, participants in the low-SES group had more difficulty retaining and recalling simple visually presented information after a 30-min delay than did participants in both the high- and medium-SES groups, although this relative difficulty was only statistically significant when compared to the high-SES group.

CMS Stories Delayed Recognition. SES group membership accounted for 2% of the variance in performance after IQ was controlled for. The adjusted means for delayed recognition were calculated across the groups after controlling for IQ, indicating that the high-SES group performed the best with the highest adjusted mean, the medium-SES group performing poorer and the low-SES showing the poorest performance. Post-hoc pairwise comparisons using identical methods to those described above indicated that the high-SES group performed significantly better than the medium-SES group (p =.002), as well as the low-SES group (p >.001). Therefore, without IQ effect, the high-SES group displayed a significantly better ability

to encode an overload of verbally presented information and recognise correct details from incorrect details after a 30 minute delay.

CMS Numbers Forward. SES group membership accounted for 7% of the variance in performance on this outcome variable when IQ was controlled for. The mean score adjusted for IQ differences were calculated across the three SES groups and indicated that the high-SES group had the largest adjusted mean, followed by the low-SES group, and lastly the medium-SES group.. Post-hoc pairwise comparisons using identical methods to those described above showed that there were statistically significant differences between the high- and medium-SES groups (p =.016). The significant difference therefore indicates that, with IQ effect removed, the high-SES group's ability for short term sequential recall of digits, presented in an auditory-verbal manner, was significantly better than that of the medium-SES group; implicating better simple attention and concentration ability in the high-SES group.

NEPSY Design Fluency. SES group membership accounted for 2% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means were calculated and after adjusting for IQ, the high-SES group had the largest adjusted mean, followed by the medium-SES group, and lastly the low-SES group. Post-hoc pairwise comparisons using identical methods to those described above indicated a significant difference between the high-SES and low-SES groups (p =.004). These data therefore indicate that the high-SES group performed significantly better than did the low-SES group in a task of mental flexibility and generativity when IQ was controlled for.

TEA-Ch Creature Counting Total Correct. SES group membership accounted for 4% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means were calculated for the three groups after IQ was controlled for and indicated that the high-SES group had the largest adjusted mean, followed by the low-SES group, and lastly the medium-SES group. Post-hoc pairwise comparisons using identical methods to those described above indicated that the high-SES group performed significantly better than the medium-SES group (p >.001), and similarly did the low-SES group outperform the medium-SES group (p =.015). In other words, of the three groups the medium-SES group had the most difficulty reaching the correct total in a test of maintaining attention and switching appropriately as indicated when IQ effect was removed.

University of Cape Town

RCF Immediate Recall. SES group membership accounted for 7% of the variance in performance on this outcome variable when IQ was controlled for. The adjusted means were calculated for the three SES groups after controlling for IQ, indicating that the medium-SES group had the largest adjusted mean, followed by the low-SES group, and lastly the high-SES group. Post-hoc pairwise comparisons using identical methods to those above showed that the medium-SES performed significantly better than the high-SES group (p =.047), however not with the Bonferroni adjusted α level (p =.017). These results show that, without IQ effect, the medium-SES group performed better on immediate recall of complex figural information than the high-SES group, albeit not significantly so.

University of Cape Town

Objective 2

My second objective was to investigate whether SES group membership impacted more on attention, memory, and executive function performance of the children than did IQ, level of formal education, age, sex, and race. In order to achieve this objective, I conducted a set of hierarchical regression analyses on the data from all participants, separated into two age bands (7- and 8-year-olds and 9- and 10-year-olds), for the entire test battery. As discussed earlier, neuropsychological performance increases with age – rapidly improving at certain ages and more gradual increases at others. I kept the age-band separation for these analyses to determine whether SES has a different effect on neuropsychological performance at different stages of development.

Multiple regression analyses of 7- and 8-year-old data.

Descriptive statistics for domain scores. The mean domain scores presented in Table 5 (in the Methods section) show that, for the majority of the cognitive domains that were assessed, participants in the low-SES group performed more poorly than those in the medium-SES group, who in turn performed more poorly than those in the high-SES group. The only domain where this pattern was broken was Inhibition, where participants in the low-SES group performed better than those in the medium-SES group.

Regression results.

As shown in Table 10, the overall regression models – that is, the models including all of the variables IQ, grade, sex, race and SES group membership – were statistically significantly good fits for the data from the following domains: Attention, Concentration and Working

Memory; Verbal Story Memory; Planning, Organization and Abstract Reasoning; Generativity; Inhibition; Switching; and Expressive Language. Despite the fact that the overall regression models for 7 of the 9 domains were statistically significantly good fits for the data, the regression analyses indicated that, after taking into account the contributions of IQ, grade, sex, and race, SES group membership was not statistically significantly associated with performance on any of the neuropsychological domains.

The domains of Visual Memory and Verbal List Memory were the only domains with statistically non-significant models, i.e. where the overall combination of variables did not significantly predict performance.

Because SES group membership was not a statistically significant predictor over and above IQ, grade, sex, and race, no post-hoc regression models were conducted on the individual test outcome measures within a domain for the 7- and 8-year-olds.

University of Cape Town

Table 10

Neuropsychological Test Performance by Domain: Primary Regression Results for 7- and 8-year-olds

	Attention, Concentration and Working Memory	Visual Memory	Verbal Story Memory	Verbal List Memory	Planning, Organization and Abstract Reasoning	Generativity	Inhibition	Switching	Expressive Language
β: Medium SES vs. High SES	0.458	0.072	-0.294	0.280	-0.084	1.031	0.028	0.247	0.053
β: Medium SES vs. Low SES	-0.093	-0.104	-0.403	-0.091	-0.015	-0.279	0.396	0.159	-0.188
Model $F(6, 49)$	9.95	2.272	4.867	2.263	95.85	4.773	4.817	15.342	15.24
Model p-level	< .001***	.052	< .001***	.053	< .001***	< .001***	< .001***	< .001***	< .001***
Step 1 R^2	0.468	0.174	0.209	0.165	0.913	0.273	0.267	0.530	0.580
Step 2 R^2	0.500	0.177	0.288	0.165	0.918	0.280	0.277	0.578	0.581
Step 2 ΔR^2	0.032	0.002	0.079	0.000	0.005	0.008	0.011	0.048	0.001
Step 3 R^2	0.500	0.198	0.288	0.183	0.918	0.302	0.339	0.609	0.633
Step 3 ΔR^2	0.000	0.022	0.000	0.018	0.000	0.022	0.062	0.003	0.051
Step 4 R^2	0.500	0.213	0.339	0.186	0.921	0.304	0.340	0.642	0.642
Step 4 ΔR^2	0.000	0.014	0.051	0.003	0.003	0.002	0.000*	0.033	0.009
Step 5 R^2	0.549	0.218	0.373	0.217	0.922	0.369	0.371	0.653	0.651
Step 5 ΔR^2	0.048	0.005	0.034	0.031	0.001	0.065	0.031	0.010	0.009

Note. Δ = change. Predictor variable entered at Step 1 = FSIQ; Step 2 = grade; Step 3 = sex; Step 4 = race; Step 5 = SES (medium SES vs. low SES and medium SES vs. high SES).

*p <.05. **p <.01. ***p <.001.

University of Cape Town

Multiple regression analyses of 9- and 10-year-old data.

Descriptive statistics for domain scores. The mean domain scores presented in Table 5 (in the Methods section) show that, for the most part, participants in the low-SES group performed more poorly than those in the medium-SES group, who in turn performed more poorly than those in the high-SES group. This pattern held for all but two domains: Visual Memory and Planning, Organization and Abstract Reasoning, where participants in the medium-SES group performed slightly better than those in the high-SES group.

Regression results. As shown in Table 11, the overall regression models – that is, the models including all of the variables IQ, grade, sex, race, and SES group membership – were statistically significantly good fits for the data from the following domains: Attention, Concentration and Working Memory; Visual Memory; Verbal Story Memory; Planning, Organization and Abstract Reasoning; Generativity; Inhibition; Switching; and Expressive Language. The only model that was statistically non-significant here was that for Verbal List Memory.

Despite the fact that the overall regression models for 8 of the 9 domains were statistically significantly good fits for the data, the regression analyses indicated that, after taking into account the contributions of IQ, grade, sex and race, SES group membership was statistically significantly associated with performance on only one of the neuropsychological domains: Attention, Concentration and Working Memory, where medium-SES vs. high-SES $\beta =$ 0.700, $p =.014$

University of Cape Town

Table 11

Neuropsychological Test Performance by Domain: Primary Regression Results for 9- and 10-year-olds

	Attention, Concentration and Working Memory	Visual Memory	Verbal Story Memory	Verbal List Memory	Planning, Organization and Abstract Reasoning	Generativity	Inhibition	Switching	Expressive Language
β: Medium SES vs. High SES	0.784	-0.818	0.679	0.237	0.358	0.926	-0.160	0.279	0.438
β: Medium SES vs. Low SES	0.168	-0.502	-0.240	-0.150	0.057	-0.498	0.113	0.029	0.147
Model $F(6, 53)$	8.403	2.493	3.312	1.584	61.721	2.591	5.755	14.134	10.476
Model *p*-level	< .001***	.034*	.008**	.170	< .001***	.028*	< .001***	< .001***	< .001***
Step 1 R^2	0.353	0.131	0.170	0.107	0.859	0.110	0.317	0.451	0.497
Step 2 R^2	0.383	0.144	0.172	0.120	0.867	0.111	0.317	0.472	0.512
Step 2 ΔR^2	0.030	0.013	0.003	0.013	0.009	0.0009	0.000	0.021	0.015
Step 3 R^2	0.388	0.159	0.194	0.142	0.867	0.111	0.342	0.473	0.518
Step 3 ΔR^2	0.005	0.015	0.021	0.022	0.000	0.000	0.025	0.0008	0.007
Step 4 R^2	0.426	0.159	0.230	0.143	0.867	0.128	0.391	0.611	0.533
Step 4 ΔR^2	0.038	0.0005	0.036	0.0009	0.000	0.017	0.049	0.138	0.014
Step 5 R^2	0.488	0.220	0.273	0.152	0.875	0.227	0.395	0.615	0.543
Step 5 ΔR^2	0.061	0.061	0.043	0.009	0.008	0.100	0.003	0.005	0.010

Note. Δ = change. Predictor variable entered at Step 1 = FSIQ; Step 2 = grade; Step 3 = sex; Step 4 = race; Step 5 = SES (medium SES vs. low SES and medium SES vs. high SES).

**p* <.05. ***p* <.01. ****p* <.001.

University of Cape Town

Post-hoc regression models for individual test outcome measures. As noted above, the domain of Attention, Concentration and Working Memory was the only one in which the primary regression analyses indicated that SES group membership was a statistically significant predictor over and above IQ, grade, sex, and race. Hence, I conducted post-hoc multiple regression analysis on the individual test outcome measures within that domain. The outcome variables that comprised this domain were CMS Numbers Forward, and Numbers Backward, as well as TEA-Ch Sky Search Targets, Sky Search Time per Target, Sky Search Attention Score, Score!, and Sky Search DT.

As shown in Table 12, the overall regression models (i.e., those including all of the predictor variables FSIQ, grade, sex, race, and SES group membership) were statistically significantly good fits for the data in these five of the eight outcome measures in the domain under consideration: CMS Numbers Forward (SES group membership was a significant predictor; this point will be discussed further below); CMS Numbers Backward (no significant individual predictor variable); TEA-Ch Sky Search Time per Target (FSIQ, sex, and medium-SES vs. high-SES group membership were significant predictors); and TEA-Ch Sky Search Attention Score (FSIQ, race, and medium-SES vs. high-SES group membership were significant predictors). The overall models for TEA-Ch Sky Search Targets, TEA-Ch Sky Search DT, and TEA-Ch Score! were not statistically significant, although grade was a significant predictor for the latter model.

In terms of real-world significance it is important and interesting to look at the change in Multiple R^2 at step 5 (SES group membership). Change in multiple R^2 at that step ranged from less 0.005 (the TEA-Ch Sky Search DT model) to 0.115 (the CMS Numbers Forward model); these are relatively small increases that suggest rather small contribution by SES to the variance in performance, that SES is not the main contributing factor to the variability in performance and therefore that the SES contribution in combination with the other predictor variables is more significant than SES group membership alone.

I constructed regression equations in order to predict group membership by neuropsychological test scores using all the predictor variables, i.e. FSIQ score, grade, sex and race: CMS Digits Forward: Group = -2.555 + 0.016 (FSIQ) + 0.383 (grade) – 0.183 (sex) + 0.399 (race) + 0.808 + 1.682; TEA-Ch Time per Target: Group = -3.835 + 0.037 (FSIQ) + 0.265

University of Cape Town

(grade) – 0.444 (sex) + 0.461 (race) + 0.313 (med-SES vs. low-SES) + 1.380; TEA-Ch Attention Score: Group = -4.146 + 0.042 (FSIQ) + 0.227 (grade) – 0.351 (sex) + 0.545 (race) + 0.530 (medium-SES vs. low-SES) + 1.450.

Table 12
Post-hoc Regression Model Results for 9- and 10-year-olds: Individual Outcome Measures in the domain Attention, Concentration and Working Memory

	CMS Numbers		TEA-Ch				
	Forward	Backward	Sky Search Targets	Sky Search Time per Target	Attention Score	Score!	Sky Search DT
β: Medium SES vs. High SES	0.809	0.028	-0.299	0.664	0.697	0.495	-0.105
β: Medium SES vs. Low SES	0.384	-0.228	-0.058	0.149	0.252	0.142	0.062
Model $F(6, 53)$	3.157	3.354	1.241	8.624	7.149	1.890	0.741
Model p-level	.010*	.007**	0.301	< .001***	< .001***	.100	.619
Step 1 R^2	0.061	0.143	0.034	0.364	0.333	0.038	0.009
Step 2 R^2	0.059	0.140	0.049	0.363	0.327	0.081	0.000
Step 2 ΔR^2	0.014	0.011	0.031	0.010	0.006	0.058	0.026
Step 3 R^2	0.049	0.127	0.063	0.395	0.339	0.088	0.009
Step 3 ΔR^2	0.006	0.002	0.029	0.041	0.023	0.022	0.008
Step 4 R^2	0.086	0.193	0.046	0.392	0.329	0.079	0.005
Step 4 ΔR^2	0.051	0.076	0.001	0.008	0.001	0.007	0.030
Step 5 R^2	0.180	0.193	0.024	0.437	0.385	0.083	0.027
Step 5 ΔR^2	0.115	0.028	0.012	0.060	0.073	0.034	0.050

Note. Δ = change. CMS = Children's Memory Scale; TEA-Ch = Test of Everyday Attention for Children. Predictor variable entered at Step 1 = FSIQ; Step 2 = grade; Step 3 = sex; Step 4 = race; Step 5 = SES (medium SES vs. low SES and medium SES vs. high SES).
*p <.05. **p <.01. ***p <.001.

University of Cape Town

As noted above, after controlling for Full Scale IQ and the effects of sex, grade, and race, SES group membership was found to be statistically significantly associated with performance on only the CMS Numbers Forward outcome variable (both the medium-SES vs. high-SES and the medium-SES vs. low-SES comparisons were significant), the TEA-Ch Sky Search Time per Target outcome variable (only the medium-SES vs. high-SES comparison was significant), and the TEA-Ch Sky Search Attention Score outcome variable (again, only the medium-SES vs. high-SES comparison was significant). I explore each of those three models in more detail below.

As Table 13 shows, on CMS Numbers Forward SES group membership was statistically significantly related to increased performance in simple attention and concentration abilities for both the medium-SES vs. low-SES and medium-SES vs. high-SES comparisons. The table also shows that none of the other predictor variables (including FSIQ) in addition to group membership had a significant impact on performance on this test. All the other predictor variables together accounted for 9% of the variability in performance, while group membership alone (i.e., at step 5 where both SES comparisons were entered) accounted for 12% of the variability in performance. The overall regression model for this subtest (including all the independent variables) was statistically significant and explained 18% of the variability in the data, $F(6, 53) = 3.157$, $p = .010$.

University of Cape Town

Table 13
Post-hoc Regression Analysis: CMS Numbers Forward

	β	*t*	*p*
Step 1			
Constant	-2.056	-2.171	.034*
FSIQ	0.021	2.190	.033*
Step 2			
Constant	-2.742	-2.295	.025*
FSIQ	0.019	1.996	.051
Grade	0.208	0.943	.350
Step 3			
Constant	-2.518	-2.010	.049*
FSIQ	0.019	1.963	.055
Grade	0.217	0.976	.333
Sex	-0.159	-0.631	.531
Step 4			
Constant	-1.449	-1.065	.292
FSIQ	0.011	1.022	.311
Grade	0.285	1.291	.202
Sex	-0.123	-0.497	.621
Race	-0.274	-1.821	.074
Step 5			
Constant	-4.536	-2.555	.014*
FSIQ	0.016	1.221	.228
Grade	0.383	1.796	.078
Sex	-0.183	-0.773	.443
Race	0.399	1.291	.202
SES (medium vs. high)	1.682	2.537	.014*
SES (medium vs. low)	0.808	2.164	.035*

*p <.05.

University of Cape Town

As Table 14 shows, on the TEA-Ch Sky Search Time per Target outcome variable SES group membership was statistically significantly related to increased performance, but for only the medium-SES vs. high-SES comparison. The table also shows that, in the final model, FSIQ and Sex also contributed significantly to the variability in performance. SES group membership alone accounted for 6% of the variability in performance on this outcome measure, with the rest of the predictor variables together contributing 39%. The overall regression model for this

outcome variable was statistically significant and explained 44% of the variability in the data, $F(6, 53) = 8.624$, $p < .001$.

Table 14

Post-hoc Regression Analysis: TEA-Ch Sky Search Time per Target

	β	*t*	*p*
Step 1			
Constant	-4.554	-5.845	< .001***
FSIQ	0.046	5.897	< .001***
Step 2			
Constant	-5.118	-5.206	< .001***
FSIQ	0.045	5.645	< .001***
Grade	0.171	0.943	.350
Step 3			
Constant		-4.554	< .001***
FSIQ	0.044	5.721	< .001***
Grade	0.193	1.092	.280
Sex	-0.404	-2.008	.049*
Step 4			
Constant	-4.130	-3.722	< .001***
FSIQ	0.041	4.773	< .001***
Grade	0.220	1.222	.227
Sex	-0.390	-1.928	.059
Race	-0.107	-0.874	.386
Step 5			
Constant	-5.643	-3.835	< .001***
FSIQ	0.037	3.465	< .001***
Grade	0.265	1.499	.140
Sex	-0.444	-2.266	.028*
Race	0.461	1.798	.078
SES (medium vs. high)	1.380	2.511	.015*
SES (medium vs. low)	0.313	1.011	.317

*$p < .05$. **$p < .01$. ***$p < .001$.

As Table 15 shows, on the TEA-Ch Sky Search Attention Score outcome variable SES group membership was statistically significantly related to increased performance, but for only the medium SES vs. high-SES comparison. The table also shows that, in the final model, FSIQ and Race also contributed significantly to the variability in performance. SES group membership

University of Cape Town

also accounted for 7% of the variability in performance on this outcome measure, with the rest of the predictor variables together contributing 39%. The overall regression model for this outcome variable was statistically significant and accounted for 39% of the variability in the data, $F(6, 53) = 7.15$, $p < .001$.

Table 15

Post-hoc Regression Analysis Results: TEA-Ch Sky Search Attention Score

	β	t	p
Step 1			
Constant	-4.362	-5.466	< .001***
FSIQ	0.044	5.515	< .001***
Step 2			
Constant	-4.798	-4.749	< .001***
FSIQ	0.043	5.291	< .001***
Grade	0.132	0.709	.482
Step 3			
Constant	-4.372	-4.188	< .001***
FSIQ	0.043	5.288	< .001***
Grade	0.149	0.804	.425
Sex	-0.303	-1.440	.155
Step 4			
Constant	-4.202	-3.602	< .001***
FSIQ	0.041	4.587	< .001***
Grade	0.160	0.844	.402
Sex	-0.297	-1.397	.168
Race	-0.044	-0.339	.736
Step 5			
Constant	-6.376	-4.146	< .001***
FSIQ	0.042	3.742	< .001***
Grade	0.227	1.230	.224
Sex	-0.351	-1.713	.093
Race	0.545	2.032	.047*
SES (medium vs. high)	1.450	2.524	.015*
SES (medium vs. low)	0.530	1.637	.108

*p <.05. **p <.01. ***p <.001.

University of Cape Town

Objective 3

My third objective was to investigate the performance, this time within each age group (i.e., 7-, 8-, 9-, and 10-year-olds separately), of the South African sample (each of the three SES groups separately) compared to the published normative data for each of the neuropsychological tests used in this study. To achieve this aim, I conducted a series of one-sample *t*-tests. Results for each age group are presented separately.

Normative comparisons for 7-year-olds. The data from the series of one-sample *t*-tests for this group are presented in Table 16. I discuss the results for each battery in separate sections below.

TEA-Ch. The average performance of participants in all three SES groups was poor compared to the published norms on all outcome variables except two: on Creature Counting Total Correct, they all performed better than the standardization sample, and on Score! the high-SES group performed at about the same level as the standardization sample. With regard to outcome variables on which the current sample performed statistically significantly more poorly than the standardization sample, the results were as follows: The high-SES group performed significantly more poorly than the published norms on Sky Search Attention Score, the medium-SES group performed significantly more poorly on all the outcome variables except Sky Search Targets, and the low-SES group performed significantly more poorly on all outcome variables.

CMS. For the most part, the performance of the SES groups in the current sample did not differ significantly from that of the standardization sample. The exceptions were these: The average performance of the high-SES group was statistically significantly better than that of the standardization sample on the Dot Locations Delayed Recall outcome variable. Similarly, the average performance of the medium-SES group was statistically significantly better than the standardization sample on the Dot Locations Delayed Recall outcome variable.

RCF. None of the SES groups performed significantly differently from the published norms on any of the outcome variables derived from this instrument.

NEPSY-II. The average performance of the high-SES group was not statistically significantly different from the published norms on any of the outcome variables here. The average performance of the medium- and low-SES groups was statistically significantly worse than the standardization sample on the following outcome variables: Design Fluency, Inhibition-Naming Completion Time, and Inhibition-Switching Combined. Participants in the medium-SES group also performed significantly more poorly than the standardization sample on the

University of Cape Town

Inhibition-Switching Completion Time outcome variable. Additionally, participants in the low-SES group also performed significantly more poorly than the published norms on the Clocks, Inhibition-Naming Combined, and Inhibition Total Errors outcome variables.

WASI. The high- and medium-SES groups performed statistically significantly better than the standardization sample on the Similarities subtest. The medium-SES group performed statistically significantly more poorly than the standardization sample on the Matrix Reasoning subtest, however, and the low-SES group performed statistically significantly more poorly than the standardization sample on both the Vocabulary and Block Design subtests.

Table 16

Normative Comparisons: Results from one-sample t-tests for 7-year-olds

	Group					
	High SES		Medium SES		Low SES	
Test battery/subtest	*t*	*p*	*t*	*p*	*t*	*p*
TEA-Ch						
Sky Search						
Targets	-0.502	.629	-0.700	.504	-5.656	< .001***
Time per Target	-0.800	.447	-6.781	< .001***	-15.00	< .001***
Attention Score	-3.773	.005*	-5.450	< .001***	-2.478	.042*
Score!	0.000	1.000	-2.521	.033*	-3.157	.016*
Creature Counting						
Total Correct	6.633	< .001***	4.583	.001*	2.221	.062
Time	-1.818	.107	-6.677	< .001***	-8.083	< .001***
Sky Search DT	-2.176	.061	-2.461	.036*	-2.442	.045*
CMS						
Dot Locations						
Learning	1.459	.183	1.435	.185	-0.695	.510
Total	1.897	.094	1.863	.095	-0.310	.766
Delayed Recall	2.887	.020*	3.748	.005**	0.333	.749
Stories						
Immediate Recall	-1.126	.293	1.473	.175	-2.049	.080
Delayed Recall	-0.785	.886	1.258	.240	-0.956	.371
Delayed Recognition	-0.147	.960	0.510	.622	-1.406	.203
Numbers						
Forward	1.886	.096	-1.926	.086	-1.256	.250
Backward	1.136	.289	-1.274	.235	-1.271	.244
Words						
Learning	1.863	.100	0.943	.370	-1.342	.222
Delayed Recall	1.890	.096	1.119	.292	0.828	.435
Delayed Recognition	0.450	.665	-1.948	.083	-1.085	.314
RCF						
Immediate Recall	0.080	.938	0.043	.966	-1.470	.185
Delayed Recall	0.131	.899	0.864	.410	-1.644	.144

University of Cape Town

Test battery/subtest	Group: High SES *t*	*p*	Medium SES *t*	*p*	Low SES *t*	*p*
NEPSY-II						
Clocks	-0.500	.631	-1.354	.209	-7.059	< .001***
Design Fluency	1.057	.321	-2.623	.028*	-5.396	.001**
Inhibition-Naming						
Completion Time	1.604	.148	-3.772	.004**	-3.347	.012*
Combined	0.105	.919	-1.548	.156	-4.237	.004**
Inhibition-Inhibition						
Completion Time	1.739	.120	-1.340	.195	-0.798	.451
Combined	0.000	1.000	-0.974	.356	-4.416	.003**
Inhibition-Switching						
Completion Time	0.532	.609	-4.456	.002**	-1.687	.136
Combined	0.000	1.000	-6.692	< .001***	-6.148	< .001***
Inhibition-Total Errors	0.832	.430	-1.765	.111	-6.624	< .001***
WASI						
Vocabulary	1.933	.089	-0.408	.693	-6.052	< .001***
Block Design	1.871	.098	0.275	.790	-3.638	.008**
Similarities	5.625	< .001***	5.582	< .001***	1.313	.231
Matrix Reasoning	2.089	.070	-2.941	.017*	-1.353	.218

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001.

University of Cape Town

Normative comparisons for 8-year-olds. The data from the series of one-sample *t*-tests for this group are presented in Table 17. I discuss the results for each battery in separate sections below.

TEA-Ch. The average performance of participants in all three SES groups was poor compared to the published norms on all outcome variables except two: on Creature Counting Total Correct, they all performed better than the standardization sample, and on Sky Search Targets the high- and low-SES groups performed better than the standardization sample. With regard to outcome variables on which the current sample performed statistically significantly more poorly than the standardization sample, the results were as follows: Both the medium- and low-SES groups performed statistically significantly more poorly than the published norms on Sky Search Time per Target, Sky Search Attention Score, and Creature Counting Time. The medium-SES also performed significantly more poorly on Sky Search DT.

CMS. For the most part, the performance of the SES groups in the current sample did not differ significantly from that of the standardization sample. The exceptions were these: The average performance of the high-SES group was statistically significantly better than that of the

standardization sample on the Dot Locations Learning, Total, and Delayed Recall outcome variables, as well as Stories Immediate Recall and Delayed Recall outcome variables. The average performance of the low-SES group was statistically significantly worse than the standardization sample on the Numbers Forward and Backward, and Words Learning outcome variables.

RCF. None of the SES groups performed significantly differently from the published norms on any of the outcome variables derived from this instrument.

NEPSY-II. For the most part, the performance of the SES groups in the current sample did not differ significantly from that of the standardization sample. The exceptions were these: The average performance of the high-SES group was statistically significantly worse than that of the standardization sample on Inhibition-Naming Completion Time. The average performance of the medium- and low-SES groups was statistically significantly worse than the standardization sample on the following outcome variables: Design Fluency, Inhibition-Switching Completion Time and Inhibition-Switching Combined. Participants in the medium-SES group also performed significantly more poorly than the standardization sample on the Inhibition-Naming Completion Time and Inhibition-Inhibition Completion Time outcome variables. Additionally, participants in the low-SES group also performed significantly more poorly than the published norms on the Inhibition-Naming Combined outcome variable.

WASI. The high- and medium-SES groups performed statistically significantly better than the standardization sample on the Similarities subtest. The high-SES group also performed significantly better than the standardization sample on both the Vocabulary and Block Design subtests. The low-SES group performed statistically significantly more poorly than the standardization sample on both the Vocabulary and Block Designs subtests.

University of Cape Town

Table 17
Normative Comparisons: Results from one-sample t-tests for 8-year-olds

	Group					
	High SES		Medium SES		Low SES	
Test battery/subtest	*t*	*p*	*t*	*p*	*t*	*p*
TEA-Ch						
Sky Search						
Targets	2.097	.066	-1.548	.156	0.743	.479
Time per Target	-1.435	.185	-4.411	.002**	-8.227	<.001***
Attention Score	-1.555	.154	-3.555	.005**	-3.786	.005**
Score!	-1.714	.121	-1.289	0.230	-1.890	.010
Creature Counting						
Total Correct	3.873	.004**	6.000	<.001***	1.118	.296

Test battery/subtest	High SES		Medium SES		Low SES	
	t	*p*	*t*	*p*	*t*	*p*
Time	-0.190	.853	-4.342	.002**	-6.652	<.001***
Sky Search DT	-1.884	.092	-7.071	<.001***	-2.254	.054
CMS						
Dot Locations						
Learning	3.713	.005**	-0.802	.443	0.486	.640
Total	4.863	<.001***	0.076	.941	1.089	.308
Delayed Recall	9.000	<.001***	1.445	.183	1.360	.211
Stories						
Immediate Recall	2.918	.002**	1.879	.093	-0.316	.760
Delayed Recall	3.259	.009**	2.077	.068	1.315	.225
Delayed Recognition	2.029	.073	-0.712	.495	-1.125	.293
Numbers						
Forward	1.175	.270	-0.455	.660	-2.985	.017*
Backward	1.113	.295	-1.263	.242	-3.131	.014*
Words						
Learning	0.610	.557	-1.527	.161	-4.061	.004**
Delayed Recall	0.281	.785	-0.802	.443	-0.693	.508
Delayed Recognition	-0.886	.399	-2.097	.066	-2.087	.070
RCF						
Immediate Recall	-0.079	.939	1.230	.250	-0.433	.677
Delayed Recall	-0.600	.563	1.086	.306	-0.428	.680
NEPSY-II						
Clocks	1.201	.261	-1.355	.208	-1.360	.211
Design Fluency	-0.791	.450	-3.231	.010*	-3.550	.008**
Inhibition-Naming						
Completion Time	-2.450	.037*	-4.500	.002**	-2.128	.066
Combined	-2.141	.061	-1.465	.177	-3.194	.013*
Inhibition-Inhibition						
Completion Time	0.919	.382	-3.145	.012*	-0.237	.819
Combined	-1.132	.287	-1.960	.082	-0.625	.550
Inhibition-Switching						
Completion Time	-0.309	.764	-4.394	.002**	-3.119	.014*
Combined	-1.100	.300	-2.429	.038*	-2.309	.049*
Inhibition-Total Errors	-1.520	.163	-1.348	.211	-1.310	.227
WASI						
Vocabulary	2.748	.023*	-2.138	.061	-5.029	.001**
Block Design	2.369	.042*	-0.102	.921	-5.933	<.001***
Similarities	5.449	<.001***	2.714	.024*	0.686	.512
Matrix Reasoning	0.290	.778	-1.760	.112	-1.990	.082

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
**p* <.05. ***p* <.01. ****p* <.001.

University of Cape Town

Normative comparisons for 9-year-olds. The data from the series of one-sample *t*-tests for this group are presented in Table 18. I discuss the results for each battery in separate sections below.

TEA-Ch. The average performance of participants in all three groups was poor compared to the published norms on all outcome variables except one: On Creature Counting Total Correct the high-SES group performed better than the standardized sample. With regard to outcome variables on which the current sample performed statistically significantly more poorly than the standardization sample, the results were as follows: All three the SES groups performed statistically significantly more poorly than the published norms on Sky Search Time per Target, Sky Search Attention Score, and Creature Counting Time. Additionally, the medium-SES group performed significantly more poorly than the standardization sample on Sky Search DT.

CMS. For the most part, the performance of the SES groups in the current sample did not differ significantly from that of the standardization sample. The exceptions were these: The average performance of the high-SES group was statistically significantly better than that of the standardization sample on Dot Locations Total and Delayed Recall, Numbers Backward, and Words Learning, Delayed Recall and Delayed Recognition. Conversely, the average performance of the low-SES group was statistically significantly worse than the standardization sample on the Stories Delayed Recognition outcome variable.

RCF. None of the SES groups performed significantly differently from the published norms on any of the outcome variables derived from this instrument.

NEPSY-II. The average performance of the high-SES group was statistically significantly better than the standardization sample on the following outcome variables: Clocks, Inhibition-Inhibition Combined, Inhibition-Switching Completion Time, and Inhibition Total Errors. The average performance of the medium- and low-SES groups was statistically significantly worse than the standardization sample on the Inhibition Switching Combined outcome variable. Additionally, participants in the low-SES group also performed significantly more poorly than the published norms on the Inhibition Total Errors outcome variable.

WASI. The high-SES group performed statistically significantly better than the standardization sample on both the Vocabulary and Similarities subtests. The low-SES group performed statistically significantly more poorly than the standardization sample on the Vocabulary, Block Design and Matrix Reasoning subtests.

University of Cape Town

Table 18

Normative Comparisons: Results from one-sample t-tests for 9-year-olds

	Group					
	High SES		Medium SES		Low SES	
Test battery/subtest	*t*	*p*	*t*	*p*	*t*	*p*
TEA-Ch						
Sky Search						
Targets	1.427	.184	1.696	.128	-0.793	.448
Time per Target	-4.64	<.001***	-5.896	<.001***	-7.906	<.001***
Attention Score	-3.292	.008**	-5.547	<.001***	-7.584	<.001***
Score!	-0.097	.925	-1.871	.098	-1.897	.090
Creature Counting						
Total Correct	9.250	<.001***	-0.263	.800	1.132	.287
Time	-2.507	.031*	-4.757	.001**	-4.772	.001*
Sky Search DT	-0.913	.383	-2.991	.017*	-1.477	.174
CMS						
Dot Locations						
Learning	1.679	.124	0.495	.634	-0.867	.408
Total	2.429	.036*	0.860	.415	-0.303	.769
Delayed Recall	2.654	.024*	0.520	.617	-1.857	.096
Stories						
Immediate Recall	1.309	.220	-0.300	.772	-1.475	.174
Delayed Recall	1.339	.210	0.187	.856	-1.378	.202
Delayed Recognition	2.125	.060	-1.554	.159	-2.979	.015*
Numbers						
Forward	1.203	.257	-2.135	.065	-0.506	.625
Backward	2.379	.039*	0.649	.535	-0.979	.353
Words						
Learning	2.276	.046*	0.308	.766	0.732	.483
Delayed Recall	2.955	.014*	1.393	.201	1.292	.228
Delayed Recognition	2.858	.017*	1.175	.274	-0.828	.430
RCF						
Immediate Recall	-1.400	.192	1.402	.199	-0.655	.529
Delayed Recall	-1.879	.090	1.368	.209	-0.361	.727
NEPSY-II						
Clocks	4.304	.002**	1.336	.218	0.000	1.000
Design Fluency	0.000	1.000	-0.737	.483	-1.724	.119
Inhibition-Naming						
Completion Time	1.573	.147	-1.279	.237	-0.375	.716
Combined	-0.841	.420	-2.089	.070	-1.935	.085
Inhibition-Inhibition						
Completion Time	1.991	.075	0.184	.859	-0.287	.780
Combined	2.232	.049*	-0.858	.416	-1.871	.098
Inhibition-Switching						
Completion Time	2.677	.023*	-1.886	.096	0.000	1.000
Combined	1.876	.090	-2.441	.041*	-5.785	<.001***
Inhibition-Total Errors	2.971	.014*	-1.720	.124	-5.786	<.001***

University of Cape Town

Test battery/subtest	Group					
	High SES		Medium SES		Low SES	
	t	*p*	*t*	*p*	*t*	*p*
WASI						
Vocabulary	2.557	.029*	0.815	.439	-9.160	<.001***
Block Design	0.856	.410	0.855	.417	-7.606	<.001***
Similarities	7.288	<.001***	1.754	.118	-1.481	.173
Matrix Reasoning	0.451	.661	-1.352	.214	-2.311	.046*

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*****$p < .05$. **$p < .01$. ***$p < .001$.

Normative comparisons for 10-year-olds. The data from the series of one-sample *t*-tests for this group are presented in Table 19. I discuss the results for each battery in separate sections below.

TEA-Ch. With regard to outcome variables on which the current sample performed statistically significantly more poorly than the standardization sample, the results were as follows: The high-SES group performed statistically more poorly on Sky Search DT, and both the medium- and low-SES groups performed significantly more poorly than the published norms on Sky Search Time per Target and Sky Search Attention Score, as well as Creature Counting Time. Conversely, the average performance of the low-SES group was statistically significantly better than that of the standardization sample on the Sky Search Targets and Creature Counting Total Correct outcome variables.

CMS. The average performance of the high-SES group was statistically significantly better than that of the standardization sample on the following outcome variables: Dot Locations Learning, Total and Delayed Recall; Numbers Forward and Backward; and, Words Learning. Similarly, the average performance of the medium-SES group was statistically significantly better than that of the standardization sample on the Dot Locations Learning and Dot Locations Delayed Recall outcome variables. Both the medium- and low-SES groups, however, performed statistically significantly more poorly than the standardization sample on the Stories Delayed Recognition outcome variable. Additionally, the low-SES group also performed significantly more poorly than the published norms on the Stories Immediate Recall and Delayed Recall, and Numbers Backward outcome variables.

RCF. None of the SES groups performed significantly differently from the published norms on any of the outcome variables derived from this instrument.

University of Cape Town

NEPSY-II. The average performance of the high-SES group was statistically significantly better than the standardization sample on the Inhibition-Naming Completion Time and Inhibition-Switching Completion Time outcome variables. The average performance of both the high- and medium-SES groups was statistically significantly better than the standardization sample on the Clocks outcome variable. Conversely, the low-SES group performed statistically significantly more poorly on all outcome variables except Clocks, Inhibition-Naming Completion Time and Inhibition-Naming Combined.

WASI. The high- and medium-SES groups performed statistically significantly better than the standardization sample on the Similarities subtest. The low-SES group performed statistically significantly more poorly than the standardization sample on all four subtests except Matrix Reasoning.

University of Cape Town

Table 19
Normative Comparisons: Results from one-sample t-tests for 10-year-olds

	Group					
	High SES		Medium SES		Low SES	
Test battery/subtest	*t*	*p*	*t*	*p*	*t*	*p*
TEA-Ch						
Sky Search						
Targets	1.857	.096	2.112	.064	2.333	.045*
Time per Target	0.643	.536	-4.070	.003**	-5.697	<.001***
Attention Score	0.782	.454	-3.034	.014*	-4.080	.003**
Score!	0.842	.422	0.256	.804	-0.859	.413
Creature Counting						
Total Correct	1.718	.120	-0.859	.413	4.272	.002**
Time	0.188	.855	-2.871	.018*	-3.992	.003**
Sky Search DT	-3.539	.006**	-1.762	.112	-0.874	.405
CMS						
Dot Locations						
Learning	4.832	<.001***	1.743	.115	0.291	.778
Total	5.173	<.001***	2.400	.040*	0.389	.706
Delayed Recall	5.250	<.001***	3.087	.013*	0.391	.705
Stories						
Immediate Recall	0.318	.758	-1.268	.237	-6.195	<.001***
Delayed Recall	-0.145	.888	-0.387	.708	-3.478	.007**
Delayed Recognition	0.867	.408	-2.967	.016*	-2.641	.027*
Numbers						
Forward	5.218	<.001***	-0.418	.686	0.318	.758
Backward	2.487	.035*	0.227	.825	-3.464	.007**
Words						
Learning	2.764	.022*	1.686	.126	-0.371	.719
Delayed Recall	1.274	.235	2.863	.019*	-0.106	.918
Delayed Recognition	-0.610	.557	0.529	.610	-1.846	.098

Test battery/subtest	Group					
	High SES		Medium SES		Low SES	
	t	*p*	*t*	*p*	*t*	*p*
RCF						
Immediate Recall	0.267	.796	1.355	.209	-0.893	.395
Delayed Recall	0.214	.835	1.522	.162	-1.114	.294
NEPSY-II						
Clocks	3.113	.012*	4.502	.002**	1.060	.317
Design Fluency	1.492	.170	-1.037	.327	-4.869	<.001***
Inhibition-Naming						
Completion Time	2.469	.036*	-0.721	.490	-2.047	.071
Combined	1.327	.217	-0.515	.619	-1.959	.082
Inhibition-Inhibition						
Completion Time	2.172	.058	-0.429	.678	-2.265	.049*
Combined	2.250	.051	-0.657	.528	-2.487	.035*
Inhibition-Switching						
Completion Time	3.822	.004**	0.345	.738	-4.025	.003**
Combined	1.186	.266	0.171	.868	-6.220	<.001***
Inhibition-Total Errors	0.745	.475	-0.470	.649	-5.449	<.001***
WASI						
Vocabulary	0.873	.405	-0.231	.823	-6.398	<.001***
Block Design	1.892	.091	0.200	.846	-5.212	<.001***
Similarities	3.856	.004**	2.848	.019*	-2.785	.021*
Matrix Reasoning	1.029	.331	0.264	.798	-1.481	.173

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence.
*p <.05. **p <.01. ***p <.001.

University of Cape Town

Objective 4

My fourth objective was to compile preliminary normative data for the test battery that I used, stratified by SES group and age. The normative data are presented in Tables 20-22 below, and the logic of stratifying by SES group and age is implied by the data presented above.

Table 20

Normative Data for 7- to 10-year-old Children from a High-SES Background

	High SES			
	7 years (n = 9)	8 years (n = 10)	9 years (n = 11)	10 years (n = 10)
Test battery/subtest	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
TEA-Ch				
Sky Search				
Targets	9.44 (3.32)	11.60 (2.41)	11.00 (2.32)	11.30 (2.21)
Time per Target	8.88 (4.16)	8.90 (2.42)	6.81 (2.27)	10.6 (2.95)
Attention Score	7.55 (1.94)	8.80 (2.44)	7.36(2.65)	10.70 (2.83)
Score!	10.00 (3.53)	8.40 (2.95)	9.90 (3.11)	10.90 (3.38)
Creature Counting				
Total Correct	13.66 (1.65)	13.00 (2.44)	13.36 (1.20)	11.10 (2.02)
Time	8.88 (1.83)	9.90 (1.66)	8.63 (1.80)	10.20 (3.35)
Sky Search DT	6.44 (4.90)	7.70 (3.86)	9.00 (3.63)	8.40 (1.42)
CMS				
Dot Locations				
Learning	11.66 (3.42)	12.20 (1.87)	11.36 (2.69)	12.70 (1.76)
Total	12.00 (3.16)	13.70 (2.41)	11.81 (2.48)	12.70 (1.49)
Delayed Recall	11.66 (1.73)	11.80 (0.63)	11.90 (2.38)	12.80 (1.68)
Stories				
Immediate Recall	9.11 (2.36)	12.90 (3.14)	11.18 (2.99)	10.30 (2.98)
Delayed Recall	9.33 (2.54)	13.90 (3.78)	11.18 (2.92)	9.90 (2.18)
Delayed Recognition	9.88 (2.26)	11.90 (2.96)	12.45 (3.83)	10.90 (3.28)
Numbers				
Forward	11.44 (2.29)	11.10 (2.96)	10.72 (2.00)	12.70 (1.63)
Backward	11.11 (2.93)	10.90 (2.55)	12.36 (3.29)	12.60 (3.30)
Words				
Learning	11.55 (2.50)	10.50 (2.59)	11.54 (2.25)	11.50 (1.71)
Delayed Recall	11.66 (2.64)	10.20 (2.25)	11.81 (2.04)	10.90 (2.23)
Delayed Recognition	10.22 (1.48)	9.10 (3.21)	11.72 (2.00)	9.50 (2.59)
RCF				
Immediate Recall	11.83 (6.80)	11.50 (6.06)	13.36 (4.86)	15.90 (5.73)
Delayed Recall	11.11 (6.86)	9.80 (5.33)	12.86 (4.35)	15.85 (7.63)
NEPSY-II				
Clocks	9.66 (2.00)	11.50 (3.95)	14.00 (3.28)	13.60 (3.65)
Design Fluency	10.88 (2.52)	9.00 (4.00)	10.00 (2.52)	11.10 (2.33)
Inhibition-Naming				
Completion Time	11.00 (1.87)	8.80 (1.54)	11.09 (2.30)	12.30 (2.94)
Combined	10.11 (3.17)	8.20 (2.65)	9.27 (2.86)	11.80 (4.28)
Inhibition-Inhibition				
Completion Time	11.22 (2.10)	10.60 (2.06)	11.45 (2.42)	11.90 (2.76)
Combined	10.00 (3.00)	9.10 (2.51)	11.45 (2.16)	11.80 (2.52)
Inhibition-Switching				
Completion Time	10.44 (2.50)	9.80 (2.04)	11.36 (1.68)	12.50 (2.06)
Combined	10.00 (2.64)	9.20 (2.29)	11.18 (2.08)	11.00 (2.66)
Inhibition-Total Errors	11.00 (3.60)	8.60 (2.91)	11.27 (1.42)	10.50 (2.12)

University of Cape Town

Test battery/subtest	High SES 7 years (*n* = 9) *M (SD)*	8 years (*n* = 10) *M (SD)*	9 years (*n* = 11) *M (SD)*	10 years (*n* = 10) *M (SD)*
WASI				
Vocabulary	11.44 (2.24)	12.50 (2.87)	113.36 (10.84)	10.80 (2.89)
Block Design	12.33 (3.74)	12.60 (3.47)	102.18 (10.84)	12.10 (3.51)
Similarities	12.77 (1.48)	12.70 (1.56)	108.72 (9.75)	12.90 (2.37)
Matrix Reasoning	11.88 (2.71)	10.30 (3.26)	11.72 (2.24)	10.90 (2.76)
VIQ	110.33 (8.84)	114.00 (12.54)	10.81 (3.15)	109.20 (14.32)
PIQ	111.44 (15.05)	109.20 (12.61)	13.27 (1.48)	108.30 (14.74)
FSIQ	112.33 (12.06)	113.00 (13.26)	10.27 (2.00)	109.40 (10.60)

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ. Data presented are scaled sores, except for RCF Immediate Recall and Delayed Recall which are raw scores.

University of Cape Town

Table 21

Normative Data for 7- to 10-year-old Children from a Medium-SES Background

	Medium SES			
	7 years (*n* = 10)	8 years (*n* = 10)	9 years (*n* = 9)	10 years (*n* = 10)
Test battery/subtest	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
TEA-Ch				
Sky Search				
Targets	9.50 (2.27)	8.50 (3.06)	11.11 (1.96)	11.30 (1.94)
Time per Target	5.90 (1.91)	7.10 (2.07)	6.22 (1.92)	6.40 (2.79)
Attention Score	6.60 (1.95)	7.50 (2.22)	6.66 (1.80)	7.00 (3.12)
Score!	7.50 (3.13)	8.20 (4.41)	7.77 (3.56)	10.30 (3.71)
Creature Counting				
Total Correct	11.40 (0.96)	11.60 (0.84)	9.88 (1.26)	9.50 (1.84)
Time	3.80 (2.93)	4.70 (3.86)	6.44 (2.24)	6.90 (3.41)
Sky Search DT	5.40 (5.91)	3.40 (2.95)	6.77 (3.23)	8.00 (3.59)
CMS				
Dot Locations				
Learning	11.10 (2.42)	9.00 (3.94)	10.77 (4.71)	11.90 (3.44)
Total	11.60 (2.71)	10.10 (4.17)	11.22 (4.26)	12.10 (2.76)
Delayed Recall	11.60 (1.34)	10.80 (1.75)	10.55 (3.20)	12.40 (2.45)
Stories				
Immediate Recall	11.30 (2.79)	12.00 (3.36)	9.55 (4.44)	9.00 (2.49)
Delayed Recall	11.30 (3.26)	11.80 (2.74)	10.22 (3.56)	9.70 (2.45)
Delayed Recognition	10.50 (3.10)	9.60 (1.77)	8.55 (2.78)	7.70 (2.45)
Numbers				
Forward	8.30(2.79)	9.50 (3.47)	8.44 (2.18)	9.60 (3.02)
Backward	9.10 (2.23)	8.55 (3.43)	10.77 (3.59)	10.20 (2.78)
Words				
Learning	10.60 (2.01)	8.80 (2.48)	10.22 (2.16)	11.20 (2.25)
Delayed Recall	11.20 (3.39)	9.40 (2.36)	11.33 (2.87)	12.30 (2.54)
Delayed Recognition	8.70 (2.11)	8.40 (2.41)	10.77 (1.98)	10.50 (3.08)
RCF				
Immediate Recall	11.83 (6.80)	14.10 (6.29)	18.27 (6.12)	17.90 (5.79)
Delayed Recall	11.11 (6.86)	13.10 (6.66)	17.33 (4.38)	18.70 (6.99)
NEPSY-II				
Clocks	8.50 (3.50)	8.00 (4.66)	11.66 (3.74)	14.70 (3.30)
Design Fluency	8.70 (1.56)	7.20 (2.74)	9.55 (1.81)	9.20 (2.44)
Inhibition-Naming				
Completion Time	7.20 (2.34)	7.00 (2.10)	9.00 (2.34)	9.40 (2.63)
Combined	8.50 (3.06)	7.90 (4.53)	8.11 (2.71)	9.60 (2.45)
Inhibition-Inhibition				
Completion Time	9.00 (2.26)	7.60 (2.41)	10.22 (3.63)	9.60 (2.95)
Combined	9.10 (2.92)	7.50 (4.03)	8.88 (3.88)	9.20 (3.85)
Inhibition-Switching				
Completion Time	6.60 (2.41)	6.10 (2.80)	8.66 (2.12)	10.30 (2.75)
Combined	7.10 (1.37)	7.20 (3.64)	7.55 (3.00)	10.20 (3.70)
Inhibition-Total Errors	8.80 (2.14)	8.10 (4.45)	8.11 (3.29)	9.40 (4.03)

University of Cape Town

Test battery/subtest	Medium SES			
	7 years (n = 10)	8 years (n = 10)	9 years (n = 9)	10 years (n = 10)
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
WASI				
Vocabulary	9.80 (1.54)	8.40 (2.36)	10.78 (2.86)	9.80 (2.74)
Block Design	10.20 (2.29)	9.90 (3.10)	10.78 (2.72)	10.20 (3.15)
Similarities	11.50 (0.84)	11.80 (2.09)	11.11 (1.90)	11.60 (1.77)
Matrix Reasoning	8.60 (1.50)	8.10 (3.41)	8.55 (3.20)	10.20 (2.39)
VIQ	102.70 (4.47)	100.00 (11.17)	105.33 (12.44)	103.30 (10.23)
PIQ	96.00 (7.25)	94.30 (13.51)	98.22 (11.41)	100.30 (12.33)
FSIQ	99.70 (4.24)	96.50 (12.53)	101.77 (11.72)	102.00 (10.58)

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ. Data presented are scaled sores, except for RCF Immediate Recall and Delayed Recall which are raw scores.

University of Cape Town

Table 22

Normative Data for 7- to 10-year-old Children from a Low-SES Background

	Low SES			
	7 years (n = 8)	8 years (n = 9)	9 years (n = 10)	10 years (n = 10)
Test battery/subtest	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
TEA-Ch				
Sky Search				
Targets	7.62 (1.18)	10.66 (2.69)	9.30 (2.79)	11.40 (1.89)
Time per Target	4.37 (1.06)	4.11 (2.14)	5.00 (2.00)	4.30 (3.16)
Attention Score	6.62 (3.85)	5.44 (3.60)	5.80 (1.75)	5.40 (3.56)
Score!	6.87 (2.79)	7.77 (3.52)	8.00 (3.33)	9.00 (3.68)
Creature Counting				
Total Correct	12.25 (2.86)	11.44 (3.87)	10.90 (2.51)	12.40 (1.77)
Time	3.00 (2.44)	5.11 (2.20)	5.10 (3.24)	5.80 (3.32)
Sky Search DT	4.50 (6.36)	5.44 (6.06)	7.10 (6.20)	8.20 (6.51)
CMS				
Dot Locations				
Learning	9.12 (3.56)	10.55 (3.43)	9.10 (3.28)	10.40 (4.35)
Total	9.62 (3.42)	11.33 (3.67)	9.70 (3.12)	10.50 (4.06)
Delayed Recall	10.25 (2.12)	10.77 (1.71)	8.70 (2.21)	10.40 (3.23)
Stories				
Immediate Recall	8.50 (2.07)	9.77 (2.10)	8.80 (2.57)	6.30 (1.88)
Delayed Recall	9.12 (2.58)	10.88 (2.02)	8.70 (2.98)	7.50 (2.27)
Delayed Recognition	7.75 (4.52)	8.33 (4.44)	7.60 (2.54)	7.90 (2.51)
Numbers				
Forward	8.75 (2.81)	7.66 (2.34)	9.40 (3.74)	10.20 (1.98)
Backward	9.25 (1.66)	7.66 (2.23)	9.00 (3.23)	8.00 (1.82)
Words				
Learning	9.25 (1.58)	7.77 (1.64)	10.60 (2.59)	9.60 (3.40)
Delayed Recall	10.62 (2.13)	9.44 (2.40)	11.20 (2.93)	9.90 (2.99)
Delayed Recognition	8.62 (3.58)	7.22 (3.99)	9.00 (3.82)	8.20 (3.08)
RCF				
Immediate Recall	9.50 (4.14)	10.77 (6.05)	14.00 (6.84)	13.55 (6.61)
Delayed Recall	8.25 (4.40)	9.94 (6.08)	14.55 (6.86)	13.15 (6.19)
NEPSY-II				
Clocks	4.50 (2.20)	8.44 (3.43)	10.00 (3.65)	11.10 (3.28)
Design Fluency	6.12 (2.03)	6.44 (3.00)	8.80 (2.20)	6.50 (2.27)
Inhibition-Naming				
Completion Time	6.00 (3.38)	7.88 (2.97)	9.60 (3.37)	8.30 (2.62)
Combined	5.00 (3.33)	7.11 (2.71)	7.60 (3.92)	7.70 (3.71)
Inhibition-Inhibition				
Completion Time	9.00 (3.54)	9.77 (2.81)	9.80 (2.20)	8.60 (1.95)
Combined	5.87 (3.56)	9.33 (3.20)	7.77 (1.76)	7.40 (3.30)
Inhibition-Switching				
Completion Time	7.87 (3.56)	7.55 (2.35)	10.00 (1.76)	7.00 (2.35)
Combined	5.50 (2.07)	7.44 (3.32)	6.10 (2.13)	5.20 (2.44)
Inhibition-Total Errors	3.62 (2.72)	7.88 (4.83)	4.60 (2.95)	4.60 (3.13)

University of Cape Town

Test battery/subtest	Low SES 7 years (n = 8) *M (SD)*	8 years (n = 9) *M (SD)*	9 years (n = 10) *M (SD)*	10 years (n = 10) *M (SD)*
WASI				
Vocabulary	6.25 (1.75)	6.77 (1.92)	6.60 (1.17)	6.30 (1.82)
Block Design	8.12 (1.45)	7.55 (1.23)	7.00 (1.24)	7.40 (1.57)
Similarities	10.87 (1.88)	10.22 (0.97)	9.30 (1.49)	8.20 (2.04)
Matrix Reasoning	8.62 (2.87)	8.11 (2.84)	7.80 (3.01)	8.60 (2.98)
VIQ	92.50 (7.94)	92.66 (5.61)	89.40 (5.79)	86.1 (8.53)
PIQ	91.25 (9.26)	89.11 (8.72)	85.9 (9.29)	89.20 (8.43)
FSIQ	91.50 (8.89)	89.66 (7.36)	86.4 (6.61)	86.10 (7.40)

Note. TEA-Ch = Test of Everyday Attention for Children; CMS = Children's Memory Scale; RCF = Rey Complex Figure Test; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ. Data presented are scaled sores, except for RCF Immediate Recall and Delayed Recall which are raw scores.

University of Cape Town

DISCUSSION

This study aimed to investigate the relationship between SES and neuropsychological performance in a sample of 7-10-year-old English-speaking South African children resident in the Western Cape. The sample consisted of 116 children from three schools (one high SES, one medium SES, and one low SES). The sample was thus divided into three SES-based groups. These groups were matched for age and years of education, but differed significantly in terms of race distribution: The high-SES group consisted predominantly of white children, the medium-SES group of coloured children, and the low-SES group of coloured and black children.

I compared three specific domains of neuropsychological functioning across the three groups: attention, memory, and executive functioning. The relationship between SES and neuropsychological/cognitive performance has been the subject of lively debate in the South African and international research literature for several decades; this study aimed to make a contribution to that literature by investigating the relationship in a South African setting in a young population, i.e., children between 7and 10 years of age. Furthermore, I aimed to provide preliminary normative data stratified by age and SES for 7- to 10-year-old children in the Western Cape.

To achieve those broad goals, I set out four specific objectives:

- *Objective 1:* To compare, across the domains of attention, memory, and executive functioning, the performance of low-, medium-, and high-SES South African children within two age bands (7- and 8-year-olds and 9- and 10-year-olds);
- *Objective 2:* To investigate whether SES group membership impacted more on attention, memory, and executive function performance of the children than did IQ, level of formal education, age, sex, and race (within the two age bands);
- *Objective 3:* To compare the performance of 7-, 8-, 9-, and 10-year-olds in the current sample within the three SES groups (i.e., low-, medium-, and high-SES children separately) to the performance of the standardization sample of each of the neuropsychological tests used in this study;
- *Objective 4:* To provide preliminary normative data, stratified by age and SES, for 7- to 10-year-old children in the Western Cape.

I discuss the first three objectives now. Objective 4 will be discussed under the heading *Real-World Significance and Practical Applications of Findings*.

University of Cape Town

Objective 1: Between SES-group comparisons of neuropsychological performance

In all the analyses of variance discussed here, IQ was held constant as a covariate because preliminary analyses found that, as expected, it was significantly associated with neuropsychological performance.

For the 7- and 8-year-olds, statistically significant between-group differences were found on tests involving processing speed in addition to response inhibition (NEPSY-II Inhibition-Inhibition Completion Time), cognitive flexibility and switching (NEPSY-II Inhibition-Switching Completion Time), and sustained attention, switching, and processing speed (TEA-Ch Creature Counting time). There were also statistically significant between-group differences on a test of language development and word knowledge (WASI Vocabulary). The latter will be discussed in a later section, while the former three are discussed in turn immediately below.

In terms of the time that it took to complete the response inhibition task, the current sample of low-SES children performed significantly better than the medium-SES children, i.e. the low-SES children completed the task in fewer seconds than their medium-SES counterparts. This surprising result is contrary to *a priori* predictions, and differs from data reported by previous studies: Both Mezzacappa (2004) and Noble et al. (2006) reported that medium-SES children performed better than low-SES children on tasks of response inhibition.

One way to explain the current data is this: The performance of the low-SES group on the task in question (NEPSY-II Inhibition-Inhibition; outcome variable completion time) covered a larger range of scores (age-adjusted scaled scores ranged from 3 to 15) than that of the medium-SES group (scores ranged from 5 to 13; see Table 5). Thus, despite some of the low-SES participants scoring lower on this task, there were three participants who scored at the highest end of the range (which, recall, was 2 points higher than the maximum score achieved by a medium-SES participant). Therefore, these outliers affected the results to such an extent that the difference between the medium- and low-SES groups proved to be significant.

Now, if one looks at the NEPSY-II Inhibition-Inhibition Combined scores, the medium-SES group performed better than the low-SES group in terms of the range of performance and the adjusted means from the ANCOVA analysis. This means that despite them performing more slowly on the task, the medium-SES participants made fewer errors than the low-SES participants. Therefore, although the low-SES participants managed to complete the task significantly faster than the medium-SES participants, they also provided fewer correct answers.

University of Cape Town

Otherwise stated, the low-SES participants may have made a trade-off between speed and accuracy that, in the end, did not serve them well.

With regard to switching, or cognitive flexibility, previous studies have reported that low-SES children have more difficulty than their higher-SES peers in completing such tasks (Lupien et al., 2001). The current results were consistent with that previous literature: I found that participants in the high-SES group outperformed both their medium- and low-SES counterparts, as they managed to complete a set-switching task more quickly.

When the task demands were increased so that sustained attention was added to set-switching, the same pattern of results held. This latter finding is consistent with data reported by Stevens et al. (2009), who found that low-SES children, from as early as the first year, performed more poorly than an age-matched high-SES group on a task that required attentional skills. This poor performance was associated with later difficulties on tasks of attentional control and switching.

For the 9- and 10-year-olds, there were statistically significant between-group differences on tests of delayed recall for simple visual information (CMS Dot Locations Delayed Recall), delayed recognition of complex verbal information (CMS Stories Delayed Recognition), simple attention and concentration (CMS Numbers Forward), non-verbal fluency and generativity (NEPSY-II Design Fluency), and a combination of sustained attention and switching (TEA-Ch Creature Counting Total Correct).

Previous studies (see, e.g., Farah et al., 2006; Hackman & Farah, 2009) have reported that SES has a significant influence on memory performance (specifically on tasks tapping long-term memory and delayed recognition functioning), especially during the first years of school and up until around age 12 years of age. The current results are consistent with those findings: Participants in the high-SES group performed significantly better than those in the low-SES group on a task that measured long-term visual memory for figural information. Also, those in the high-SES group performed significantly better than those in both the medium- and low-SES groups on a task that required encoding of an overload of verbally presented information and then, after a delay period, distinguishing correct details from incorrect details.

Literature suggests a few reasons for high-SES children to outperform their lower-SES peers on tasks of memory. These reasons include the effects of chronic environmental stressors on particular brain regions, in this case the hippocampus, and less sophisticated organization of information for later recall or recognition (Evans, 2004; Jensen & Frederikson, 1973).

University of Cape Town

In terms of range of performance on a task of delayed recall of visual information, participants in both the low- and high-SES groups managed to reach the maximum score. However, in the low-SES group the minimum score was 3 points lower than that within the high-SES group (i.e., there was more variance in performance of the low-SES participants). The low- and medium-SES groups' poor performance on a task of delayed recognition of verbally presented information could be due to the nature of the test itself: The two stories that were presented included details with which many participants were not familiar (e.g., lake, game ranger, clubhouse, woods etc.). The medium- and low-SES participants were able to recognise certain basic details, but only the high-SES participants who could recall exact information and distinguish between correct and incorrect details.

With regard to the domain of attention, 9- and 10-year-old participants in the medium-SES group performed more poorly than those in both the high- and low-SES groups on two tests of attentional abilities. Furthermore, participants in the high-SES group performed significantly better than did those in the medium-SES group on a task of simple attention and concentration (short-term auditory memory for digit sequences). The range of performance of the medium-SES participants was smaller (digit strings ranged from 4 to 7 digits) than that of the high-SES and low-SES groups (digit strings ranged from 4 to 8 digits). Although this difference is, on face value, not very large, very few of the high-SES participants recalled fewer than 5 digits, whereas only a few medium-SES participants were able to recall more than a 5-digit string. These findings are unusual and not entirely consistent with previous studies, which report poorer performances in low-SES children compared to their age-matched peers form high-SES backgrounds on tasks that assess attentional abilities (Farah et al., 2006; Lupien et al., 2001).

Results for tests that required the ability to sustain attention, and to switch responses in a specified manner as fast as possible, resembled results for simple attention and concentration: Again, participants in the medium-SES group performed more poorly than those in the high- and low-SES groups (the high-SES group performed better than the low-SES group but not significantly so). This means that the medium-SES participants had more difficulty sustaining attention and making the appropriate mental switches.

Previous studies (see, e.g., Lipina et al., 2005; Stevens et al., 2009) reported results that are broadly consistent with the one reported above. Those studies suggest that children from lower SES backgrounds present with deficits in attentional control and switching. It is rather unexpected, however, that participants in the medium-SES group performed significantly more

University of Cape Town

poorly than those in both the high- and low-SES groups. In general, the medium-SES participants performed within the average range of performance for this test, whereas more than half of the low-SES participants achieved above average scores on this task. In terms of time to complete the task, the medium-SES participants managed to complete the task in less time than the low-SES participants. There were, however, no statistically significant between-group differences in the time that it took participants to complete this task.

With regard to between-groups differences on executive functioning tasks in the 9- and 10-year-olds, the only statistically significant result was obtained on a task of cognitive flexibility/generativity: Participants in the high-SES group displayed a significantly better ability than those in the low-SES group on a task that required them to generate novel figures or designs spontaneously (but following specified criteria and rules) in a given time. It is surprising, however, that only one measure of executive functioning rendered statistically significant between-group differences, given that SES is well-established as being critically associated with these tasks and that high-SES children consistently outperform their peers from lower-SES backgrounds on such tasks (Bjorklund & Weiss, 1985; Kishiyama et al., 2008; Mezzacappa, 2004; Noble et al., 2005). A possible explanation for this result is provided later at the end of this section.

In summary, it is clear from the results above that SES does not have a uniform influence on neuropsychological performance across domains or across age. I found that, at the ages of 7- and 8-years old, children from high-SES backgrounds outperformed their lower-SES peers on tasks of attentional switching and of attentional switching in combination with sustained attention; these differences were particularly evident when completion time of these tasks was taken as the outcome measure. The three 7- and 8-year-old groups did not differ significantly in terms of completing the tasks as required, but they did differ in terms of how much time it took them to do so adequately and without significant error. These results therefore suggest that, at this age, high-SES children are able to sustain attention and focus on the task at hand while switching between responses better, and provide the correct responses quicker, than middle- and low-SES children.

The same explanation applies for the result I found for the completion time of a task that required response inhibition. However, with regard to this latter task, the current data ran contrary to previous findings showing that medium-SES children performed better than low-SES children (Mezzacappa, 2004; Noble et al., 2005): Here, low-SES children proved to be faster at

University of Cape Town

providing correct responses after having applied the rule of inhibition of the natural response (i.e., in this case saying “up” instead of “down” and vice-versa, and “circle” instead of “square” and vice-versa).

In terms of attention abilities, there were no SES-based differences for the 9- and 10-year-olds for tasks of processing speed, but there were for tasks of simple attention and concentration, as well as sustained attention and switching. High-SES children recalled a longer sequence of digits and therefore showed superior simple attention and concentration when compared to the two lower-SES groups. The three groups did not differ significantly in completion time of a task which required sustained attention and switching, but the medium-SES group appeared to have the most difficulty in sustaining attention and switching responses appropriately and reaching the correct answer in the end. The medium-SES group in this case, therefore, was more easily distracted by the fact that they had to switch at a certain point during the task and they seem to have had difficulty performing the switches correctly in order to proceed with the task and complete it.

The fact that the two age bands rendered such different results in the domain of attention confirms that age and developmental stage play an important role in neuropsychological performance. In terms of sustained attention, older children generally perform better than younger children because they have reached, or are approaching, a plateau of performance which occurs due to functional reorganization in the brain (Betts et al., 2006; Kirk, 1985; Klenberg et al., 2001; Manly et al., 2001). The results I found are consistent with these findings. Attentional switching is believed to be a more complex task which develops over a longer period until adolescence (Davidson et al., 2006). The 7- and 8-year-olds took longer to complete the switching tasks and therefore they appeared to have less difficulty with the task of switching because it took them longer to switch appropriately and provide the correct response. The 9- and 10-year-olds, on the other hand, completed the switching task in a faster time compared to the 7- and 8-year-olds, but their accuracy in providing the correct responses was still relatively poor.

Considering the effect of SES on attentional abilities during childhood, these results are consistent with the literature that suggests that high-SES children outperform their low-SES peers. Low-SES children present with difficulties in selective attention, cognitive control and regulating behaviour as early as the first year of life (Farah et al., 2006; Lipina et al., 2005), with prominent SES-differences during the early childhood years (Lupien et al., 2001). Literature suggests that these compromised attentional abilities in low-SES children have notable effects on

University of Cape Town

the development of other cognitive skills during childhood, including selective attention, switching, and executive attention (Lipina et al., 2005; Mezzacappa, 2004; Stevens et al., 2009). The current results indicate that the high-SES children consistently outperform their lower-SES peers for all ages, suggesting that these differences will remain as the children age.

Results for 9-10-year-old performance on memory tasks were consistent with *a priori* expectations: Participants in the high-SES group performed better than those the medium- and low-SES groups. At the age of 9-10 years, children are expected to have reached a certain level of improved memory ability as they have undergone a transition in memory development that typically occurs at around 8 years of age (Anderson & Lajoie, 1996). The current results, therefore, suggest that SES played a more significant role in memory performance in the 9- and 10-year-olds than it did in the 7- and 8-year-olds.

Jensen and Frederikson (1973) suggest that classification styles that children use in sorting and recalling tasks differ as a function of SES; in other words, rather than a direct influence of SES on recall, the performance on children on recall tasks is moderated by their classification style. The same authors also argued that parental education level plays a role in the classification styles of children, with low-SES children being less familiar with the adult-defined taxonomic categories that are typically found in higher-SES homes as a result of higher levels of parental education. Therefore, the current results suggest that as children grow older and memory tasks become more complex (in this case from 9 years of age and older), SES-related differences are more pronounced because high-SES children are more efficient in classification of information in order to recall it later on, possibly as a result of exposure to such strategies from their highly-educated parents.

The single significant result for one of the executive functioning outcome variables suggests that that particular task (design fluency) is sensitive to SES influence. Studies of the development of executive functioning report that design fluency is one of the skills that develops early on (i.e., before the age of 8 years), with more gradual increases up to the age of 11 years (Romine & Reynolds, 2005). Therefore, in terms of age and developmental stage, no significant effect was expected for the 9- and 10-year-olds on a design fluency task. The fact that there was indeed a significant result on this task, after IQ was controlled for, suggests that SES was the significant contributor to variance in performance.

In terms of executive functioning in general, it is known to be one of the cognitive domains with a prolonged developmental trajectory; from childhood until early adulthood

University of Cape Town

(Anderson, V. A., Anderson, P., et al, 2001; Fuster, 2002; Korkman et al., 2001; Romine & Reynolds, 2005; Welsh et al., 1991). It is exactly this extended period of development of this domain that creates the opportunity for environmental factors (e.g. SES, home and school environment, parenting styles, other childhood experiences) to play a role in its development and functioning (Hackman & Farah, 2009). From the current results it seems as though the effect of SES on executive functioning becomes more prominent with age; in the case of this study SES was significantly associated with generativity at 9- to 10-years of age, but none other. SES-related differences are thus expected on other factors of executive functioning (i.e. inhibition, switching, planning, organization and abstract reasoning) after the age of 10 years. The differences in performance between high- and lower-SES children are expected to remain, and possibly increase, as a result of the differences between the SES groups in terms of factors such as the availability of educational resources and a learning home environment, as well as quality of education and academic attainment.

Objective 2: Predicting neuropsychological performance using SES group membership alongside other demographic variables

I conducted a series of regression analyses, again separately for the 7- and 8-year-old and 9-and-10-year-old age bands, to explore this objective. Contrary to *a priori* expectations based on previous literature, and in contrast to the ANCOVA results reported above, SES group membership alone was not found to have a significant impact on performance on any of the administered tests for the 7- and 8-year-old group. However, when SES group membership was combined with the other independent variables (viz., FSIQ, grade, sex, and race), the overall regression models were a statistically significant good fit for the data in five of the seven composite domains (Attention, Concentration and Working Memory; Verbal Story Memory; Verbal List Memory; Planning, Organization and Abstract Reasoning; Generativity; Inhibition; Switching; and Expressive Language).

For the 9- and 10-year-old children, the overall regression models for eight of the nine composite domains were significant but on only one of these domains – Attention, Concentration and Working Memory – was SES group membership statistically significantly associated with variations in performance. Post-hoc regression analyses of the dependent variables that comprised that domain revealed that lower SES group membership, together with the other independent variables, was associated with poorer performance on five of the eight outcome

University of Cape Town

scores, but that on only three of these scores was SES group membership alone a significant contributor to variation in performance. The performance of the 9- and 10-year-olds on those three outcome variables is discussed in more detail below.

On a test of simple attention and concentration as measured by short-term auditory memory for digit sequences (CMS Digits Forward), participants in the high-SES group performed better than those in the medium-SES group, who in turn performed better than those in the low-SES group. This result is consistent with previous studies which indicated better performance by high-SES children compared to their lower-SES peers on tasks of attention (Farah et al., 2006; Lipina et al., 2005). The fact that this statistically significant difference exists at a basic attention level is important because deficits in attentional abilities early in childhood have been proven to have significant consequences for the acquisition of other skills such as executive functioning, more complex attentional skills (e.g., selective attention and attentional control/switching), language, and reading (Lipina et al., 2005; Stevens et al., 2009). The implication, therefore, is that lower-SES children are at a disadvantage from early on in their development and, because the SES effect is present at such a basic level of cognition, they are likely to have more difficulty in acquiring certain higher cognitive skills and performing at the same level on tasks tapping those skills as their high-SES peers.

SES group membership also contributed significantly to the variance in performance when 9-10-year-old medium-SES children were compared to their high-SES counterparts on a test of selective and focused attention (and, specifically, on a measure of how much time it took them to identify all of the target items on a page containing both targets and distracters; viz., the TEA-Ch Sky Search Time per Target outcome variable). The pattern of data on this test of selective and focused attention in addition to processing speed and mental tracking suggests that children from higher SES backgrounds were able to focus more completely on the task at hand, to avoid distractions, and to do so in a time-efficient manner.

Similarly, SES group membership contributed to a significant portion of the variance in performance on a task that provided a pure indication of selective/focused attention (the TEA-Ch Sky Search Attention Score). On this subtest, children from a high-SES background had better ability to not only focus their attention on the task at hand despite distracting stimuli, but to do so at a faster pace and more accurately than children from a medium-SES background.

When compared to the results from the ANCOVA analyses, these results are consistent for only one of the subtests, CMS Digits Forward. Group membership contributed the most

University of Cape Town

variance in performance (ANCOVA) and was the only predictor that made a significant contribution to performance (except for FSIQ, which was significant in the first step when it was also the only variable included in the regression model). On the other two subtests (TEA-Ch Sky Search Time per Target and TEA-Ch Sky Search Attention Score), group membership contributed significantly but only in combination with other predictor variables.

In attempting to account for this pattern of data, one has to consider what each of these three outcome variables measures: The two TEA-Ch outcome variables measured selective/focused attention and processing speed in conjunction with selective/focused attention, respectively, whereas the CMS Digits Forward outcome variable measured simple attention and concentration. Tasks of selective attention are more complex than those that require simply repeating strings of digits. SES therefore seems to have a notable, and singular, influence on attention tasks at a basic and simple level; however, it is at more complex levels of attention that factors other than SES also begin to contribute significantly to the variance in performance. In the task of selective/focused attention together with processing speed, FSIQ and sex were both significant predictors and in the task of selective/focused attention alone, FSIQ and race contributed significantly to the model. It is no surprise that FSIQ had a significant impact as this was expected – exactly the reason for doing the ANCOVA analyses in order to remove the FSIQ effect and isolate SES relationship and performance, and why FSIQ was included in the first step of the regression model as it was expected to account for the most variance in the data.

University of Cape Town

Objective 3: Comparisons to published normative data

These analyses were performed separately for each SES group (i.e., low, medium and high SES separately) within each age group (i.e., 7-, 8-, 9-, and 10-year-olds separately); in other words, there were 12 separate analyses here. I will discuss the results for each age group separately, and in the end discuss the overall set of results in terms of how it compares to extant literature and what it means in terms of real-world significance.

7-year-olds. With regard to tests of attention, concentration and working memory, the average performance of all three SES groups was poor compared to that of the normative sample, with the exception of three outcome variables (TEA-Ch Score!, CMS Numbers Forward, and CMS Numbers Backward). In other words, regardless of SES group, the abilities of the current participants on tests of selective, focused, sustained, and sustained-divided attention, as well as on tests of simple attention and concentration and working memory, were poorer than those of

the age-appropriate standardization samples for those tests. Of interest here, however, was that the high-SES group (a) performed better (but not statistically significantly so) than the published norms on a test of simple attention and concentration, as well as a test of working memory, and (b) performed at the expected level on a test that measured sustained attention.

With regard to tests of memory, there were no statistically significant differences in performance between the standardization samples and any of the three SES groups, with the exception of one outcome variable (CMS Dot Locations Delayed Recall). In other words, regardless of SES, the 7-year-olds in this sample showed similar performance to the age-appropriate standardization samples on tests of immediate recall, delayed recall, and delayed recognition of both simple and complex information presented either verbally or visually. With regard to the exception noted above, the high- and medium-SES groups performed significantly better than the standardization sample on a test of delayed recall of simple, visually-presented information.

With regard to tests of executive functioning, the average performance of the high-SES group was better (albeit not statistically significantly better)than that of the standardization sample, but the average performance of both the medium- and low-SES groups was statistically significantly worse than that of the normative sample. In other words, on tasks of inhibition, certain aspects of switching, generativity, and planning, and organization and abstract reasoning, the high-SES group's abilities were comparable to that of the standardization sample, whereas the abilities of the medium- and low-SES groups were significantly poorer than those of the standardization sample. Interestingly, however, the high- and medium-SES groups exhibited significantly better abilities than those of the standardization sample in a task of cognitive flexibility and switching while counting, as well as on a task of verbal categorical reasoning.

In summary, on tests of attention, concentration, and working memory, the average performance of 7-year-old South African children was poorer than 7-year-old children in the standardization sample; this difference was particularly noticeable in the case of the medium- and low-SES children in the current sample. On tests of memory, the average performance of 7-year-old South African children was broadly similar to their age peers in the standardization sample. On tests of executive functioning, high-SES 7-year-old South African children did not perform significantly differently than the 7-year-olds in the standardization samples, but the medium- and low-SES 7-year-old South African children performed significantly more poorly than their age peers in the standardization samples.

University of Cape Town

8-year-olds. With regard to tests of attention, concentration and working memory, the average performance of the three SES groups was poor compared to that of the normative sample. In other words, regardless of SES groups, 8-year-olds in the current sample performed more poorly on tests of selective, focused, sustained, and sustained-divided attention, as well as simple attention, concentration, and working memory, than the age-appropriate standardization samples. Participants in the medium- and low-SES groups, in particular, performed significantly more poorly on two outcome variables involving sustained attention, and those in the low-SES group displayed significantly poorer abilities on tests of simple attention and concentration and working memory.

With regard to tests of memory, there were statistically significant differences in performance between the published norms and the three SES groups on six of the outcome variables (CMS Dot Locations Learning, CMS Dot Locations Total, CMS Delayed Recall, CMS Stories Immediate Recall, CMS Stories Delayed Recall, and CMS Words Learning). The high-SES group performed significantly better than the standardization sample on tests of simple visual recall (including immediate and delayed recall) and complex verbal recall (including immediate and delayed recall, as well as delayed recognition). The low-SES group performed significantly more poorly than the standardization sample on a measure of simple immediate verbal recall. In other words, the high-SES 8-year-olds' abilities for immediate and delayed recall of simple figural information, as well as immediate and delayed recall of an overload of verbally presented information, was better than that of the standardization sample, while these abilities did not differ significantly from the standardization sample for the medium- and low-SES participants. Regardless of SES, the 8-year-olds in this sample showed similar performance to the age-appropriate standardization sample on tests of immediate recall, delayed recall and delayed recognition of simple verbal information, except for the low-SES group which showed significantly poorer immediate recall abilities, as noted above.

With regard to tests of executive functioning, the average performance of all three SES groups did not differ significantly from that of the standardization sample on tests of planning and organization (as measured by clock drawings) and non-verbal analogical reasoning. The average performance of all three SES groups on tasks of inhibition, switching, and generativity was poorer than that of the standardization sample: Participants in the medium- and low-SES groups performed significantly more poorly on a task that required switching between figural stimuli, on a task that assessed switching and cognitive flexibility, and on a task that required

University of Cape Town

generation of unique designs in a given time. Participants in the medium-SES group also completed an inhibition task in a significantly slower time than did the standardization sample. On a block design task of planning, organization and concept formation, participants in the high-SES group performed significantly better than the standardization sample, whereas those in the low-SES group performed significantly more poorly. Interestingly, the high- and medium-SES groups exhibited significantly better abilities than the standardization sample on a task of cognitive flexibility and switching while counting, as well as a task of verbal categorical reasoning.

In summary, on tests of attention, concentration, and working memory, the average performance of the 8-year-old South African children was poorer than that of 8-year-old children in the standardization sample; this difference was particularly noticeable in the case of the medium- and low-SES children in the current sample. On tests of memory, the average performance of the 8-year-old South African children was broadly similar to their age peers in the standardization sample, with the exception of the high-SES children who performed significantly better than the standardization sample on tests of visual memory and verbal memory for more complex information. On tests of executive functioning, the average performance of 8-year-old South African children was poorer than their age peers in the standardization sample; this difference was particularly noticeable in the case of the medium- and low-SES children in the current sample.

9-year-olds. With regard to tests of attention, concentration and working memory, the average performance of participants in all three SES groups was not significantly different from that of the standardization sample, with the exception of three outcome variables. On two tasks of selective and focused attention, participants in all three SES groups performed significantly more poorly than the standardization sample; and, on a task of working memory, participants in the high-SES group performed significantly better than the normative sample. Hence, on measures of simple attention, concentration and working memory, and on tasks of sustained and sustained-divided attention, the performance of 9-year-olds in the current sample, regardless of SES, did not differ significantly from that of the relevant standardization samples.

With regard to tests of memory, there were statistically significant differences in performance between the published norms and the three SES groups on six outcome variables. More specifically, regardless of SES, the 9-year-olds in this sample showed similar performance to the age-appropriate standardization sample on tests of immediate recall, delayed recall, and

University of Cape Town

delayed recognition of simple and complex information presented either verbally of visually. The high-SES group displayed significantly better abilities than that of the standardization sample on tasks of immediate recall after distraction and delayed recall of simple visual information, and on tasks of immediate recall, delayed recall, and delayed recognition of simple verbal information. The low-SES group performed significantly more poorly than the standardization sample on a task of complex verbal delayed recognition.

With regard to tests of executive functioning, the average performance of all three SES groups did not differ significantly from the standardization sample on a task requiring generation of figural designs. All three SES groups, however, performed significantly more poorly than the standardization sample on a measure of completion time of a switching task. The average performance of the high-SES group was significantly better than that of the standardization sample on tasks of planning and organization (as measured by clock drawings), inhibition, switching in a counting task and a task of cognitive flexibility and switching figural information. Participants in the medium- and low-SES groups performed significantly more poorly than the standardization sample on tasks of switching between figural information, however. Participants in the low-SES group also performed significantly more poorly than the standardization sample on a task of non-verbal concept formation, planning and organization, as well as one of non-verbal analogical reasoning.

In summary, on tests of attention, concentration and working memory, the average performance of 9-year-old South African children was poorer than that of their age peers in standardization studies; although the high-SES children performed better than the standardization sample on a few outcome variables, the entire sample's performance in general was significantly poorer across the board. On tests of memory, the average performance of 9-year-old South African children did not differ significantly from that of their age peers in the standardization samples, except for tests of simple visual memory and simple verbal memory, on which participants in the high-SES group performed significantly better than the standardization sample. On tests of executive functioning, the high-SES 9-year-old children performed similarly to, or better than, their age peers from the standardization sample (except for a single outcome variable on which they performed more poorly), the medium-SES 9-year-old children performed more poorly than their age peers in the standardization samples on most of the outcome variables, and the low-SES 9-year-olds generally performed more poorly than their age peers in the standardization sample and significantly more poorly on many of the outcome variables.

University of Cape Town

10-year-olds. With regard to tests of attention, concentration and working memory, the average performance of the high-SES group was better than that of the standardization sample – significantly so on tests of simple attention, concentration and working memory – except for a measure of sustained-divided attention on which their performance was significantly worse than that of the standardization sample. Participants in the medium- and low-SES groups, however, performed significantly more poorly than the standardization sample on tests of selective and focused attention. In other words, the high-SES participants' abilities on tests of selective, focused, and sustained attention, as well as on tests of simple attention and concentration and working memory, were similar to or better than those of their age peers in the standardization sample, whereas these abilities in the medium-and low-SES groups were poorer than those of the age-appropriate standardization samples. Interestingly, however, participants in the low-SES group performed significantly better than the standardization sample on a test of focused attention.

With regard to tests of memory, participants in the high- and medium-SES groups performed significantly better than the standardization sample on a task that required immediate and delayed recall of visual information. On a task of simple verbal recall, participants in the high-SES group performed significantly better than those in the normative sample with regard to immediate recall, whereas those in the medium-SES group performed significantly better than the normative sample with regard to delayed recall. The low-SES group's performance on a task of immediate and delayed recall, as well as delayed recognition of an overload of verbally presented information, was significantly poorer than that of the standardization sample. In other words, the average performance of the high-SES children was similar to or better than that of the standardization sample, the average performance of the medium-SES children was similar to or poorer than that of the standardization sample, and the average performance of the low-SES group was poorer than that of the standardization sample.

With regard to tests of executive functioning, participants in the high- and medium-SES groups performed significantly better than those in the standardization sample on a test of planning and organization (as measured by clock drawings), as well on as a test of verbal categorical reasoning. Participants in the high-SES group also performed significantly better than the standardization sample on a test of cognitive flexibility and switching of figural information. Participants in the low-SES group performed significantly more poorly than the normative sample on tests of switching between figural stimuli, but on a counting task which required

University of Cape Town

switching this group performed significantly better than the standardization sample; the completion time of the task was significantly poorer however (the medium-SES group performed similarly). The low-SES participants' abilities on tasks of generativity and design fluency, inhibition, non-verbal planning and organization, and verbal categorical reasoning were significantly worse than that of the standardization sample. In other words, the average performance of the high-SES group was better than that of their age peers in the standardization sample, the average performance of the medium-SES group was poorer (however not significantly) than that of the standardization sample, and the average performance of the low-SES group was significantly poorer than that of their age peers in the standardization sample on most outcome variables.

In summary, on tests of attention, concentration and working memory, the average performance of 10-year-old high-SES South African children was not significantly different from that of their age peers in the standardization sample; however, the 10-year-old medium- and low-SES children's performance was significantly poorer than that of their age peers in the standardization sample. On tests of memory, the average performance of the 10-year-old high-SES South African children was better than that of 10-year-old children in the standardization sample; in contrast, medium-SES children performed broadly similarly to or more poorly than their age peers in the standardization sample, and low-SES children performed significantly more poorly than their age peers in the standardization samples. On tests of executive functioning, the average performance of 10-year-old high-SES South African children was similar to or better than that of their age peers in the standardization samples, whereas the average performance of 10-year-old medium- and low-SES South African children was poorer than that of their age peers in the standardization samples.

Discussion of overall Objective 3 findings. The general trend of association between SES and performance on the neurocognitive tests, in all four age groups, was consistent with *a priori* expectations based on previous literature: high-SES children outperformed their age-matched peers from lower-SES backgrounds (Bjorklund & Weiss, 1985; Farah et al., 2006; Hackman & Farah, 2009; Kishiyama et al., 2008; Lupien et al., 2001; Mezzacappa, 2004; Noble et al., 2005; Stevens et al., 2009). Of interest in this section, though, is the comparison of the three SES groups to the normative samples of the tests in the battery. Based on previous findings (e.g., Shuttleworth-Edwards, Kemp et al., 2004; Skuy et al., 2001;), I predicted that the high-SES group would perform similarly to or better than the standardization samples, that the medium-

University of Cape Town

SES group would perform similarly or more poorly than the standardization samples, and that the low-SES group would perform significantly more poorly than the standardization samples.

The current results were broadly consistent with these predictions. At 7-, 8-, 9-, and 10 years old, the average performance of the high-SES children was, with only a few exceptions, similar to or better than that of the standardization sample. In those exceptional cases, the high-SES children in this sample tended to perform significantly more poorly than the norms, but still outperformed their South African age-matched peers from medium- and low-SES backgrounds. In contrast, the average performance of participants in both the medium- and low-SES groups was poorer than that of the standardization samples, with the low-SES group performing significantly more poorly than the standardization sample on more outcome variables than the medium-SES group. I will now discuss certain factors that could account for this pattern of findings: SES (contributing and proximal factors), race, and quality of education.

With regard to SES, the current results can be interpreted from at least two perspectives: (a) in terms of the factors that contribute to SES and therefore contributed to the current sample's expected and achieved performance, and (b) the proximal factors related to SES which could have contributed to performance. As is clear from the results throughout this study and as is consistent with the literature, high-SES children outperform their age-matched peers from lower-SES backgrounds on neurocognitive tests. The demographic characteristics of the current sample of high-SES children included parental education of no less than 12 years, parental employment higher than category 6 on the Hollingshead occupational index (Hollingshead, 1975) (i.e., these parents held skilled jobs which required a certain level of tertiary education; they ranged from small business owners to higher executives/major professionals) and annual household income in excess of R100 000. The demographic characteristics of the current sample of medium-SES children included parental education of no less than 8 years, with many having finished their formal schooling (i.e., with 12 years of education) and some having gone on to tertiary education; parental employment ranging from level 5 (skilled manual labour) to level 8 (business managers of medium businesses, lesser professions) on the Hollingshead occupational index; and annual household income ranging from R5 000 to more than R100 000. The demographic characteristics of the current sample of low-SES children included parental education typically in the 8-11 years range; parental employment that ranged from unskilled manual labour to administrative duties, and many more unemployed parents than in the medium- or high-SES groups; and annual household income R25 000 or less in most cases.

University of Cape Town

These demographic factors have all been found to influence cognitive development and performance in children. Parents who have acquired more formal schooling tend to provide a more cognitively stimulating home environment and to have a more verbal and supportive teaching style (Harris et al., 1999). Parental education and employment, as well as the prestige of the parent's job, influence home learning environment and parenting style – parents with high-prestige jobs encourage problem-solving, create an energetic home learning environment, and supply the necessary resources for such an environment (Duncan & Magnuson, 2003; Parcel & Menhagan, 1990). Similarly, high parental income is associated with a higher level of school-readiness, mastery of skills such as colour naming, sorting, counting, letters and names of everyday objects, and successful subsequent course of schooling (Duncan et al., 1998).

The proximal factors related to SES are also likely to have impacted on the current results. SES is associated with home environment, collective SES (or the neighbourhood in which the child grows up), as well as school environment and quality of education. As mentioned above, home environment is closely associated with level of parental education, parental employment, and annual household income. Hence, low-SES children are generally less likely to have exposure to learning resources such as books and computers (Battin-Pearson et al., 2000) and their physical living conditions are likely to be crowded, resulting in fewer exchanges and exchanges of poor quality between parent and child; the allocation of time and attention to each child becomes limited (Bradley et al., 2001).

Naturally, SES does not only exist on a personal level, but also influences macro environmental levels such as communities and neighbourhoods. Community-level SES and neighbourhood of residence is determined by the level of SES of its inhabitants, and in turn, the community or neighbourhood determines the level of environmental hazards, environmental stressors, and exposure to violence (Bradley & Corwyn, 2002; Leventhal & Brooks-Gunn, 2000).

School environment is also associated with SES, in terms of the family's personal SES as well as collective SES, and also impacts on the level and quality of education that the child receives. In terms of quality of education, the average performance of the current sample was also consistent with previous findings suggesting that quality of education influences neuropsychological performance (Cavé & Grieve, 2009; Manly, J. J., et al., 2000; Shuttleworth-Edwards, Kemp et al., 2004). In the current sample, the high-SES participants were selected from a private school which, according to Shuttleworth-Edwards, Kemp et al. (2004), indicates they received a superior quality of education. In contrast, both the medium- and low-SES

University of Cape Town

participants attended schools previously run by the Department of Training and Education (DET), which, again according to Shuttleworth-Edwards, Kemp et al. (2004) indicates they received a relatively poor quality of education.

Quality of education, like SES, is determined by various factors, including physical school quality, accessibility to learning resources, qualification of teachers, and pupil-teacher ratios (Nell, 1999b; Shuttleworth-Edwards, Kemp et al., 2004; Van der Berg, 2009). Naturally, SES plays a role in quality of education as it determines the demographics of the school as well as that of its learners. Shuttleworth-Edwards, Kemp et al. (2004) argue that in neuropsychological assessment, controlling for the effects quality of education leads to automatic grouping of other influential factors such as language and reading ability, material advantage, and parental education, and it is therefore a crucial category for use in clinical settings. Their findings indicate that adults from disadvantaged backgrounds and poor quality of education performed significantly more poorly than the standardization sample of the WAIS-III, whereas their peers with high quality of education performed at a level broadly equivalent to that of the standardization sample and that of their peers from advantaged backgrounds (Shuttleworth-Edwards, Kemp et al., 2004). In their recent study, Cavé and Grieve (2009) selected their sample according to the same criteria as the Shuttleworth-Edwards study, and they found similar results in a sample of high school learners.

University of Cape Town

In terms of current-day use, these selection criteria are somewhat outdated – especially in terms of research on paediatric populations. In adult populations these criteria could still apply because participants would have attended school during the years when schools were categorised in this manner. However, educational policies and classification of schools according to DET and Model C changed with the dismantling of Apartheid more than 15 years ago, and these classifications have therefore lost their relevance with regard to children who attend school at present. The certain and definitive criteria of the past have become problematic as public and independent schools started to resemble one another in recent years: Schools are now recognised as public (state) and independent (private) schools (i.e. the different types of Apartheid schools have been collapsed into only these two categories); both types of schools receive state subsidies and can charge fees (i.e. they are managed on a mixture of public and private funds); both types of schools include rich and poor schools (i.e. independent does not imply high-SES, it refers to the manner in which the school is managed); and, both schools follow the national curricula, but with considerable freedom to choose content and learning processes through the outcomes-based

approach (Hofmeyr, 2000). The main focus of these changes in the educational system was equity and redress in terms of resource allocation and curricula, with the aim of establishing a level of good quality of education across the board (i.e. maintaining that of the former Model C and private schools, and improving that of former DET school).

Therefore, bearing these changes in mind, it seems as though SES is, potentially, a more important factor to consider in cognitive testing than quality of education, as it allows direct measurement of the factors associated with cognitive performance (such as parental education, material advantage etc.), instead of making assumptions about these factors based on the level of quality of education that the child receives. Quality of education, as mentioned before, is associated with SES and it surely is an important factor in cognitive performance, as the current study and previous literature indicate; however, SES provides more information relevant to cognitive performance on a personal and individual level, as well as a collective and community level.

The current results are also consistent with international literature in terms of findings on the association between race and neurocognitive test performance. In the past, and especially in South Africa, race was used to classify people and to make assumptions about their SES and performance on these kinds of tests. In more contemporary times, researchers and clinicians make use of many more variables in order to measure a person's SES, and race is considered as an important factor to bear in mind when conducting a research study or assessing a patient in the clinical setting. Also, race is now interpreted as being a proxy for certain other intrinsic factors that have an effect on cognitive performance (such as attitudes and behaviours), rather than a single factor in itself (Manly, J. J., 2005).

Nonetheless, it is still important to consider race, in and of itself, as a factor because studies in this field and others commonly report on the test score gap between white people and their black counterparts (see, e.g., Magnuson & Duncan, 2006; Manly et al., 2000; Shuttleworth-Edwards, Kemp et al., 2004). In the current study, the racial distribution was not even among the three SES groups: The high-SES group consisted predominantly of white children, the medium-SES group predominantly of coloured children, and the low-SES group of coloured and black children. Therefore, when interpreting the current findings in the light of this racial breakdown, they are consistent with findings from previous literature: (i) White children, at all ages, outperformed their coloured and black peers, and (ii) coloured and black children performed

University of Cape Town

significantly more poorly than the standardization samples (Shuttleworth-Jordan, 1996; Skuy et al., 2001; Zindi, 1994).

What is notable from these race-based results is the direction of performance of the three SES groups over the age range of 7- to 10-years. The average overall performance of the 7- and 8-year-olds was broadly similar, with the high-SES groups outperforming their age peers and generally performing similarly to or better than the standardization samples of the various tests. The results from the 9- and 10-year-olds indicate a broader range of performance: Whereas the high-SES children still perform similar to or better than the standardization sample (although on more outcome variables than in the 7- and 8-year-olds), the low-SES children performed significantly more poorly than the standardization samples on more outcome variables – especially in the 10-year-olds. In other words, in terms of race the white 7- and 8-year-olds outperformed their coloured and black peers, and generally performed similarly to or better than the standardization samples of the various tests. In the 9- and 10-year-old group the white children still performed similar to or better than the standardization sample, while the coloured and black children performed significantly more poorly than the standardization samples; especially in the 10-year-olds.

These results are consistent with Magnuson and Duncan's (2006) review of the black-white test score gap among young children, reporting that on average, black learners begin school with much poorer academic skills, and that this gap seems to grow during school years. The factors of particular interest with regard to this gap include family income, parental schooling and family structures. Considering family income and parental education in the current sample, there were significant between-group differences in favour of the high-SES children – therefore indicating that the white children come from backgrounds which include higher family income and higher levels of parental education compared to that of the coloured and black children. These results therefore suggest that factors associated with cognitive performance, such as these mentioned here, not only differ in terms of SES but also in terms of race, supporting the argument for the consideration of race when interpreting cognitive performance.

Real-World Significance and Practical Applications of Findings

The current study confirmed the general trend described in previously published studies: with few exceptions, higher-SES children generally performed better than lower-SES children on tests of neuropsychological function. One of the aims of this study, apart from investigating the

University of Cape Town

relationship between SES and neuropsychological performance in a South African sample of 7- to 10-year-old children, was to provide preliminary normative data for the test battery that I used.

From the results of this study it is clear that, consistent with previously published local and international research, there is a noticeable and significant relationship between SES and neuropsychological performance in children. As discussed earlier, this relationship (although not equally noticeable across all cognitive domains) appears to become more prominent and present in the cognitive domains of attention, memory, and executive functioning as children grow older. That is to say, in the current study, poor test performance in the domains of attention and executive functioning were significantly associated with lower SES across the age range of 7-10 years; in the domain of memory, however, this association was only statistically significant at age 9-10years. If not addressed, this more prominent SES effect on neuropsychological performance as individuals age can potentially have great consequences.

Because SES is such an integrated and encompassing concept, with influences from and on many different aspects of an individual's life, there are no simple ways of bridging the cognitive performance gap between low- and high-SES children. The focus, therefore, should not be on what cannot be done, but rather on what can be done in order to enable low-SES children to catch up to their higher SES peers in terms of neurocognitive abilities. Also, on a clinical level and in terms of assessment, the use of adequate demographically-sensitive norms will prevent children from low-SES backgrounds being diagnosed as performing on an impaired level where they are, in fact, performing adequately compared to their age- and SES-peers.

Interventions attempting to bridge this SES gap with regard to neurocognitive functioning obviously face numerous challenges; one of these is the fact that there are multiple possible levels at which the intervention might be applied. In terms of macro level factors contributing to SES (i.e.. parental education, parental employment, and yearly household income), extensive and costly intervention is needed to eradicate poverty and to thus ensure that lower-SES individuals are at least provided for in terms of basic needs. It seems unlikely that this goal will be reached soon, however, as poverty and the divide between high- and low-SES are intractable phenomena. Intervention on this level has, however, been found to contribute positively to neurocognitive functioning in children. Fernald, Gertler, and Neufeld (2008) conducted a study investigating the effect of conditional cash transfer (CCT) programmes on child cognitive, language, and motor development. Whereas traditional welfare programmes involved awarding cash benefits to families with a household income that fell below a certain cut-off, or families who lived within a

University of Cape Town

geographically targeted region, CCT programmes involve awarding cash payment only if families comply with a set of certain requirements. The conditional nature of the benefits separates CCT programmes from other cash distribution or welfare programmes. CCT programmes aim to alleviate poverty and have been implemented in developing countries, particularly in Latin America. This particular study was set in Mexico; the CCT programme (Oportunidades) involved low-income families receiving cash payments if they complied with a certain set of requirements which included obtaining preventative medical care, children receiving regular medical check-ups, children attending school a minimum of 85% of the time and not repeating a grade twice. Fernald et al. (2008) found that this additional family income was associated with improvement on several measures of cognitive development (such as long-term and short-term memory language functioning) in low-SES children in the study.

In terms of more proximal factors affecting SES, however, quality of education is an aspect that benefits from intervention. By ensuring that children receive good quality basic education, their chances of continuing and completing their schooling increase (Van der Berg, 2009). Van der Berg (2009) recently reported that South African learners have previously undertaken internationally benchmarked standardized tests measuring their performance in mathematics (TIMMS; Reddy, 2005) and reading literacy (PIRLS; Mullis et al., 2007), and assessing the level of educational quality that they receive (Van der Berg & Louw, 2006). Results from these tests indicated a high variance in performance patterns in the South African population, with learners from historically disadvantaged communities still performing more poorly than learners from wealthier areas, suggesting that the quality of education that these children received corresponded to the socioeconomic level of the area in which they were resident. Therefore, if the quality of education offered to children from historically disadvantaged communities could be improved, their academic and cognitive performance might be closer to the level displayed by children from higher-SES areas.

Improving quality of education is easier said than done, though, as this improvement requires a multitude of resources (e.g., funds to appoint teachers with adequate qualifications, funds to appoint additional teachers in order to decrease the teacher-pupil ratio, improving teacher discipline to ensure that teachers use school hours for teaching, supplying learners with basic school supplies etc). Furthermore, by simply increasing resources without providing teachers with skills, quality of education cannot improve and successful outcomes cannot be guaranteed (Van der Berg, 2009). Improvement of quality of education, therefore, depends on

University of Cape Town

resource allocation along with resource efficiency, which depends on adequate and competent school management and administration (Van der Berg & Burger, 2002). Van der Berg and Burger (2002) also state that improvement of quality of education among low-SES South African populations is likely to be rewarding, especially in the long run, as this plays a role in economic growth and upward mobility of the largest part of the workforce.

At even more micro level, a focus of intervention might be the actual neurocognitive development of the child him/herself. According to Noble et al. (2005), this is a promising approach because specific domains can receive attention as needed. Educational intervention has been shown to have potential to narrow the performance gaps across SES, and long-term effects of early childhood programs have demonstrated that early childhood education produces persistent and cost-effective effects on academic achievement (Barnett, 1998). However, in order to maximise the potential for narrowing the gap in cognitive performance across SES, precision of intervention is critical.

Stevens et al. (2009) suggest that specific deficits should be identified early on in order to start intervention, so that low-SES children can catch up or compensate for what they do not possess inherently or for what they have missed out on due to their level of SES. Interventions that have been implemented have, for example, shown that training in executive control tasks in children with weak performance on such tasks has led to generalised improvement in inhibitory control – so general, in fact, that inhibitory control was evident on non-trained tasks (Dowsett & Livesey, 2000). Another successful intervention also focused on executive function; here, low-SES children's performance improved dramatically on tests of cognitive control after they were trained in thinking out loud, planning pretend games, and completing other activities involving executive functioning (Diamond, Barnett, Thomas, & Munro, 2007).

In the South African setting, however, it is questionable whether such interventions are practical, and more importantly whether they could be practical for the low-SES children who will need to benefit from them. Resources in low-SES schools and communities are limited as it is, and other factors (e.g., ensuring that low-SES children receive at least one cooked meal per day at school, and that children receive basic literacy and numeracy education) are of higher priority and require more immediate attention.

Practical application: Objective 4 - preliminary normative data. The final aim of this study was to provide preliminary norms, stratified by age and SES and specific to English-speaking 7-10-year-old children resident in the Western Cape, for the tests that were used. In

University of Cape Town

terms of practical application, these norms are preliminary and a step in the direction of developing relevant and usable normative data for the entire South African population. These norms will be particularly useful in a clinical- and medico-legal environment where tests similar to those included in the current battery are used to determine neuropsychological deficits as a result of injury or other pathology, as well as for pre- and post-operative testing. Local demographically-sensitive normative data (including variables such as age, IQ, education, and gender) will improve diagnostic accuracy more than using the current model of published norms adjusted according to clinicians' own anecdotal clinical knowledge and experience, which continues to direct practice and research in South Africa.

The reason for stratifying the norms according to SES and not only age level, is implied by the results of this study: Children of the same age, but of different SES, perform significantly differently from one another. In terms of practical application of these norms, such stratification will enable clinicians to compare a child's performance to that of his peers from a similar SES background – which, as discussed previously, more than likely encompasses the quality of education which the child receives – rather than relying on intuition and assumptions when interpreting the quality of the child's performance.

Previous studies have shown that stratification of norms according to age alone, level of education alone, or race alone is problematic. Education has an important influence on cognitive test performance and studies have shown that groups with higher levels of education perform better on neuropsychological tests (Rosselli & Ardila, 2003). Therefore, norms stratified by age alone do not allow for variation in performance as a result of educational level, i.e., children of the same age may differ by two years in terms of formal education ; it would not be unexpected for the child with more years of education to outperform his/her age peers with fewer years of education. Stratification according to level of education alone is as problematic: There may be children of varying ages in the same class (i.e., same number of years of education, differing ages).

Although previous studies have shown that there are racial differences on neuropsychological test performance (Magnuson & Duncan, 2006; Manly et al., 2000; Shuttleworth-Edwards, Kemp et al., 2004), race as a classification is better used as a proxy for factors such as SES, as well as for psychological factors (e.g., behaviour and attitudes during the testing process) and experiences; these elements, and not race *per se*, may, in actual fact, account for the differences in test performance between white and black populations (Manly, J. J., 2005).

University of Cape Town

Furthermore, by controlling for factors such as quality of education, educational level, and language abilities, studies have indicated that race is not homogenous in terms of psychometric test performance (Manly et al., 2000; Shuttleworth-Edwards, Kemp et al., 2004; Skuy et al., 2001). In other words, race as a variable cannot be ignored but its inclusion should be based on its contribution in terms of explaining variability in performance as a result of the factors that it presents, and it should guide further investigations in finding reasons for the variability in performance, rather than simply serving the purpose of classification.

There are various weaknesses to address with regard to these preliminary norms, all of which should be addressed by future studies. Firstly, once the entire sample was divided into the three SES groups and four age groups, the sample sizes in each resultant cell were very small (sizes varied between 8 and 11 participants per cell). Mitrushina et al. (1999) suggest that 50 cases are an adequate sample size, as smaller sample sizes have proved to be highly influenced by individual differences and do not provide a reliable estimate of the population mean. Secondly, although three SES levels were included, the spectrum of SES in South Africa is much wider – including much lower and higher SES levels. Based on the current results, even greater differences in performance can be expected when the entire spectrum of SES is investigated. Thirdly, the current norms are only based on children from three schools in and around Cape Town. Replication of this study in the other provinces would render norms that will be representative of South African children, rather than children from the Western Cape. Fourthly, the age range of the current sample was relatively small, especially compared to the age ranges included in the tests included in the battery (e.g., TEA-Ch: 6-16 years; CMS: 5-16 years; RCF: 6-89 years; NEPSY-II: 7-16 years; WASI: 6-89 years). A broader age range will greatly increase the usefulness of such norms and will encourage practitioners to use these tests in a clinical setting. Fifthly, future studies should attempt to recruit equal numbers of boys and girls in those larger groups so as to enable investigation of possible sex differences in cognitive performance.

Lastly, stratification by additional variables such as years of education, quality of education, sex, and IQ will minimise the need for intuitive adjustment of scores, as clinicians will be able to match their patient to norms based on various relevant factors.

University of Cape Town

Other Findings of Interest

I will briefly mention two interesting findings which were not relevant to the specific aims of the study. Although the domain of language was not a focus of investigation in this

study, the WASI includes two verbal subtests (Vocabulary and Similarities), both of which were included in the statistical analyses, and both of which delivered some interesting data. (For the purposes of this study, the Vocabulary subtest was used as a measure of expressive language, and the Similarities subtest was used as a measure of verbal categorical reasoning.)

First, when IQ was controlled for, there were significant differences in Vocabulary performance across the SES groups within the 7- and 8-year-old group. Not surprisingly, high-SES 7- and 8-year-olds performed better than their medium-SES counterparts, who in turn performed better than the low-SES children in this age group. Furthermore, when the performance of the current sample was compared to their age peers in the standardization sample of the WASI, the low-SES group consistently performed significantly more poorly on Vocabulary over the four age ranges included in this study. And, interestingly, the high-SES 8- and 9-year-old children in the current sample performed significantly better than their age peers in the standardization sample on this test.

A multitude of reasons probably account for this pattern of data; based on previous literature (e.g., Battin-Pearson et al., 2000; Duncan & Magnuson, 2003; Evans, 2004; Harris et al., 1999), it would not be unreasonable to attribute these SES-based differences to home environment (including home language, quality of language spoken in the home, and exposure to educational resources that help develop word knowledge and that encourage language development) and to parental influence (which encompasses parental education, employment, and involvement).

The second interesting finding was that, for the 7- and 8-year-olds in the current sample, all three SES-groups performed better than the standardization sample on the WASI Similarities subtest; the medium- and high-SES groups performed significantly better than the standardization sample. For the 9- and 10-year-olds, however, results looked different. In the 9-year-old group, the high-SES children's performance was significantly better than that of the standardization sample, the medium-SES children's performance did not differ significantly from that of the standardization sample, and the low-SES children's performance was poorer than that of the standardization sample (although not significantly so). In the 10-year-old group, the average performance of high- and medium-SES participants was significantly better than that of the standardization sample, whereas the average performance of low-SES participants was significantly poorer than that of the standardization sample. A possible explanation for these results lies in the relationship between SES, parental influence and executive functioning.

University of Cape Town

SES is known to influence executive functioning, but in terms of categorical reasoning the literature suggests that low-SES children perform more poorly than their high-SES peers not necessarily due to an inability to perform a task on the level of high-SES children, but rather because of different knowledge structures (Bjorklund & Weiss, 1985; Waber et al., 1984). Bjorklund and Weiss (1985) reported that low-SES children make the shift from complementary classification (e.g., the fact that dogs and cats have four legs and a tail) to taxonomic classification (e.g. the fact that dogs and cats are both animals) later than do higher-SES children. In a similar vein, Rosselli and Ardila (2003) argue that one cannot simply assume that children of parents with low levels of education and from low-SES backgrounds are deprived of knowledge and skills, but that it is more a case of having developed different types of learning than children from high-SES parents with high levels of education.

University of Cape Town

Limitations and Directions for Future Research

During the conduct of the current study, a number of limitations emerged; I discussed some of these under *Practical application: Objective 4 - preliminary normative data*, and I discuss another below, and provide some discussion as to how it might be addressed in future studies.

One limitation was that SES could have been more precisely defined. For instance, a more comprehensive demographic questionnaire and asset index (as in Myer et al., 2008) might have provided more precise information with regard to participants' socioeconomic circumstances, and might thus have allowed more stringent criteria and parameters for classification into SES groups. Future studies might also want to conduct personal interviews rather than rely on parents to return forms to the school; this strategy might result in a better response rate, and it would certainly allow for more questions to be raised (by both the researchers and the participants) and for queries to be clarified. If these suggestions were to be followed by future studies, the researchers running those studies will be able to further investigate individual participants whose performance differed from that of their peers: For example, if a low-SES child performs better than the rest of the participants in his group, the researcher will be able to look into his/her background and determine which aspect of SES contributed to this observed performance.

A suggestion for future research is to continue the current research as a longitudinal study in order to detect further SES effects on neuropsychological performance across childhood.

Specifically in terms of executive functioning, longitudinal research would shed light on the influence of SES on this domain due to its prolonged developmental trajectory and development up until late adolescence/early adulthood. Such a longitudinal study will also help resolve the question of whether the magnitude of SES-related performance differences changes with age. Although I did not directly test for this, the current results suggested that the difference in performance between high- and low-SES increased with age (i.e., the average performance of the 10-year-old high- and low-SES children differed much more than did that of the 7-year-old high- and low-SES children) – especially, but not exclusively, in terms of executive functioning. In terms of performance on attention tasks, only the 10-year-old high-SES group's average performance was better than the standardization sample (although not significantly), and it would be interesting to see whether the other SES groups catch up to the high-SES group or whether their performance would stay below that of their high-SES peers and that of the standardization sample.

Additionally, clinical populations such as children with ADHD, TBI, epilepsy, and other neurological or learning difficulties can also be investigated. The tests included in this battery are well known, well standardized, and frequently used internationally, whereas in South Africa we are burdened with outdated and limited locally published tests and norms; hence, a contemporary and established battery of tests with culturally and demographically-sensitive norms would make a valuable contribution to the practice of neuropsychology in South Africa.

University of Cape Town

REFERENCES

Adler, N. E., Boyce, T., Chesney, M. A., Cohen, S., Folkman, S., Kahn, R. L., & Syme, S. L. (1994). Socioeconomic status and health: The challenge of the gradient. *American Psychologist, 49,* 15-24.

Adler, N. E., Marmot, M., McEwen, B. S., & Stewart, J. (1999). *Socioeconomic Status and Health in Industrialized Nations.* New York: New York Academy of Sciences.

Anderson, S. J. (2001). On the importance of collecting local neuropsychological data. *South African Journal of Psychology, 31,* 29-34.

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Catroppa, C. (2001). Development of executive functions through late childhood and adolescence in an Australian sample. *Developmental Neuropsychology, 20,* 385-406.

Anderson, V., & Lajoie, G. (1996). Development of memory and learning skills in school-aged children: a neuropsychological perspective. *Applied Neuropsychology, 3,* 128-139.

Anderson, V., Northam, E., Hendy, J., & Wrennal, J. (2001). *Developmental Neuropsychology – A Clinical Approach.* Hove, England: Psychology Press.

Andrews, G., Halford, G. S., Bunch, K. M., Bowden, D., & Jones, T. (2003). Theory of mind and relational complexity. *Child Development, 74,* 1476-1499.

Ardila, A. (1995). Directions of research in cross-cultural neuropsychology. *Journal of Clinical and Experimental Neuropsychology, 77,* 143-150.

Baddeley, A. (1986). *Working Memory.* Oxford: Oxford University Press.

Baddeley, A. (1990). *Human memory: Theory and practice.* Hove, England: Lawrence Erlbaum Associates, Inc.

University of Cape Town

Barnett, W. S. (1998). Long-term cognitive and academic effects of early childhood education on children in poverty. *Preventative Medicine, 27,* 204-207.

Baron, I. S. (2004). *Neuropsychological evaluation of the child.* New York: Oxford University Press.

Battin-Pearson, S., Newcomb, M. D., Abbott, R. D., Hill, K. G., Catalano, R. F., & Hawkins, J. D. (2000). Predictors of early high school drop-out: a test of five theories. *Journal of Educational Psychology, 92,* 568-582.

Baum, A., Garafalo, J. P., & Yali, A. M. (1999). SES and chronic stress: does stress account for SES effects on health? In N. E. Adler, M. Marmot, B. S. McEwen & J. Stewart (Eds.), *Socioeconomic Status and Health in Industrialized Nations.* New York: New York Academy of Sciences.

Behrman, J. R., & Rosenzweig, M. R. (2002). Does increasing women's schooling raise the schooling of the next generation? *American Economic Review, 92,* 323-334.

Bellgrove, M. A., Domschke, K., Hawi, Z., Kirley, A., Mullins, C., Robertson, I. H., & Gill, M. (2005). The methionine allele of the COMT polymorphism impairs prefrontal cognition in children and adolescents with ADHD. *Experimental Brain Research, 163,* 352-360.

Betts, J., McKay, J., Maruff, P., & Anderson, V. (2006). The development of sustained attention in children: The effect of age and task load. *Child Neuropsychology, 12,* 205-221.

Beyer, S. (1995). Maternal employment and children's academic achievement: Parenting styles as mediating variable. *Developmental Review, 15,* 212-253.

Bjorklund, A., Lindahl, M. & Plug, E. (2006). The origins of intergenerational associations: Lessons from Swedish adoption data. *Quarterly Journal of Economics, 121,* 999-1027.

University of Cape Town

Bjorklund, D. F., & Weiss, S. C. (1985). Influence of socioeconomic status on children's classification and free recall. *Journal of Educational Psychology, 77,* 119-128.

Bowey, J. A. (1995). Socioeconomic status differences in preschool phonological sensitivity and first-grade reading achievement. *Journal of Educational Psychology, 87,* 476-487.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53,* 371-399.

Bradley, R. H., Corwyn, R. F., Burchinal. M., McAdoo, H. P., & Garcia Coll, C. (2001). The home environments of children in the United States. Part 2: relations with behavioural development through age 13. *Child Development, 72,* 1868-1886.

Brainerd, C. J., & Reyna, V. F. (2001). Fuzzy-trace theory: Dual processes in memory, reasoning, and cognitive neuroscience. *Advances in Child Development and Behaviour, 28,* 41-100.

Brickman, A. M., Cabo, R., & Manly, J. J. (2006). Ethical issues in cross-cultural neuropsychology. *Applied Neuropsychology, 13,* 91-100.

Brocki, K., & Bholin, G. (2004). Executive functions in children age 6-13: a dimensional and developmental study. *Developmental Neuropsychology, 26,* 571-593.

Brooks-Gunn, J., Guo, G., & Furstenburg, F. F. (1993). Who drops out and who continues beyond school? A 20-year follow-up of black urban youth. *Journal of Research on Adolescence, 3,* 271-294.

Case, R. (1992). The role of the frontal lobes in the regulation of cognitive development. *Brain and Cognition, 20,* 51-73.

Casey, B. J., Giedd, J. N., & Thomas, K. M. (2000). Structural and functional brain development and its relation to cognitive development. *Biological Psychology, 54,* 241-257.

University of Cape Town

Cattell, R. B. (1940). A culture free intelligence test. Part I. *Journal of Educational Psychology, 31,* 161-179.

Cavé, J., & Grieve, K. W. (2009). *The effect of quality of education on neuropsychological performance.* Unpublished master's thesis, University of South Africa, South Africa.

Claassen, N. C. W., Kraynauw, A. H., Paterson, H., & Mathe, M. W. G. (2001). *A standardization of the WAIS-III for English-speaking South Africans.* Pretoria, South Africa: Human Sciences Research Council.

Cohen, M. J. (1997). *Children's Memory Scale*. San Antonio, TX: The Psychological Corporation.

Cohen, M. J., Ricci, C. A., Kibby, M. Y., & Edmonds, J. E. (2000). Developmental progression of clock face drawing in children. *Child Neuropsychology, 6,* 64-76.

Cohen, R. A. (1969). Conceptual styles, culture conflict, and nonverbal tests. *American Anthropologist, 71,* 828-856.

Comber, L. C., & Keeves, J. P. (1973). *Science education in nineteen countries: International studies in evaluation I.* New York: John Wiley & Sons.

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention and their mutual constraints within the human information processing system. *Psychological Bulletin, 104,* 163-191.

Cowan, N. (1995). *Attention and memory: An integrated framework.* New York: Oxford University Press.

University of Cape Town

Crone, E. A., Ridderinkhof, R. K., Worm, M., Somsen, R. J. M., & Van der Molen, M. W. (2004). Switching between spatial stimulus-response mappings: A developmental study of cognitive flexibility. *Developmental Science, 7,* 443-455.

Crook, C. J. (1995). The role of mothers in the educational and status attainment of Australian men and women. *Australian and New Zealand Journal of Sociology, 31,* 45-73.

Davidson, M. C., Amso, D., Cruess Anderson, L., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition and task switching. *Neuropsycholgia, 44,* 2037-2078.

Davis-Kean, P. (2005). Influence of parent education and family income on child achievement: The indirect role of parent expectations and the home environment. *Journal of Family Psychology, 19,* 294-304.

Della Sala, S., Baddeley, A., Papagno, C., & Spinnler, H. (1995). Dual-task paradigm. A means to examine the central executive. In J. Grafman, K. J. Holyoak, & F. Boller (Eds.), *Structure and functions of the human prefrontal cortex* (Annals of the New York Academy of Sciences, Vol. 769, pp. 161-190). New York: New York Academy of Sciences.

Della Sala, S., Gray, C., Baddeley, A., Allamano, N., & Wilson, L. (1999). Pattern span: a tool for unwelding visuo-spatial memory. *Neuropsychologia, 37,* 1189-1199.

De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J.-A., Proffitt, T. M., Mahony, K., & Pantelis, C. (2003). Normative data from the Cantab. I: Development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology, 25,* 242-254.

Demsky, Y., Carone, D. A. J., Burns, W. J., & Sellers, A. (2000). Assessment of visual-motor coordination in 6- to 11-year-olds. *Perceptual and Motor Skills, 91,* 311-321.

Diamond, A. (1995). Evidence of robust recognition early in life even when assessed by reaching behaviour. *Journal of Experimental Child Psychology, 59,* 419-456.

University of Cape Town

Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science, 318,* 1387-1388.

Diamond, A., Kirkham, N. Z., & Amso, D. (2002). Conditions under which young children CAN hold two rules in mind and inhibit a prepotent response. *Developmental Psychology, 38,* 352-362.

Dilworth, J. E., Greenberg, M. T., & Kusché, C. (2004). Early neuropsychological correlates of later clock drawing and clock copying abilities among school aged children. *Child Neuropsychology, 10,* 24-35.

Dowsett, S. M., & Livesey, D. J. (2000). The development of inhibitory control in preschool children: the 'executive skills training'. *Developmental Psychobiology, 36,* 161-174.

Duncan, G., & Magnuson, K. A. (2003). Off with hollingshead: socioeconomic resources, parenting and child development. In M. H. Bornstein & R. H. Bradley (Eds.), *Socioeconomic status, parenting, and child development* (pp. 83-106). Mahwah, NJ: Lawrence Erlbaum.

Duncan, G. J., Yeung, W. J., Brooks-Gunn, J., & Smith, J. R. (1998). How much does childhood poverty affect the life chances of children? *American Sociological Review, 63,* 406-423.

Edelman, G. M. (1987). *Neural Darwinism.* New York: Basic Books.

Engel, P. M. J., Santos, F. H., & Gathercole, S. E. (2008). Are working memory measures free of socioeconomic influence? *Journal of Speech, Language, and Hearing Research, 51,* 1580-1587.

Evans, G. W. (2004). The environment of childhood poverty. *American Psychologist, 59,* 77-92.

Eviatar, Z. (2000). Culture and brain organization. *Brain and Cognition, 42,* 50-52.

University of Cape Town

Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Gianetta, J. M., Brodsky, N. L., Malmud, E. K., & Hurt, H. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research, 1110,* 166-174.

Fernald, L. C. H., Gertler, P. J., & Neufeld, L. M. (2008) Role of cash in conditional cash transfer programmes for child health, growth and development: an analysis of Mexico's Oportunidades. *Lancet, 371,* 828-837.

Fuster, J. M. (2002). Frontal lobe and cognitive development. *Journal of Neurocytology, 31,* 373-385.

Galotti, K. (1989). Approaches to studying formal and everyday reasoning. *Psychological Bulletin, 105,* 331-351.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134,* 31-60.

Gathercole, S. E. (1998). The development of memory. *Journal of Child Psychology and Psychiatry, 39,* 3-27.

Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science, 7,* 155-170.

Giedd, J. N., Blumenthal, J., Jeffries, N. O., Castellanos, F. X., Liu, H., Zijdenbos, A., Paus, T., Evans, A. C., & Rapaport, J. L. (1999). Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience, 2,* 861-863.

Gilbert, A. J. (1986). *Psychology and social change in the third world: A cognitive perspective*. Unpublished doctoral dissertation, University of South Africa, Pretoria, South Africa.

University of Cape Town

Gómez-Pérez, E., & Ostrosky-Solís, F. (2006). Attention and memory evaluation across the life span: Heterogenous effects of age and education. *Journal of Clinical and Experimental Neuropsychology, 28,* 477-494.

Goswami, U., & Brown, A. L. (1989). Melting chocolate and melting snowmen: Analogical reasoning and causal relations. *Cognition, 35,* 69-95.

Gray, J. R., & Thompson, P.M. (2004). Neurobiology of intelligence: science and ethics. *Nature Reviews Neuroscience, 5,* 471-482.

Greenfield, P. M. (1997). You can't take it with you: Why ability assessments don't cross cultures. *American Psychologist, 52,* 1115-1124.

Guo, G., Brooks-Gunn, J., & Harris, K. M. (1996). Parents' labor-force attachment and grade retention among urban black children. *Sociology of Education, 69,* 217-236.

Hackman, D. A., & Farah, M. J. (2009). Socioeconomic status and the developing brain. *Trends in Cognitive Science, 13,* 65-73.

Halford, G. S. (1993). *Children's understanding: The development of mental models.* Hillsdale, NJ: Lawrence Erlbaum.

Hamilton, B. L. (1977). An empirical investigation of the effects of heterogenous regression slopes in analysis of covariance. *Educational and Psychological Measurement, 37,* 701-712.

Harris, Y. R., Terrel, D., & Allen, G. (1999). The influence of education context and beliefs on the teaching behaviour of African American mothers. *Journal of Black Psychology, 25,* 490-503.

Heaton, S. C., Reader, S. K., Preston, A. S., Fennell, E. B., Puyana, O. E., Gill, N., & Johnson, J. H. (2002). The Test of Everyday Attention for Children (TEA-Ch): Patterns of performance in children with ADHD and clinical controls. *Child Neuropsychology, 7,* 251-264.

University of Cape Town

Hemp, F. (1989). *Neuropsychological impairment in children following head injury*. Unpublished doctoral dissertation, University of Cape Town, Cape Town, South Africa.

Hofmeyr, J. (2000, March). *The emerging school landscape in post-apartheid South Africa.* Paper presented at the meeting of the Independent Schools Association of South Africa, Johannesburg, South Africa.

Hollingshead, A. B. (1975). *Four factor index of social status.* New Haven, CT: Yale University.

Howell, D. C. (2004). *Fundamental Statistics for the Behavioural Sciences* (5th edition). USA: Thomson Wadsworth.

Jensen, A. R., & Frederikson, J. (1973). Free recall of categorized and uncategorized lists: A test of the Jensen Hypothesis. *Journal of Educational Psychology, 65,* 304-312.

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychological Review, 17,* 213-233.

Kalmijn, M. (1994). Mother's occupational status and children's schooling. *American Sociological Review, 59,* 257-275.

Keeves, J. P., & Saha, L. J. (1992). Home background factors and educational outcomes. In J. Keeves (Ed.), *The IEA study of science III: Changes in science education and achievement 1970 to 1984* (pp. 165-186). Oxford UK: Pergamon.

Kirk, U. (1985). Hemispheric contributions to the development of graphic skills. In C. Best (Ed.), *Hemispheric function and collaboration in the child* (pp. 193-228). New York: Academic Press.

Kishiyama, M. M., Boyce, W. T., Jimenez, A. M., Perry, L. M., & Knight, R. T. (2008). Socioeconomic disparities affect prefrontal function in children. *Journal of Cognitive Neuroscience, 21,* 1106-1115.

University of Cape Town

Klebanov, P. K., Brooks-Gunn, J., Chase-Lansdale, P. L., & Gordon, R. (1997). Are neighborhood effects on young children mediated by features of the home environment? In J. Brooks-Gunn, G. J. Duncan, & J. L. Aber (Eds.), *Neighborhood poverty: Vol. 1. Context and consequences for children* (pp. 119-145), New York: Russell Sage Foundation.

Klenberg, L., Korkman, M., & Lahti-Nuutilla, P. (2001). Differential development of attention and executive functions in 3- to 12 year old Finish children. *Developmental Neuropsychology, 20,* 330-407.

Klimkeit, E. I., Mattingley, J. B., Sheppard, D. M., Farrow, M., & Bradshaw, J. L. (2004). Examining the development of attention and executive functions in children with a novel paradigm. *Child Neuropsychology, 10,* 201-211.

Kohn, M. L. (1963). Social class and parent-child relationships: An interpretation. *American Journal of Sociology, 68,* 471-480.

Korkman, M., Kemp, S. L., & Kirk, U. (2001). Effects of age on neurocognitive measures of children ages 5 to 12: A cross-sectional study on 800 children from the United States. *Developmental Neuropsychology, 20,* 331-354.

Korkman, M., Kirk, U., & Kemp, S. (2007). *NEPSY-II.* San Antonio, TX: The Psychological Corporation.

Korrup, S. E., Ganzeboom, H. B. G., & Van Der Lippe, D. (2002). Do mothers matter? A comparison of models of the influence of mother's and father's education and occupational status on children's educational attainment. *Quality and Quantity, 36,* 17-42.

Lehto, J. E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21,* 59-80.

University of Cape Town

Levav, M., Bartko, J. J., French, L. M., & Mirsky, A. F. (1999). Multinational neuropsychological testing: Performance of children and adults. *Journal of Clinical and Experimental Neuropsychology, 20,* 658-672.

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: the effect of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin, 126,* 309-337.

Levin, H. S., & Hanten, G. (2005). Executive functions after traumatic brain injury in children. *Pediatric Neurology, 33,* 79-93.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological Assessment (4th ed.).* New York: Oxford University Press.

Lichtenstein, P., & Pederson, N. L. (1997). Does genetic variance for cognitive abilities account for genetic variance in educational achievement and occupational status? A study of twins reared apart and twins reared together. *Social Biology, 44,* 77-90.

Lin, C. C. H., Chen, W. J., Yang, H., Hsiao, C. K., & Tien, A. Y. (2000). Performance on the Wisconsin Card Sorting Test among adolescents in Taiwan: Norms, factorial structure, and relation to schizotypy. *Journal of Clinical and Experimental Neuropsychology, 22,* 69-79.

Lipina, S., Martelli, M., Vuelta, B., & Colombo, J. (2005). Performance on the A-not-B task of Argentinean infants from unsatisfied and satisfied basic needs homes. *Interamerican Journal of Psychology, 39,* 49-60.

Lowther, J. L., & Mayfield, J. (2004). Memory functioning in children with traumatic brain injuries: a TOMAL validity study. *Archives of Clinical Neuropsychology, 19,* 105-118.

Luciana, M. & Nelson, C. A. (1998). The functional emergence of prefrontally-guided working memory systems in four- to eight-year-old children. *Neuropsychologia, 36,* 273-293.

University of Cape Town

Lupien, S. J., King, S., Meaney, M. J., & McEwen, B. S. (2001). Can poverty get under your skin? Basal cortisol levels and cognitive function in children from low and high socioeconomic status. *Development and Psychopathology, 13,* 653-676.

Luria, A. R. (1973). *The Working Brain.* New York: Basic Books.

Luster, T., Rhoades, K., & Haas, B. (1989). The relation between parental values and parenting behaviour: A test of the Kohn hypothesis. *Journal of Marriage and the Family, 51,* 139-147.

Magnuson, K. A., & Duncan, G. J. (2006). The role of family socioeconomic resources in the black-white test score gap among young children. *Developmental Review, 26,* 365-399.

Manly, J. J. (2005). Advantages and disadvantages of separate norms for African Americans. *The Clinical Neuropsychologist, 19,* 270-275.

Manly, J. J. (2008). Critical issues in cultural neuropsychology: Profit from diversity. *Neuropsychological Review, 18,* 179-183.

Manly, J. J., Jacobs, D., Touradji, P., Small, S., Merchant, C., Bell, K., & Stern, Y. (2000). Are ethnic group differences in neuropsychological test performance explained by reading level? A preliminary analysis. *Journal of the International Neuropsychological Society, 6,* 245. Abstract.

Manly, T., Anderson, V., Nimmo-Smith, I., Turner, A., Watson, P., & Robertson, I. H. (2001). The differential assessment of children's attention: The Test of Everyday Attention for Children (TEA-Ch), normative sample and ADHD performance. *Journal of Child Psychology and Psychiatry, 42,* 1065-1081.

Manly, T., Robertson, I. H., Anderson, V., & Nimmo-Smith, I. (1999). *Test of Everyday Attention for Children (TEA-Ch).* London: Harcourt Assessment.

University of Cape Town

Marks, G. N. (2008). Are father's or mother's socioeconomic characteristics more important influences on student performance? Recent international evidence. *Social Indicators Research, 85,* 293-309.

McCarthy, R. A., & Warrington, E. K. (1994). Disorders of semantic memory. *Philosophical Transactions: Biological Sciences, 346,* 89-96.

McKay, K. E., Halperin, J. M., Schwartz, S. T., & Sharma, V. (1994). Developmental analysis of three aspects of information processing: Sustained attention, selective attention and response organization. *Developmental Neuropsychology, 10,* 121-132.

McLoyd, V. (1998). Socioeconomic disadvantage and child development. *American Psychologist, 53,* 185-204.

Medina, K. L., Hanson, K. L., Schweinsburg, A. D., Cohen-Zion, M., Nagel, B. J., & Tapert, S. F. (2007). Neuropsychological functioning in adolescent marijuana users: subtle deficits detectable after a month of abstinence. *Journal of the International Neuropsychological Society, 13,* 807-820.

Mercy, J. A., & Steelman, L. C. (1982). Familial influence on the intellectual attainment of children. *American Sociological Review, 47,* 532-542.

Merriman, W. E., Azmita, M., & Perlmutter, M. (1988). Rate of forgetting in early childhood. *International Journal of Behavioural Development, 11*, 467-474.

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

Miller, B. L., Benson, D. F., & Johnson, J. K. (2003). Frontal lobes: clinical and anatomic aspects. In T. E. Feinberg & M. J. Farah (Eds.), *Behavioural Neurology and Neuropsychology*. New York: McGraw Hill.

University of Cape Town

Mirsky, A. F. (1996). Disorders of attention: A neuropsychological perspective. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory and executive function.* Baltimore, Maryland: Paul H. Brookes Publishing Co., Inc.

Mirsky, A. F., Anthony, B. J., Duncan, C. C., Ahearn, M. B., & Kellman, S. G. (1991). Analysis of the elements of attention: A neuropsychological approach. *Neuropsychological Review, 2,* 109-145.

Mitrushina, M. N., Boone, K. B., & D'Elia, L. F. (1999). *Handbook of Normative Data for Neuropsychological Assessment.* New York: Oxford.

Morris, P. A., Gennetian, L. A., Duncan, G. J., & Huston, A. C. (2009). How welfare policies affect child and adolescent school performance: investigating pathways of influence with experimental data. In J. Ziliak (Ed.), *Welfare Reform and Its Long-Term Consequences for America's Poor.* New York: Cambridge University Press.

Mulenga, K., Ahonen, T., & Aro, M. (2001). Performance of Zambian children on the NEPSY: A pilot study. *Developmental Neuropsychology, 20,* 375-383.

Mullis, V. S., Martin, M. O., Kennedy, A. M., & Foy, P. (2007). *PIRLS 2006 International Report.* Chestnut Hill, MA: TIMMS & PIRLS International Study Center, Lynch School of Education, Boston College.

Mundfrom, D. J., Perrett, J. J., Schaffer, J., Piccone, A., & Roozeboom, M. (2006). Bonferroni adjustments in tests for regression coefficients.*Multiple Linear Regression Viewpoints, 32,* 1-6.

Myer, L., Ehrlich, R. I., & Susser, E. S. (2004). Social epidemiology in South Africa. *Epidemiological Reviews, 26,* 112-123.

University of Cape Town

Myer, L., Stein, D. J., Grimsud, A., Seedat, S., & Williams, D. R. (2008). Social determinants of psychological distress in a nationally-representative sample of South African adults. *Social Science & Medicine, 66,* 1828-1840.

Nell, V. (1999a). Luria in Uzbekistan: The vicissitudes of cross-cultural neuropsychology. *Neuropsychology Review, 9,* 45-52.

Nell, V. (1999b). Standardising the WAIS-III AND WMS-III for South Africa: Legislative, psychometric, and policy issues. *South African Journal of Psychology, 29,* 128-137.

Nelson, C. (1995). The ontogeny of human memory: A cognitive neuroscience perspective. *Developmental Psychology, 31,* 723-735.

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental Science, 8,* 74-87.

O'Brien, L. M., Mervis, C. B., Holbrook, C. R., Bruner, J. L., Smith, N. H., McNally, N., McCliment, M. C., & Gozal, D. (2004). Neurobehavioural correlates of sleep-disordered breathing in children. *Journal of Sleep Research, 13,* 165-172.

Osterrieth, P. A. (1944). Le test de copie d'une figure complex: Contribution a l'étude de la perception et de la mémoire. *Archives de Psychologie, 30*, 286 – 356.

Ostrosky-Solís, F., Ardila, A., & Rosselli, M. (1999). NEUROPSI: a brief neuropsychological test battery in Spanish with norms by age and educational level. *Journal of the International Neuropsychological Society, 5,* 413-433.

Parasuraman, R., & Greenwood, P. M. (1998). Selective attention in aging and dementia. In R. Parasuraman (Ed.), *The attentive brain* (pp. 711-733). Cambridge, MA: MIT Press.

University of Cape Town

Parcel, T. L., & Menaghan, E. O. (1990). Maternal working conditions and children's verbal facility: studying the intergenerational transmission of inequality from mothers to young children. *Social Psychology Quarterly, 53,* 132-147.

Paus, T. (2005). Mapping brain maturation and cognitive development during adolescence. *Trends in Cognitive Sciences, 9,* 60-68.

Posner, M. (1978). *Chronometric explorations of mind.* Hillsdale, NJ: Lawrence Erlbaum Associates Ltd.

Reddy, V. (2005). Cross-national achievement studies: learning from South Africa's participation in the Trends in International Mathematics and Science Study (TIMSS). *Compare, 35,* 63-77.

Rheinheimer, D. C., & Penfield, D. A. (2001). The effects of type I error rate and power of the ANCOVA *F* test and selected alternatives under nonnormality and variance heterogeneity. *Journal of Experimental Education, 69,* 373-391.

Riccio, C. A., Avila, L., & Ash, M. J. (2010). Pesticide poisoning in a preschool child: a case study examining neurocognitive and neurobehavioural effects. *Applied Neuropsychology, 17,* 153-159.

Richland, L. E., Morrison, R. G., & Hollyoak, K. J. (2004, August). *Working memory and inhibition as constraints on children's development of analogical reasoning.* Paper presented at the Twenty-sixth Annual Conference of the Cognitive Science Society, Chicago, IL.

Romine, C. B., & Reynolds, C. R. (2005). A model of the development of frontal lobe functioning: Findings from a meta-analysis. *Applied Neuropsychology, 12,* 190-201.

Rosselli, M. & Ardila, A. (2003). The impact of culture and education on non-verbal neuropsychological measurement: A critical review. *Brain and Cognition, 52,* 326-333.

University of Cape Town

Savage, R. S., Cornish, K., Manly, T., & Hollis, C. (2006). Cognitive processes in children's reading and attention: The role of working memory, divided attention, and response inhibition. *British Journal of Psychology, 97,* 365-385.

Scarr, S., & Weinberg, R. A. (1978). The influence of "family background" on intellectual attainment. *American Sociological Review, 43,* 674-692.

Schacter, D. L., Chiu, C-Y. P., & Ochsner, K. N. (1993). Implicit memory: a selective review. *Annual Review of Neuroscience, 16,* 159-182.

Schretlen, D. J., & Shapiro, A. M. (2003). A quantitative review of the effects of traumatic brain injury on cognitive functioning. *International Review of Psychiatry, 15,* 341-349.

Shuttleworth-Edwards, A. B., Donnelly, M. J. R., Reid, I., & Radloff, S. E. (2004). A cross-cultural study with culture fair normative indications on WAIS-III Digit Symbol-Incidental Learning. *Journal of Clinical and Experimental Neuropsychology, 26,* 921-932.

Shuttleworth-Edwards, A. B., Kemp, R. D., Rust, A. L., Muirhead, J. G. L., Nigel, P. H., & Radloff, S. E. (2004). Cross-cultural effects on IQ test performance: A review and preliminary normative indications on WAIS-III test performance. *Journal of Clinical and Experimental Neuropsychology, 26,* 903-920.

Shuttleworth-Jordan, A. B. (1996). On not reinventing the wheel: A clinical perspective on culturally relevant test usage in South Africa. *South African Journal of Psychology, 26,* 96-102.

Siegler, R. S. (1991). *Children's thinking.* Englewood Cliffs: Prentice-Hall.

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*, 1413 – 1425.

University of Cape Town

Smith, J., Brooks-Gunn, J., & Klebanov, P. (1997). Consequences of Growing Up Poor for Young Children. In G. Duncan & J. Brooks-Gunn (Eds.), *Consequences of Growing Up Poor.* New York: Russell Sage.

Sowell, E. R., Delis, D., Stiles, J., & Jernigan, T. L. (2001). Improved memory functioning and frontal lobe maturation between childhood and adolescence: A structural MRI study. *Journal of the International Neuropsychological Society, 7,* 312-322.

StatSoft, Inc. (2009). STATISTICA (data analysis software system), version 9.0. www.statsoft.com.

Stevens, C., Lauinger, B., & Neville, H. (2009). Differences in the neural mechanisms of selective attention in children from different socioeconomic backgrounds: an event-related brain potential study. *Developmental Science, 12,* 634-646.

Straub, D., Loch, K., Evaristo, R., Karahanna, E., & Strite, M. (2002). Toward a theory-based measurement of culture. *Journal of Global Information Management, 10,* 13-23.

Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A compendium of neuropsychological Tests – Administration, norms, and commentary (3rd ed).* New York: Oxford University Press.

Sweet, J. J., Moberg, P. J., & Suchy, Y. (2000). Ten-year follow-up survey of clinical neuropsychologists: Part I. Practices and Beliefs. *The Clinical Neuropsychologist, 14,* 18-37.

Teng, E. L., & Manly, J. J. (2005). Neuropsychological testing: Helpful or harmful? *Alzheimer's Disease & Associated Disorders, 19,* 267-271.

Thatcher, R. W. (1992). Cyclical cortical reorganization during early childhood. *Brain and Cognition, 20,* 24-50.

University of Cape Town

Thornton, H. B., Nel, D., Thornton, D., Van Honk, J., Baker, G. A., & Stein, D. J. (2008). The neuropsychiatry and neuropsychology of lipoid proteinosis. *The Journal of Neuropsychiatry and Clinical Neurosciences, 20,* 86-92).

Turner, J. H. (1970). Entrepreneurial environments and the emergence of achievement motivation in adolescent males. *Sociometry, 33,* 147-165.

Turner, M. A. (1999). Annotation: Repetitive behaviour in autism: A review of psychological research. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 40,* 839-849.

Van der Berg, S. (2009, September). *Poor educational quality in South Africa: Issues of equity and efficiency.* Presented at the seminar of the Directorate: Research Services Western Cape in collaboration with the Cape Higher Education Consortium, Cape Town, South Africa.

Van der Berg, S., & Burger, R. (2002, March). *Education, poverty and inequality in South Africa.* Paper presented at the Conference of the Centre for the Study of African Economies, Oxford, UK.

Van der Berg, S., & Louw, M. (September, 2006). *Lessons learnt from SACMEQII: South African student performance in regional context.* Paper presented at the conference on Investment Choices for Education in Africa, Johannesburg, South Africa.

Vella, K., Campbell, A., Lincoln, N., Whitehouse, W., Walker, D., Williams, J., & Morgan, K. (2007). Child brain injury research programme: Preliminary data on predictive validity of the Health Utilities Index in children with acquired brain injury. *Archives of Disease in Childhood, 92* (Suppl. I), A7.

Waber, D. P., Carlson, D., Mann, M., Merola, J., & Moylan, P. (1984). SES-related aspects of neuropsychological performance. *Child Development, 55,* 1878-1886.

University of Cape Town

Walker, S. O., Petrill, S. A., & Plomin, R. (2005). A genetically sensitive investigation of the effects of the school environment and socio-economic status on academic achievement in seven-year-olds. *Educational Psychology, 25,* 55-73.

Welsh, M. C. (2002). Developmental and clinical variations in executive functions. In D. L. Molfese & V. J. Molfese (Eds.), *Developmental variations in learning: Applications to social, executive function, language, and reading skills* (pp. 139-185). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Welsh, M. C., Pennington, B. F., & Groisser, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7,* 131-149.

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children – Revised (WISC-R).* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1997). *Administration and scoring manual for the Wechsler Adult Intelligence Scale Third Edition (WAIS-III).* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI).* San Antonio, TX: The Psychological Corporation.

Wilson, B. A., Ivani-Chalian, R., & Aldrich, F. (1991). *The Rivermead Behavioural Memory Test for Children Aged 5 to 10 Years.* Cambridge, UK: Thames Valley Test Company.

Zindi, F. (1994). Differences in psychometric performance. *The Psychologist, 7,* 549-552.

University of Cape Town

APPENDIX A

Demographic Questionnaire and Asset Index

PARENT QUESTIONNAIRE AND ASSET INDEX

GENERAL INFORMATION

Full name (Parent):	
Telephone:	Work: ( ) Home: ( ) Cell:
How would you describe your ethnicity / race?	1. Black 2. Coloured 3. White 4. Asian 5. Other(specify):
Home Language:	
Full name (Child):	
Gender:	M F
Date of Birth:	
Grade:	
Nr of children in home	

HOUSEHOLD INCOME: (Please circle appropriate number)

Household income per year:	1. R0 2. R1 – R5 000 3. R5001 – R25 000 4. R25 001 – R100 000 5. R100 001+

PARENTAL EDUCATION: (Please complete; e.g. Grade 12, university grade etc.)

Father	
Mother	

PARENTAL EMPLOYMENT: (Please complete; e.g. manager, doctor, teacher etc.)

Father	
Mother	

University of Cape Town

MATERIAL AND FINANCIAL RESOURCES (ASSET INDEX): (Please circle appropriate number)

Which of the following items, in working order, does your household have?

Items	Yes	No
1. A refrigerator or freezer	1.	1.
2. A vacuum cleaner or polisher	2.	2.
3. A television	3.	3.
4. A hi-fi or music center (radio excluded)	4.	4.
5. A microwave oven	5.	5.
6. A washing machine	6.	6.
7. A video cassette recorder or dvd player	7.	7.

Which of the following do you have in your home?

Items	Yes	No
1. Running water	1.	1.
2. A domestic servant	2.	2.
3. At least one car	3.	3.
4. A flush toilet	4.	4.
5. A built-in kitchen sink	5.	5.
6. An electric stove or hotplate	6.	6.
7. A working telephone	7.	7.

Do you personally do any of the following?

Items	Yes	No
1. Shop at supermarkets	1.	1.
2. Use any financial services such as a bank account, ATM card or credit card	2.	2.
3. Have an account or credit card at a retail store	3.	3.

University of Cape Town

APPENDIX B

Parent/Guardian's Informed Consent Form

UNIVERSITY OF CAPE TOWN
DEPARTMENT OF PSYCHOLOGY

Informed Consent to Allow Participation in Research and Authorization for Collection, Use, and Disclosure of Cognitive Performance and Other Personal Data

You are being asked to allow your child to take part in a research study. This form provides you with information about the study and seeks your authorization for the collection, use and disclosure of your child's cognitive performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to your child and answer all of their questions. Your child's participation is entirely voluntary. Before you decide whether or not they can take part, read the information below and ask questions about anything you do not understand. By allowing participation in this study you and your child will not be penalized or lose any benefits to which you would otherwise be entitled.

1. Name of Participant ("Study Subject")

____

2. Title of Research Study

The relationship between socioeconomic status (SES) and neuropsychological performance in South African children

3. Principal Investigator and Telephone Number(s)

Kevin G. F. Thomas, Ph.D.
Senior Lecturer
Department of Psychology
University of Cape Town
021-650-4608

Fransien Schoeman
Masters student
Department of Psychology
University of Cape Town
0833911629

4. What is the purpose of this research study?

The main purpose of this research is to describe the influence of SES on the neuropsychological test performance of South African children between Grade 1 and Grade 4, on this particular battery of neuropsychological test. Specifically, we plan to compare the performance of low and high SES children, and to determine the influence of more years of formal schooling on the performance of the subjects. These results will be used as norms for a greater research programme involving pediatric traumatic brain injury (TBI).

5. What will be done if your child takes part in this research study?

In this study a series of cognitive tests will be administered. The tests measure certain aspects of your child's memory and thinking skills.

6. If you choose to allow your child to participate in this study, how long will they be Involved in the research?

The experiment consists of two sessions. Both sessions should last between 60 and 90 minutes each. If at any time during the sessions your child finds any of the procedures uncomfortable, they will be free to stop participating without penalty.

7. How many people are expected to participate in the research?

120

8. What are the possible discomforts and risks?

There are no known risks associated with participation in this study. A possible discomfort your child may experience is slight fatigue. If they become tired during any of the tests, they can take a break. They will be allowed to take breaks whenever they want to. At the conclusion of the study procedures, all participants will be fully debriefed.

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigator listed on the front page of this form.

9. What are the possible benefits to your child?

Your child's cognitive performance will be measured on the domains of memory, attention and executive function, and feedback will be available. This is, however, a research study and therefore the data obtained will only be used for research purposes and not on a clinical basis. Feedback will therefore only indicate a general range of performance of the population that participated in the study. Further enquiries regarding participants' cognitive functioning should be referred to a clinician.

10. What are the possible benefits to others?

Information from this study will improve our understanding of how SES affects functioning in children. The results of the study will also be used as norms for future research in a South

African context.

11. If you choose to allow your child to take part in this research study, will it cost you anything?

Allowing your child to participate in this study will not cost you anything. The research will be conducted at the school your child is currently attending.

12. Can your child withdraw from this research study?

You are free to withdraw your consent and to stop you child participating in this research study at any time. If you do withdraw your consent, there will be no penalty.

If you have any questions regarding the rights of a research subject, you may phone the Psychology Department offices at 021-650-3430.

13. If your child withdraws, can information about your child still be used and/or collected?

Information already collected may be used.

14. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect you and your child's privacy?

Information collected will be stored in locked filing cabinets or in computers with security passwords. Only certain people have the right to review these research records. These people include the researchers for this study and certain University of Cape Town officials. Your child's research records will not be released without your permission unless required by law or a court order.

15. What information about your child may be collected, used and shared with others?

This information gathered will be records of your child's performance on cognitive tests, as well as information on their history and current psychological functioning.

16. How will the researcher(s) benefit from your child being in the study?

In general, presenting research results helps the career of a scientist. Therefore, the Principal Investigator and others attached to this research project may benefit if the results of this study are presented at scientific meetings or in scientific journals.

17. Signatures

As a representative of this study, I have explained to the participant the purpose, the procedures, the possible benefits, and the risks of this research study; and how the participant's performance and other data will be collected, used, and shared with others:

____ ______________________
Signature of Person Obtaining Consent and Authorization Date

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You agree to allow participation in this study. You hereby authorize the collection, use and sharing of your child's performance and other data. By signing this form, you are not waiving any of your legal rights.

____ ______________________
Signature of Person Consenting and Authorizing Date

____ ______________________
Name of Child Age

Please indicate below if you would like to be notified of future research projects conducted by our research group:
_______________ (initial) Yes, I would like to be added to your research participation pool and be notified of research projects in which I might participate in the future.

Method of contact:

Phone number: ____________________________
E-mail address: ____________________________
Mailing address: __________________________________
____
____

APPENDIX C

Assent Form for Participants

Name of Participant ("Study Subject")

____

I am going to be required to complete some tests. The person who is going to administer the tests has told me that I can stop if I am feeling tired and need to take a break, that I may end my participation at any stage during the test period, and that nobody else will be told my answers to the questions in the tests.

___________________________________ _______________

Signature of Child Date

___________________________________ _______________

Signature of Researcher Date

University of Cape Town

APPENDIX D

Example of Feedback Report

University of Cape Town
Department of Psychology

10 June 2010

Dear [name]'s parents,

Thank you very much for consenting to your child, [name]'s, participation in my research study during February 2009. He was selected as a participant and assented to participate. During the two testing sessions various cognitive tests were administered and [name] completed the entire battery. This battery included tests of memory, attention, planning, organization, and executive functioning (that is, reasoning, judgment, and problem solving). Because this is a research study and not an individual clinical assessment, the feedback I can give you about results of these tests can only be stated in terms of the range in which your child performed.

These ranges are determined by the population in which the test was developed (and most of our tests were developed in the United States or United Kingdom). Therefore, if the table below indicates that your child performed in the "average" range, then what we are saying is that, on the test in question, your child's performance was the same as that of an average child of the same age in the US or UK.

Results for test battery:

Test of:	Range of performance
Memory	Average
Attention	Average
Executive Functioning	At the expected level
Planning and organization	Average

Please complete the attached Demographic Questionnaire as confirmation of receiving this report and send it back to the school as soon as possible.

If you have any questions or concerns about the study or about our findings, you may contact us on the numbers below. Also, if you would like a copy of the final research report we are creating, please e-mail Ms. Schoeman.

Fransien Schoeman
MA Candidate
Department of Psychology
University of Cape Town
0833911629
fransien.schoeman@gmail.com

Kevin G. F. Thomas, Ph.D.
Senior Lecturer and Supervisor
Department of Psychology
University of Cape Town
021-650-4608
kevin.thomas@uct.ac.za

University of Cape Town