

Verbal Fluency and Vocabulary in English in Bi/Multilingual Adolescents Living with HIV-1 in South Africa



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Declaration of Authorship

I, Cindy van Wyk, hereby declare that the research report here submitted is my own, unaided work. All direct or indirect sources used are acknowledged as references.

This research has not been submitted to another institution, University or examination board and has not been published.

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Roles and Responsibilities

This study formed part of a larger research project in which a number of individuals played key roles. These are outlined below.

- Urvashi Maganlal was part of the 2012 M.A. Neuropsychology cohort and was the originator of the idea for the project. She has played an integral role in the logistical running of the project and has been instrumental in setting up meetings and liaising with the relevant people at Rahima Moosa Mother and Child Clinic. She was also part of the data collection team for the HIV-positive and HIV-negative samples and scoring of the tests. She is investigating executive functioning in HIV-positive adolescents on anti-retroviral treatment. She will conduct the relevant statistical analyses to examine executive functions.
- Daniel Greenslade was part of the 2012 M.A. Neuropsychology cohort and is one of the original members of the research team. He was involved early on in the conceptualisation of the research, and has also been involved in the data collection of the HIV-positive and HIV-negative samples and scoring of the tests. He is investigating visuospatial functioning in HIV-positive adolescents on anti-retroviral treatment.
- Shona Fraser was part of the 2012 M.A. Neuropsychology cohort is one of the members of the research team. She has been involved in the data collection of the HIV-positive and HIV-negative samples and scoring of the tests. She is investigating memory functioning in HIV-positive adolescents on anti-retroviral treatment.
- Jessica Rice was part of the 2012 M.A. Neuropsychology cohort and is one of the members of the research team. She has been involved in the data collection of the HIV-positive and HIV-negative samples and scoring of the tests. She is investigating attentional functioning in HIV-positive adolescents on anti-retroviral treatment.
- Stephanie MacIlwaine was part of the 2012 M.A. Neuropsychology cohort and is one of the members of the research team. She has been involved in the data collection of the HIV-positive and HIV-negative samples and scoring of the tests. She is investigating motor functioning in HIV-positive adolescents on anti-retroviral

treatment. She will conduct the relevant statistical analyses to examine motor functions.

- Kelly Holland was part of the M.A. Psychology (Research) programme in 2012 and is one of the members of the research team. She has been involved in the data collection of the HIV-positive and HIV-negative samples, scoring of tests, and capturing the data. She is investigating the overall neuropsychological profile in HIV-positive adolescents on anti-retroviral treatment.
- Psychology Honours students, Psychology First Year Students and Psychometry students from the University of the Witwatersrand were involved in the data collection of the HIV-negative sample.
- Ms. Aline Ferreira Correia was the supervisor of Jessica Rice and Cindy van Wyk and was responsible for managing their participation in the research project.
- Ms Enid Schutte was the supervisor of Urvashi Mangalal and Daniel Greenslade and played an integral role in the original conceptualisation and formation of the research project. She helped formulate the research plan and provided the means to access the HIV-negative contrast sample.
- Prof. Marilyn Lucas was the supervisor of Stephanie MacIlwaine and was responsible for managing her participation in the research project. In addition she was the head of the M.A. Neuropsychology programme and as such played an overarching role in ensuring the viability of the research project.
- Associate Prof. Kate Cockcroft was the supervisor of Shona Fraser and was responsible for managing her participation in the research project.

Abstract

South Africa has the most prominent percentage of individuals living with the Human Immunodeficiency Virus (HIV) in the world, with the most prominent form of transmission of HIV in South Africa being vertical mother-to-child transmission. From 1997 until 2004, South Africa had limited access to ARV treatment at and after birth due to the government legislation. As a consequence, treatment of HIV may only have been initiated after clinical presentation of immune deficiency. A paucity of information therefore exists regarding this population in addition to the specific age demographic of adolescents. Adolescents may be negatively influenced by the cortical thinning associated with HIV, and this study therefore aims to investigate the verbal fluency and vocabulary (in English) of 30 bi- or multilingual seropositive adolescents that are currently on a managed anti-retroviral programme in comparison to an HIV-negative contrast group of 70 bi- or multilingual adolescents in South Africa (matched for age, education, and socioeconomic status). The study found that there were no significant results between the HIV-positive and HIV-negative groups on the measures of vocabulary, semantic naming, or phonemic naming in 'F' as determined by their performance on the neuropsychological assessments. Significant results were noted between the HIV-positive and HIV-negative groups on the phonemic naming categories of 'A' and 'S' however, and negative correlations between performance in these categories and current viral load, and viral load at Highly Active Antiretroviral Therapy (HAART) initiation were also noted. This research formed part of a broader study examining the overall neurocognitive effects of HIV-1 infection in adolescents in South Africa.

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1. Introduction

The Human Immunodeficiency Virus (HIV) and acquired immune deficiency syndrome (AIDS) together represent a global public health issue. Approximately 33.2 million people worldwide were believed to be living with HIV by the end of 2007 (Shisana, Rehle, Simbayi, Zuma, Jooste, & Pillay-van-Wyk, 2009; UNAIDS, 2008), whilst it is believed nearly 30 million people have died due to AIDS-related illnesses since the 1970s (UNAIDS, 2010).

Sub-Saharan Africa is the most affected area, with over two thirds of the infected people worldwide living in this region (UNAIDS, 2009). Statistics South Africa released mid-year population estimates in 2011 that stated that the total number of persons living with HIV in South Africa increased from an estimated 4.21 million in 2001 to 5.38 million in 2011 – indicating that an estimated 10.6% of the South African population is HIV-positive. Despite the prevalence of HIV-infections in sub-Saharan and South Africa, the majority of the literature on the HIV-1 infections is focused on American or European-based Clade B HIV-1 infections. This is in spite of the fact that 35 % of the world's HIV-infected population living in Southern Africa is infected with Clade C HIV-1 (Shisana et al., 2009).

HIV infection is associated with a number of secondary Central Nervous System (CNS) diseases that take advantage of the progressive immune deficiency that is resultant (Ellis, Calero & Stockin, 2009). Of these secondary diseases, HIV-related encephalopathy is often found and is linked to HIV-associated neurocognitive disorders (HAND) (Ellis et al., 2009). This association between HIV and deficits cognitive function has been well documented in adult populations (Lawler, Mosepele, Ratcliffe, Seloilwe, Steele, Nthonatsang, & Steenhoff, 2010; Melrose, Tinaz, Castelo, Courtney, & Stern, 2008; Singh, Joska, Goodkin, Lopez, Myer, Paul et al., 2010; Toborek, Woo Lee, Flora, Pu, Andras, Wylegala, & Nath, 2005). Specific deficits have been noted in language and communication (Coplan, et al., 1998; McNeilly, 2005; Wolters, Brouwers, Civitello, & Moss, 1997). However, the majority of these studies have been conducted on infants and young children and have not explored the complex linguistic contexts, Clade-specific HIV-1 infection, and the South African population.

There are also limited studies exploring HIV infection in paediatric populations, and of these the results are inconclusive due to either the smaller sample sizes or the broad age group of the population ranging from neonates to adolescents (Govender, Eley, Walker, Petersen, &

Wilmshurst, 2011; Koekkoek, de Sonnevile, Wolfs, Licht, & Geelan, 2008; Wachslar-Felder & Golden, 2002).

The general aim of the proposed study is therefore to examine verbal fluency and vocabulary in English in multilingual seropositive adolescents (between the ages of 13 and 15 years old) currently on a managed anti-retroviral (ARV) programme as compared to a matched control group of uninfected, HIV-negative adolescents living in South Africa. This aim was addressed utilising an ex post facto comparative research design in which the neuropsychological functioning of two sample groups (one HIV-positive, one HIV-negative) were compared statistically. This will be discussed in full in the methodology section, and thereafter the results of the statistical analysis will be presented. This will be followed by a discussion of these results with reference to the current available literature.

2. Literature Review

2.1 HIV Pathogenesis

The Human Immunodeficiency Virus Type 1 (HIV-1) is a retrovirus that primarily infects two cellular subgroups of immune system cells; activated CD4⁺ lymphocytes (T-cells), and macrophages (Ellis et al., 2009). HIV manifests once the virus has entered the body by directing the lymphocytes and macrophages to manufacture reverse transcriptase which converts viral RNA (ribose nucleic acid) into DNA (Deoxyribose Nucleic Acid) (Ellis et al., 2009). The conversion error of RNA to DNA is not detected by the immune system and this allows for rapid genetic mutation and DNA base substitutions (Ellis et al., 2009).

HIV is capable of crossing the blood-brain barrier, and can therefore alter the structure and function of several neural systems (Woods et al., 2010). The most notable neural system that is altered is the fronto-striatal-thalamo-cortical loops (Ellis, Langford & Masliah, 2007). The alteration of these neural systems is done indirectly in the cerebrospinal fluid (CSF) through viral factors, host factors, and co-factors (Civitello, 2003; Ellis et al., 2009). Neurotoxic viral factors are HIV genome codes for certain proteins that interfere with Central Nervous System (CNS) function and cause neuronal cell damage. Two of the most important proteins are gp120 (HIV envelope protein that is involved in synaptodendritic damage of neurons), and 'Tat' (transactivator of transcription that is associated with mitochondrial dysfunction) (Ellis et al., 2009). Gp120 interacts with host cellular receptors

and alters glutamate pathways, inducing cytokine production thereby injuring neurons and affecting the activation state of microglia and astrocytes (Ellis et al., 2009). Tat is in turn produced by infected astrocytes and causes mitochondrial dysfunction, dendritic loss, and cell death in neurons at concentrations lower than those needed to support viral replication (Ellis et al., 2009).

Host factors are the neurotoxic secondary effects of HIV infection that can intensify nervous system damage (Ellis et al., 2009). These involve the activation of the receptors of pro-inflammatory cytokines and chemokines, found in microglia, astrocytes, oligodendrocytes and neurons, resulting in structural and functional neuronal changes and apoptosis (Ellis et al., 2009; Koekkoek et al., 2008; Toborek et al., 2005). Co-factors are co-morbidities of the infected individual that may exacerbate pathogenesis of HIV. These include drug and alcohol abuse, or viral co-pathogens such as hepatitis C virus (Ellis et al., 2009).

The HI-virus, if left untreated, proceeds through four stages in its clinical course. The first stage lasts approximately 2 to 4 weeks and is characterised by asymptomatic incubation (Ellis et al., 2009). This is then followed by an acute, symptomatic infection stage which last roughly 4 weeks (Kahn & Walker, 1998). The symptomatology of this stage is similar to that of many other viral infections and may also pass without detection (Ellis et al., 2009). Once this stage has passed, the latency stage comes into effect. This entails a relatively silent period of ongoing viral replication and immune destruction with a varying duration that ranges from weeks to over a decade, and patients may feel relatively well (Gottlieb et al., 2002). If untreated, the HI-virus causes progressive immune system destruction (as noted in the decline in CD4+ and CD8+ T cells), and the results is Acquired Immune Deficiency Syndrome (AIDS) (Ellis et al., 2009).

2.2 Epidemiology

HIV and AIDS together represent a global public health issue. Approximately 33.2 million people worldwide were believed to be living with HIV by the end of 2007 (UNAIDS, 2008), whilst it is believed nearly 30 million people have died due to AIDS-related illnesses since the 1970s (UNAIDS, 2010).

Sub-Saharan Africa remains the region most affected by HIV, with over two thirds of worldwide HIV infections presenting there, and accounting for 72% of AIDS related deaths in

2008 (UNAIDS, 2008). Despite efforts to reduce the prevalence of HIV roughly 1.9 million new infections were reported in sub-Saharan Africa between 2007 and 2009 (UNAIDS, 2010). It is believed that women and children are the most vulnerable to HIV infection in developing countries, such as those seen in Africa (Wachsler-Felder & Golden, 2002). This belief is reflected in the percentages of HIV-infected women and children living in Africa and sub-Saharan Africa. 87% of all HIV-infected children under the age of 15 are found in sub-Saharan Africa, whilst 80% of HIV-infected women live in Africa (Wachsler-Felder & Golden, 2002).

Within sub-Saharan Africa, South Africa is home to the largest population of HIV-infected people in the world (UNAIDS, 2009), and it is known that the primary mode of infection in children in South Africa is through vertical mother-to-child transmission (Shisana et al., 2005). In 2003, it was estimated that 96 228 infants were infected with HIV through vertical transmission in South Africa (Department of Health, 2003). Vertical transmission can involve pre-natal, peri-natal or post-natal transmission, through breastfeeding, which has the highest survival rate (Newell et al., 2004). Studies have shown fairly even distributions across different age groups of seropositive children suggesting better survival rates for HIV-infected children than was initially predicted (Shisana et al., 2005)

HIV infection can also be classified according to different subtypes, or clades. HIV-1 Clade A accounts for nearly 79% of infections in Eastern Europe, Russia, and Asia (Hemelaar et al., 2006), whilst HIV-1 Clade AE is the predominant subtype in South and Southeast Asia. HIV-1 Clade B is the most widely studied clade of HIV, despite being responsible for only 10 % of infections worldwide in areas such as Western Europe, Australia, and America (McCutchan, 2006). HIV-1 Clade C accounts for approximately 50 % of HIV infections worldwide and is the predominant subtype in sub-Saharan Africa (Ellis et al., 2009). Therefore, despite being the most prevalent clade of HIV-1 infection worldwide, Clade C is not extensively studied leaving a dearth in international and local literature on the neurological and neuropsychological sequelae of this particular subtype of HIV-1 infection.

2.3 HIV and Anti-Retroviral Treatments

The use and advances in pharmacokinetic treatments such as anti-retrovirals (ARVs) contribute to the higher survival rates of children infected with HIV. In South Africa, prior to

1995, the prognosis for HIV-infected individuals was bleak with disease progression rapidly leading to death. The advent of triple combination Anti-Retroviral Treatment (cART), also referred to as Highly Active Anti-retroviral Treatment (HAART), when combined with treatment compliance, dramatically increased life expectancy (Woods, Moore, Weber, & Grant, 2009). Individuals with HIV are now expected to live more than 20 years after initial infection and diagnosis (Skinner, Adewale, DeBlock, Gill, & Power, 2009). In the case of adults, HAART improved life expectancy and reduced the prevalence of HIV-associated central nervous system disorders, particularly HIV-associated encephalopathy (HIVE) and other neurological opportunistic infections (Civitello, 2003; Martin et al., 2006; Patel et al., 2009). According to the UNAIDS fact sheet (2009), 44% of adults and children in sub-Saharan Africa had access to anti-retroviral (ARV) treatment by the end of 2008.

While morbidity rates have dropped substantially since the introduction of anti-retrovirals, HIV-induced disabilities have become of prime importance for both psycho-social and socio-economic reasons. Policy decisions fuelled by unsubstantiated fears of AZT toxins and the high cost of ARV's at the time prevented the blanket ARV rollouts in the public sector (Butler, 2005). Many children were only placed on ARV treatment based on the severity of clinical symptomatology and/or viral loads, with effective preventative mother to child treatment (PMTCT) programmes curtailed (Coovadia, 2009). Epidemiological studies in South Africa subsequently reported that infant mortality was at its peak between 1997 and 2002 (Bourne, Thompson, & Brody, 2009).

Studies from the US show that ARV-naïve children who were placed onto HAART after presenting symptomatically show greater neurocognitive deficits when compared to children who are placed on ARV's from birth due to the restrictive impact the treatment has on the progression of the disease (Laughton et al., 2010). Consequently, it can be expected that South African children who were born HIV positive during this period (1994 – 2004/5), and who did not immediately receive HAART, would be inclined to greater amounts of neurocognitive deficits, despite being placed on HAART several years after vertical acquisition (Smith, Adnams, & Eley, 2008).

2.4 HIV and Cognitive Impairment

Neuropsychological deficits have long been associated with HIV-1 infection, and were identified early on in the course of the HIV epidemic as sequelae of infection (Cysique & Brew, 2009). As it has been well established that the brain is vulnerable to disease in vitro, with examples such as spina bifida and rubella being well-documented (Zillmer, Spiers & Culbertson, 2008), it is believed that HIV has a similar impact on the early stages of neurodevelopment (Gay et al., 1995). Radiological studies with HIV seropositive children have revealed some CNS abnormalities such as myelinopathy, cortical atrophy and calcification, especially in the basal ganglia and frontal cortex white matter (Belman et al., 1985; Belman et al., 1986; Civitello, 2003; Epstein, Berman, Sharer, Khademi & Desposito, 1987; Gay et al., 1995). Neural injuries such as these can lead to the development of HIV-associated neurocognitive disorders, which are estimated to occur in 30-50% of people living with HIV infection (Antinori et al., 2007). It has been noted that HIV progresses faster in children than in adults, causing a higher incidence of neurological abnormalities (Waschler-Felder & Goldern, 2002). This HIV encephalopathy is central to the paediatric neurological profile of HIV-infected children (McNeilly, 2005).

It is believed that children experience a faster progression of HIV due to the speed at which their developing nervous and immune systems are compromised, as well as the devastating effect the virus has on their development (Belman, 1997; Brouwers et al., 1996; UNAIDS, 2010). HIV-infected children are therefore at a greater risk for developing neurological and neuropsychological impairments associated with the direct effect of HIV on the CNS. Additionally, children born to HIV-infected mothers have an even greater risk profile for negatively affected development due to factors such as low birth weight, poor prenatal care, and potential foetal drug and alcohol exposure (McNeilly, 2005).

Studies exist that have explored the neuropsychological sequelae of HIV positive children (Koekkoek et al., 2008; Martin, et al., 2006; Patel, et al., 2009; Smith et al., 2008; Wachsler-Felder & Golden, 2002). Indeed, developmental delay in infancy and progressive cognitive impairments in older children forms the predominant developmental feature of paediatric HIV (McNeilly, 2005).

In the pre-HAART era, deficits included a broad range of disorders arising from HIV encephalopathy (HIVE) induced pervasive CNS dysfunctions and neurodevelopmental delays (which has a slow onset), to CNS opportunistic infections. As previously noted, disease vulnerability is closely linked to neurocognitive deficits as studies show that patients with lower CD4 counts are more vulnerable to neuropsychological impairment (Cysique & Brew, 2009). Indeed, children who were placed HAART after presenting symptomatically showed greater neurocognitive deficits compared to children who were placed on ARV's from birth (Laughton et al., 2010). It is therefore apparent that the age of starting HAART is an important predictor for neuropsychological outcome (Smith et al., 2008).

In school-going children, the first signs of neuropsychological involvement were usually declining academic performances, behavioural changes, psychomotor impairment with eventual progressive cognitive impairment and the emergence of pyramidal tract signs (Civitello, 2003). The neuropathology associated with HIV infection leads to observable cognitive deficits in HIV-infected children in areas of motor-functioning (Blanchette, Smith, King, Fernandes-Penney & Read, 2002; Gay et al., 1995; Nozyce, Hittelman, Muenz, Durako, Fischer & Willoughby, 1994), visuospatial functioning (Stebbins, Smith, Bartt, Kessler, Adeyemi & Martin et al., 2007; Pomara, Crandall, Choi, Johnson & Lim, 2001), memory (Bassel, Rourke, Halman, & Smith, 2002; Boivin, 2010; Gendelman, 2005; Goldman-Rakic, 1995; Petrides, 1995), executive functioning (Melrose et al., 2009; Laughton et al., 2010), and language and speech (Coplan et al., 1998; Wolters et al., 1995; Wolters et al., 1997).

2.4.1 HIV and Language

It is important to differentiate language and speech as separate concepts. Speech refers to the audible, motor function of communicating language, whereas language is seen as any system for representing and communicating ideas (Kolb & Whishaw, 2009). Language is a complex higher mental function involving the meanings of words, the organisation of these words into sentences, how they are produced as speech, sign, or written form, and how they are understood (Gazzaniga, Ivry, & Mangun, 2009).

Language and speech are good indicators of overall CNS integrity as they are sensitive to a variety of neurodevelopmental insults (Coplan et al., 1998). In light of the HIV pandemic both locally and internationally, it is considered "important to investigate how the virus can impact language and communication functions" (Mupawose & Broom, 2010, p. 147).

General observations of behaviour, cognitive testing, and language screening measures in a variety of studies internationally have shown that language and speech abnormalities are present in children with HIV infection (Epstein, Sharer, & Loeske, 1986; Papola, Alvarez, & Choen, 1994; Pizzo, et al., 1988; Tardieu, Mayaux, Seibel, Funck-Brentan, Straub, & Blanche, 1995). Indeed, international clinical and pre-clinical studies have shown that disorders of communication (such as language and speech) are common in HIV-infected infants and children (McNeilly, 2005).

The anatomical areas associated with language include the inferior frontal gyrus, the superior temporal gyrus, the ventral aspects of the precentral and postcentral gyrus, the supramarginal gyrus, the angular gyrus, the medial temporal gyrus in addition to the insula, Heschl's gyrus, and the posterior arcuate fasciculus (Kolb & Whishaw, 2009). In traditional neuro-cognitive development, myelination undergoes a significant growth period during the first two years of life and continues throughout adolescence into adulthood. It is a critical process to ensure the efficient and rapid communication between the complicated networks of neurons. Wachsler-Felder and Golden (2002) state that "disruption of myelination processes in young children can cause delays in language, sequencing and integration" (p. 449). Additionally, major gains are seen in language development in the first two years, and from 2 – 6 years, white and grey matter volumes continue to increase (Wachsler-Felder & Golden, 2002).

Consequently it would be expected that if the HIV disrupts the un-myelinated nervous system still in the process of development, there would be disruptions in the development of language functions. Specific impairments in verbal ability (including vocabulary and verbal fluency), basic reading skills, and expressive and receptive language function have been noted in HIV-infected children (Brackis-Cott, Kang, Dolezal, Abrams & Mellins, 2009; Coplan et al., 1998; McNeilly, 2005; Wolters et al., 1997; Wolters et al., 1995; Woods et al., 2010).

In terms of language functioning, investigations into verbal fluency and vocabulary will be considered in the present research.

2.4.1.1 Verbal Fluency

Verbal fluency is believed to measure the efficiency of lexical access from a particular category – either phonemic (retrieving words that begin with a particular letter or

phoneme), or semantic (words that belong to a particular category such as 'animals') (Thames et al., 2012). The neural systems that are believed to underpin verbal fluency performance include the left inferior frontal gyrus, anterior cingulate cortex, and supramarginal gyrus (Hirshorn & Thompson-Schill, 2006; Phelps, Hyder, Blamire & Shulman, 1997).

Research indicates that HIV-infected adults often display impaired verbal fluency relative to healthy controls (Marsh & McCall, 1994; Rippeth et al., 2004). Assessing verbal fluency is therefore an important tool in determining potential cognitive decline (Bialystok, Craik, Green, & Gollan, 2009). However, a dearth of information is evident when seeking to better understand the impact of HIV infection on verbal fluency in adolescents and school-aged children (Martin et al., 2006).

Most research, such as that performed by Millikin, Trepanier and Rourke (2004), focus on HIV infection in an adult population. Millikin et al.'s (2004) study had a large participant sample of 217 adults with HIV-infection who all underwent a comprehensive neuropsychological assessment in order to determine on the impact of HIV disease severity, depressed mood, and HAART on verbal fluency components in an adult sample. The assessments included the 'F', 'A', and 'S', subtests of the Controlled Oral Word Association Test (COWAT) for phonemic fluency, and the 'Animals' subtest for category fluency. The authors did find that advanced HIV-infection was related to impairment in phonemic fluency performance in comparison to normative data (Millikin et al., 2004). The effect of HAART was implicated in this research as it mediated performance in the group with AIDS diagnosis, suggesting that ARV treatment and disease severity should be explored when assessing verbal fluency (Millikin et al., 2004). Additionally, the adults with AIDS and co-morbid depression did not show disproportionately more impairment on switching, or any other verbal fluency parameter indicating that depression in this instance does not impact on verbal fluency in an adult population with AIDS (Millikin et al., 2004).

One of the few studies that investigate semantic verbal fluency in HIV-infected school-age had a sample of 22 children between the ages of 6 and 17 years of age of whom 18 were currently treated with HAART, two had just begun HAART, and two were still drug naïve. The researchers wished to determine if there were neurocognitive impairments present in the

sample, and if so were they related to various patient, disease or treatment factors (Koekkoek et al., 2008). The study found that the HIV-positive children showed significantly poorer performance than the age-related norms on measures of verbal fluency, baseline speed, pattern recognition, set shifting, and visuospatial memory (Koekkoek et al., 2008). This study, however, did not examine the HIV-positive individual's performance in comparison to a contrast sample of age-related peers but rather to existing normative data. The present research however, cannot rely on normative data as an indication of verbal fluency performance due to the lack of culturally appropriate test material and demographically correct normative data.

Further support for the deleterious effect of HIV-infection on verbal fluency comes from Woods et al. (2010) who, in their study of 74 individuals with HIV infection found a significant association with biomarkers associated with HIV-infection and deficits in action (verb) fluency in an adult population. Thames et al. (2012) also found evidence for the neuropathogenesis of HIV-infection as it relates to verbal fluency in their study of 20 HIV-positive older adults who underwent MRI scans. The study found that the specific deficits noted in the verbal fluency of HIV-positive older adults are linked to dysfunction in the selective areas of the basal ganglia (Thames et al., 2012). This study also made use of the COWAT but employed an additional experimental manipulation of forced switching between specific categories or phonemes following the generation of each word (Thames et al., 2012). This raises questions as to whether the study was assessing executive function to a greater degree than word generation abilities.

Further support for research into verbal fluency and HIV-infection in a South African population comes from a 2002 study by Benito-Cuadrado, Esteba-Castillo, Bohm, Cejudo-Bolivar, and Pena-Casanova who found that verbal fluency tests are culturally biased and highly influenced by socio-cultural factors. The authors of that study go so far as to suggest that a case-control group enrolling HIV-negative children with similar socio-economic backgrounds would be able to provide more definitive answers regarding the relationship between HIV-infection and verbal fluency (Benito-Cuadrado et al., 2002).

The above literature indicates that although HIV-infection is linked to deficits in verbal fluency, there is a paucity of research on the performance, in English, of bilingual HIV-

positive adolescents on a managed ARV programme on measures of verbal fluency that control for socio-economic backgrounds.

2.4.1.2 Vocabulary

Assessing vocabulary is considered an integral part of neuropsychological testing (Bialystok et al., 2009). Coplan et al.'s (1998) study is important to note as they deduced that language deterioration may precede evidence of a decline in global cognitive ability. They came to this conclusion by studying 9 infants and young children infected with HIV, and 69 seropositive but uninfected infants and children aged 6 weeks to 45 months. All the participants underwent periodic language testing with the Early Language Milestone Scale (2nd edition) at 3 month intervals, and those participants who were undergoing ARV treatment were also assessed using the Bayley Scale of Infant Development or the McCarthy Scales of Children's Abilities (Coplan et al., 1998). Their results indicated that 7 of the 9 infants and young children with HIV infection were observed as experiencing language deterioration. In addition to this, children who began antiretroviral treatment immediately showed a marked improvement in language ability (Coplan et al., 1998). This is particularly important for the South African context in which many of the adolescent population living with HIV-1 may not have had immediate exposure to ARV treatment and therefore experienced abnormalities in language prior to treatment. These abnormalities may have persisted into the treatment programme. Coplan et al. (1998) therefore posited that because the recovery of language function sometimes preceded improvement on measures of global cognitive ability, periodic assessment of language development should be conducted as a means of monitoring disease progression and the efficacy of drug treatments.

A 2005 study by Jeremy et al. attempted to understand the relationship between neuropsychological functioning and viral load in stable antiretroviral therapy-experienced HIV-infected children. They administered a wide range of measures of cognitive functioning to 489 HIV-infected children who were aged 4 months to 17 years and had been treated previously for at least 16 weeks with ARVs (Jeremy et al., 2005). The authors found that neuropsychological functioning in general was significantly poorer at baseline for the HIV-infected children as compared with established norms for their age (Jeremy et al., 2005). In particular the children with higher viral loads displayed poorer cognitive performances.

However, of particular note was the finding that after 48 weeks of treatment with ARVs the only significant improvement in cognitive functioning was in the Vocabulary score – although the effect size was relatively small (Jeremy et al., 2005). This implication of this in the present study is important as it not only illustrates the importance of vocabulary assessment, but also demonstrates how treatment can result in improvement in this arena.

Brackis-Cott et al. (2009) offer one of a limited number of international studies that examine the impact of perinatal HIV infection on adolescent's receptive language and word recognition skills. The study included 206 perinatally HIV-infected older school-aged children and adolescents aged between 9 and 16 years of age, and 134 sero-converters. The Peabody Picture Vocabulary Test (PPVT-III) was utilised in the study to determine the receptive language abilities of the participants, and the reading subtest of the Wide Range Achievement Test (WRAT-3). No contrast group was used in the research; instead the scores of the adolescents were compared to their age-appropriate norms to determine their current level of receptive language and word recognition ability (Brackis-Cott et al., 2009). The researchers found that the sample of perinatally HIV-infected youths displayed poor verbal ability, including vocabulary, and a lack of basic skills needed for reading (Brackis-Cott et al., 2009). They noted that the performance of the participants was well below age expectations and the HIV-positive adolescent's performance was statistically worse as compared to the seroreverters on both measures of reading and language ability. This study also raises the important issue of the implications of poor language skills as they may limit the adolescent's ability to fully comprehend and understand their illness which may compromise their ability to adhere to their medication regimes (Brackis-Cott et al., 2009).

It is, however, important to note that the majority of studies performed on HIV-infected children range in sample ages from 1 to 15 years of age. Few studies exist that focus specifically on adolescent HIV-infected individuals, and virtually no studies exist which highlight the impact of HIV-infection on language function in this age group in a South African setting. The current management of HIV infection through ARV treatment has lead to a larger number of children reaching adolescence than previously (Brackis-Cott, Kang, Dolezal, Abrams & Mellins, 2009), and this age group is of particular interest due to the issues surrounding the advent and roll-out of antiretroviral treatments for HIV-infected children in South Africa.

2.5 Bilingualism and Multilingualism

Bialystok, Craik, Green and Gollan (2009) state that “as the world becomes more interconnected, it is increasingly apparent that bilingualism is the rule and not the exception” (p. 89). Indeed, nowhere is this more apparent than in the South African context where constitutional recognition has been given to eleven languages to deem them official languages. This has created a population in which the majority of its inhabitants are multilingual (Bethlehem, de Picciotto & Watt, 2003), and it is therefore imperative when discussing aspects of language in a South African context to consider bilingualism or multilingualism as a factor.

Interest has grown in the field of language development of children exposed to two or more languages, and to this effect research has indicated that bilingualism enhances cognitive flexibility (Mathur, Tiwari & Bellur, 2010). This is supported by research performed on bilingual 12 month old infants who, upon being presented with auditory stimuli to learn differing response, demonstrated more flexible learning than their monolingual counterparts (Kovacs & Mehler, 2009).

However, bilingualism and multilingualism bring with them a unique set of variables and logistical difficulties (Adler, 2001) that interact with, and impact upon the reach of neuropsychological assessment, therapy, research, or intervention. For instance, research exists to support the theory that the major language milestones regarding competence in sounds, words, and sentences that form the foundation of acquiring language are passed at equivalent times for children growing up in bi- and monolingual households (Bialystok et al., 2009). Bilingual children, however, have been noted to make unequal progress in developing vocabularies (Bialystok et al., 2009). It is therefore important to acknowledge that language skills that traditionally develop in synchrony for monolingual speakers may develop at different rates in one or both languages for bilingual children (Pearson, 2002).

In the local context, South African schools express a widespread preference for education in English. Due to the partial implementation of Revised National Curriculum Statement’s Language Policy, South African educators face the challenges of large numbers of English for Speakers of Other Languages (ESOL) learners in their classes (PANSALB, 2000). The resultant effect of bi- and multilingualism in this instance therefore is that while learners may be able

to use English competently among peers and in social settings, they may not be proficient in the type of language expected in the classroom (Cummins, 2000). While it may take ESOL learners approximately two years to become competent in ‘social’ English, it takes them five to seven years to reach the same level as their first-language peers in terms of instructional English (Cummins, 2000). The developmental progress of language acquirement and usage in bilingual adolescents therefore necessitates that all results from the present research must be interpreted within a bilingual or multilingual framework as “the regular use of two languages by bilingual individuals has been shown to have a broad impact on language and cognitive functioning” (Bialystok et al., 2009, p. 89).

Indeed, reliable differences have been found between HIV-negative monolinguals and bilingual people on verbal fluency tasks such as the Controlled Oral Word Association Test (Bialystok et al., 2009), with bilingual individuals scoring lower than their monolingual counterparts. However, in consideration of either phonemic or semantic fluency, bilingual individuals performed worse on semantic fluency than on letter or phonemic fluency (Bialystok et al., 2009). In addition to this, it has already been noted that bilingual children often have a smaller vocabulary in each language in comparison to monolingual children (Bialystok et al., 2009). The differences between monolingual and bilingual children in regards to verbal fluency and vocabulary can, in part, be attributed to the fact that these individuals must learn almost double the amount of words and more sentence patterns than their age-related monolingual counterparts at various developmental stages (Peña, Gillam, Bedore & Bohman, 2011). Therefore, any assessment of verbal fluency and vocabulary must take bilingualism into account in order to ensure that any possible deficits are not seen as directly related to an external factor, but rather that bilingualism plays a role in language development.

2.6 Rationale

The interactions of a treatment initiation, HIV-infection related deficits, bi- and multilingualism, and as well as the lack of information on HIV-1 infection and the South African context all combine to present a unique local picture of adolescent HIV infection.

Within the literature on paediatric HIV, there is consensus that neuropsychological impairments do exist in seropositive HIV children (Wachsler-Felder & Golden, 2002).

However, clinical symptomologies differ from region to region (Rao et al., 2008) and as such the results of HIV-1 Clade B infection research, which is primarily performed in an American or European context, cannot be generalised to a South African population consisting of predominantly HIV-1 Clade C infection. This factor adds viability to the study through the importance of assessing HIV-1 related neurocognitive impairments in a South African context, where the majority of the world's HIV infections are seen.

Additionally, studies on neuropsychological functioning and ARV treatment in HIV / AIDS populations demonstrate that one of the most important methodological principles in studying on HIV positive individuals who are currently being treated with ARVs is the selection of appropriate samples to study (Cysique & Brew, 2009). Existing research on HIV-infection and neurocognitive functioning (including language and communication) has, for the most part, focused on infants, children, and adults, with a paucity surrounding adolescents with vertically acquired HIV (Brackis-Cott et al., 2009; Martin et al., 2006). International reports indicate that older school-age children who were perinatally HIV-infected display significant learning problems that affect their academic performance, developmental milestones, and ability to function independently (Wolters et al., 1995). This research will therefore address a particular subset of HIV-infected individuals which has to date received little attention (Brackis-Cott et al., 2009), despite the importance of neurocognitive development during this time.

As children transition from early to middle adolescence, language and reading skills are critical building blocks for literacy and future academic success (Denti & Guerin, 2004; Durham & Farkas, 2009; Ippolito et al., 2008). Therefore language deterioration can be seen as a significant precedent marker of potential global cognitive deficits in children (Coplan et al., 1998). However the lack of knowledge surrounding HIV-1 infection's potential impact on verbal fluency and vocabulary (in English) in bilingual adolescents in a South African context is an important topic that needs to be addressed. As such, research into the effects of HIV-1 on language function in adolescents on a managed ARV treatment program in a South African context is an appropriate and viable area of focus.

This research may also be seen as adding to the existing literature base on HIV-infection and could form part of a foundation upon which further studies of this nature could be determined.

The bilingualism in this age group is also an important factor to consider due to the transition from childhood to early and middle adolescence, highlighting the importance of language and reading skills as critical building blocks for literacy and future academic success (Denit & Guerin, 2004; Durham & Farkas, 2009; Ippolito et al., 2008; Shapiro, 2008). The assessment of verbal fluency and vocabulary in English in a South African context is not a superfluous task. Research has shown that in Zulu-English bilingual individuals, provided the individual's language proficiency is balanced and assessment cannot occur in both languages, it is preferable to test verbal fluency in English (Bethlehem et al., 2003). Additionally, research has shown that it is inappropriate to apply monolingual normative data to bilingual populations on verbal fluency scales (Nell, 2000). Therefore, through the use of a matched control group this research hopes to provide valid research regarding the interaction between HIV-infection and verbal fluency and vocabulary in South Africa as this is underrepresented research and knowledge area.

Finally, it has been discussed already that HIV-infection impacts negatively on cognitive functioning or development in children and adolescents. However, compounding this is the belief that young bilingual children from low-Socio-Economic Status (SES) families, such as may be seen in this research, may be at risk for early literacy difficulties due to their low levels of vocabulary (August & Shanahan, 2006; Snow, Burns, & Griffin, 1998). In particular, maternal education level is associated with a child's vocabulary development in low-SES backgrounds (Hart & Risley, 1995) and as the majority of South Africa's population live in low-SES environments, this further highlights the express need for research into HIV-infected adolescents in a South African context.

2.7 Research Question

The previous literature gives rise to the following research question:

What are the presentations of verbal fluency and vocabulary in English in bilingual adolescents living with HIV-1 compared to a contrast HIV- control group?

3. Methodology

3.1 Research Aims

3.1.1 General

To establish the relationship between verbal fluency and vocabulary in English in bilingual adolescents living with HIV-1 in comparison to a matched, HIV-negative control group.

3.1.2 Specific

1. To ascertain if there are any statistically significant differences in **verbal fluency** attributable to the adolescent's HIV+ status. This will be determined through a comparison of scored results from neuropsychological tests conducted on the HIV + sample and a matched HIV – control sample.
2. To ascertain if there are any statistically significant differences in **vocabulary** attributable to the adolescent's HIV+ status. This will be determined through a comparison of scored results from neuropsychological tests conducted on the HIV + sample and a matched HIV – control sample.

3.2 Variables

3.2.1 Independent Variable

Theoretically, the Human Immuno-deficiency Virus (HIV) is retrovirus that infects lymphocytes and macrophages, enabling the conversion of viral RNA into DNA and leading to a compromised immune system. HIV infection leads to acquired immunodeficiency syndrome (AIDS).

The human immunodeficiency virus has two categorisations as an independent variable in the present research:

3.2.1.1 HIV+

Vertically-transmitted HIV seropositive status indicates the presence of the HI virus, the HIV antibodies, and the HIV antigens and is managed by an ARV treatment programme.

The independent variable is operationalised as the HIV-1 seropositive status of adolescent children as diagnosed by a medical professional using standard medical tests, such as ELISA, Western Blot or Rapid Tests, and/or HI virus antigen tests. This will be confirmed on the basis of access to collateral information pertaining to the participant, including access to

medical files, regarding HIV-1 positive diagnosis and subsequent admission to the Rahima Moosa Mother and Child Clinic for ARV treatment for HIV-1 infection.

3.2.1.2 HIV-

HIV-negative status is the absence of the HI virus, the HIV antibodies and the HIV antigens.

HIV negative status of the adolescent is operationalised by the participant's lack of diagnosis or involvement in an HIV-1 treatment programme (for which HIV status must be confirmed), the absence of chronic ARV medication intake, as well as the lack of absenteeism from school due to possible HIV secondary infections. An appropriate questionnaire and collateral information about the participant regarding medication use or participation in any treatment programmes will be taken into consideration in this operationalisation.

3.2.2 Dependent Variables

3.2.2.1 Verbal Fluency

Definition: Verbal fluency refers to the capacity of a person to self-generate, in rapid fashion, phonemic categories (e.g. names of different words beginning with a given letter of the alphabet) or within some semantic category (e.g., animals, fruits, vegetables) (Prigatano, Gray & Lomay, 2008).

Operationalisation: The raw scores obtained in the measurement results of the following neuropsychological assessment instrument: the Controlled Oral Word Association Test's Phonemic 'F', 'A', and 'S' categories and the semantic 'Animals' and 'Fruit' categories. Seven scores will be measured; the total number of words per trial ('F', 'A', and 'S') and the total number of words, in addition to the number of items generated in each of the semantic trials ('Animals' and 'Fruit') and the overall items generated.

3.2.2.2 Vocabulary

Definition: The acquisition, recollection, and coherent expression of words; an indication of crystallised knowledge (Prifitera, Saklofske, & Weiss, 2005).

Operationalisation: The raw scores obtained in the measurement results of the following neuropsychological assessment instrument: the Vocabulary subtest of the WISC-R.

3.2.3 Extraneous Variables

Extraneous Variables that were controlled for:

- Test administration: The neuropsychological assessment consisted of the same battery of tests for all administrations to all participants, strictly following the standardised testing version. As the administration of one test may affect the participant's performance in another test, this was controlled for by repeating the order of the test battery in each assessment of each participant.
- Demographics: The contrast group was deemed comparable by means of a biographical questionnaire, through which factors such as socio-economic status, gender, and education level were matched. This eliminated the potential confounds associated with these factors on the results.
- Language: All subjects were required to be bilingual. This was achieved through methodological techniques such as a biographical questionnaire. The presence of eleven official languages in South Africa necessitates the inclusion criteria of a minimum of at least four years of English medium schooling to enable effective participation in standardised neuropsychological assessment.
- Clade: Participants collateral information was examined to determine which clade of HIV-1 infection they have. Clade C infections were focused upon.
- Experimental Environment: The environment in which the experimental group was assessed had good ventilation and lighting with minimal interference or disruption. There was adequate equipment within the room which was homogenous across the different offices utilised.

Extraneous Variables that cannot be controlled for:

According to McBurney (2001) threats to internal validity present as the following:

- Environment: The environment where the contrast sample interview and assessments were conducted was not homogenous and therefore could not be controlled for. In addition to this, the assessment environments differed for both the HIV-positive and HIV-negative sample and this was not controlled for.
- Duration of ARV treatment: The length of ARV treatment was not control for and therefore individuals of varying treatment length were assessed. The age and health level at ARV commencement is positively associated with neuropsychological test

performance (Wright, 2009), and therefore performances on the assessment could not be considered equivocal with regard to treatment.

- Drug regimen: The drug regimes of the HIV-positive participants were not homogenous. However, all participants will be on first-line ARVs.
- CD4⁺ count: This relates to the overall health of the individuals. Poorer health generally is associated with poorer test performance overall. This was not examined in this study.
- Gender: Both males and females were included.
- Personality: An achievement-oriented personality may perform differently on the tests compared to a more laid-back personality. This was not examined in this study.
- Motivation: High motivation to do well on the tests may generally result in better test performance than someone who is not motivated and does not make sufficient effort on the tests. This was not examined in this study.
- Mood: Depression and apathy, as well as other affective disorders, affect neuropsychological test performance (Beblo, Sinnamon, & Baune, 2011). This was not examined in this study.
- The subjectivity of the researchers: Some researchers may be more lenient in their application of scoring rules than others. However, all researchers will be trained in test administration and scoring to reduce this effect as far as possible.
- Fatigue of the participants: This research formed part of a larger study in which an extended assessment battery was utilised. The extended battery could lead to fatigue in the participants and fatigue is known to negatively affect test performance (Krupp & Elkins, 2000). The battery of tests was, however, administered in the same order so participants were exposed to the same number of tests at each stage of the testing process. This may assist in reducing the confounding effects on the tests within this study.
- Possible previous exposure to neuropsychological testing: Participants who have been exposed to testing previously are more test wise and have an advantage in test performance compared to others (McBurney, 2001). This was not examined or controlled for in this study.

- Test administrators: All assessors received the same training in the administration of the test battery and are all of post-graduate academic level. However, as the assessors are not homogenous, inter-assessor variability may occur (Yeates, O'Neill, Mann, & Eva, 2012).
- Test-taker anxiety: The participant's trait anxiety or desire to perform well on assessments can affect the participant's performance on neuropsychological assessments (Hoffman & al'Absi, 2004; McBurney, 2001), and therefore not provide a valid calculation of an individual's ability. Although the administrators took care to place the participants at ease, this element was not controlled for.
- Participant expectations: Participant's may have expected to perform better on tests or assessments than they did, and this may have lead to negative psychological risks and decreased test performance.
- General Health: This study did not control for general health at the time of assessment, although chronic illness was controlled for or used as an exclusion criterion.

4. Research Design

A quantitative, non IV-manipulated, exploratory, cross-sectional, quasi-experimental, ex post facto design was utilised in the present research to address the research question and to explore both relationships between variables as well as potential differences between groups.

4.1.1 Sample

The sample consisted of 30 HIV-positive adolescents between the ages of 13 to 15 years old. A contrast group of 73 HIV-negative children will also be tested for comparative purposes, and will be controlled for socioeconomic status (operationalised by the area in which they live), gender, and education. For purposes of fluency of reading, Group 1 will consistently refer to the 30 HIV-positive bi- or multilingual adolescents whilst Group 2 will indicate the HIV-negative contrast group.

Participants for the contrast group were obtained from the same schools in the Orlando area of Soweto reported on by Skuy et al. (2001). They were selected on the basis of age, gender, and socioeconomic status in order to form an appropriate contrast for the

experimental group. Socioeconomic status was determined through the biographical questionnaire. A letter was sent home with the children explaining the research, which included a request that should the child not be on chronic medication, HIV positive, have experienced a head injury, have any neurological impairment, or is living outside of the nuclear family structure, a response to the request for participation is not necessary. In this way the exclusion criteria that apply to the HIV-positive group was operationalised in the HIV-negative control group.

4.1.2 Inclusion and Exclusion Criteria

Both the experimental and contrast groups were selected according to the following inclusion or exclusion criteria:

4.1.2.1 Language

A minimum of four completed years of English medium school education was required. This criterion is needed in order to minimise the extraneous impact of language proficiency in testing second language English speakers.

4.1.2.2 Institutionalised Children

Children that have been raised in an institutional setting or without a parent or guardian were excluded from the research. This was done based on the strong support found in the literature that institutionalisation brings with it its own set of neuropsychological sequelae (Pollack, et al., 2010).

4.1.2.3 Neurological Compromise

Based on similar neurobiological reasoning, additional exclusion criteria included any form of neurological compromise such as Epilepsy, Meningitis, Traumatic Brain Injury, and Encephalitis. Neurological compromise may produce neuropsychological deficits unrelated to HIV infection (MacAllister & Schaffer, 2007; Merkelbach, Sittinger, Schweizer, & Muller, 2000; Vakil, 2005; Vanderploeg, Crowell, & Curtiss, 2001). Therefore the exclusion of these factors was done to reduce the impact of possible confounding variables to keep the integrity of the internal validity so that the results of the instruments reflect the deficits caused by HIV and not any other cause.

Table 4.1**Age and Gender of Participant Samples**

Group	N	Level of Education (M)	Age (M)	Gender
Group 1	30	7.9	14.08	14 (M) 16 (F)
Group 2	71	8.6	14.2	33 (M) 33 (F)
			Missing = 8	Missing = 5
Total	101		93	96

Table 4.1 illustrates that the mean level of education for Group 2 is 8.6 years which equates to roughly Grade 8 (excluding possible Grade R and 0 exposure). Group 1's mean level of education (7.9) is similar to Group 2 which promotes the equivalency of the two groups in terms of mean level of education. Additionally, the mean age of the two groups and the gender distribution within each group is also highly equivalent which indicates the suitability of the two groups for comparative analysis.

Table 4.2**Age Distribution of Participant Samples**

Age	Group 1	Group 1 %	Group 2	Group 2 %
13	10	33.33	17	26.98
14	9	30.00	20	31.75
15	10	33.33	24	38.10
16	1	3.33	2	3.17
Total	30	100.0	63	88.7

Table 4.2 indicates that the majority of the participants in Group 2 were 15 years old (38.10% of the total sample) whilst the age distribution of the participants in Group 1 was

more evenly spread between 13 years of age (33.33%), 14 years of age (30.00%), and 15 years of age (33.33%).

Table 4.3

Handedness of Participant Samples

Group	Writing			Cutting			Kicking			Total
	Right	Left	Both	Right	Left	Both	Right	Left	Both	
Group 2	61 (87.14 %)	8 (11.43 %)	1 (1.43 %)	59 (84.29 %)	9 (12.86 %)	2 (2.86 %)	38 (54.29 %)	15 (21.43 %)	17 (24.29 %)	70 (98.6%)
Group 1	27 (90.00 %)	3 (10.00 %)	0 (0.00 %)	26 (86.67 %)	3 (10.00 %)	1 (1.11 %)	18 (60.00 %)	8 (26.67 %)	4 (13.33 %)	30 (100%)

Table 4.3 illustrates the handedness of the participant sample and indicate that for both samples the majority of the participants were right handed for all the activities listed, and are therefore considered appropriately contrasted.

4.2 Procedure

4.2.1 Pre-Experimental

Ethical clearance for the research was obtained prior to the start of the study through the submission and acceptance of a proposal to the University of the Witwatersrand Human Research Ethics Committee (Medical).

In accordance with the Human Sciences Research Council and the Health Professionals Council of South Africa ethical code, written informed consent was sought from the participant's parent, carer, or legal guardian (please see Appendix C).

The researcher was given access to the patient files at the Empilweni Clinic at Rahima Moosa Mother and Child Clinic during the adolescent clinic day. Once an appropriate file was selected, the researcher invited the adolescent and guardian to participate in the study while they await their clinic check-up with the doctor. If the parent, carer, or legal guardian

of the participant not be literate or proficient in the English language, a medical professional at Rahima Moosa Hospital assisted in the translation of the research request.

It was conveyed to the parent or guardian, and the adolescent, that they could decline participation without the fear of negative consequences on their medical treatment.

If the parent or guardian of the adolescent consented to the assessment, a meeting with the participant, parent or guardian, and the researcher took place during which information relating to the research and the participant's role and rights in the research was explained. Once the participant had indicated, through written assent, that they will be a part of the study and the parent or guardian has signed the informed consent form, the data collection began (please see appendices 1-8). Data collection was performed by all principal researchers in the overall study.

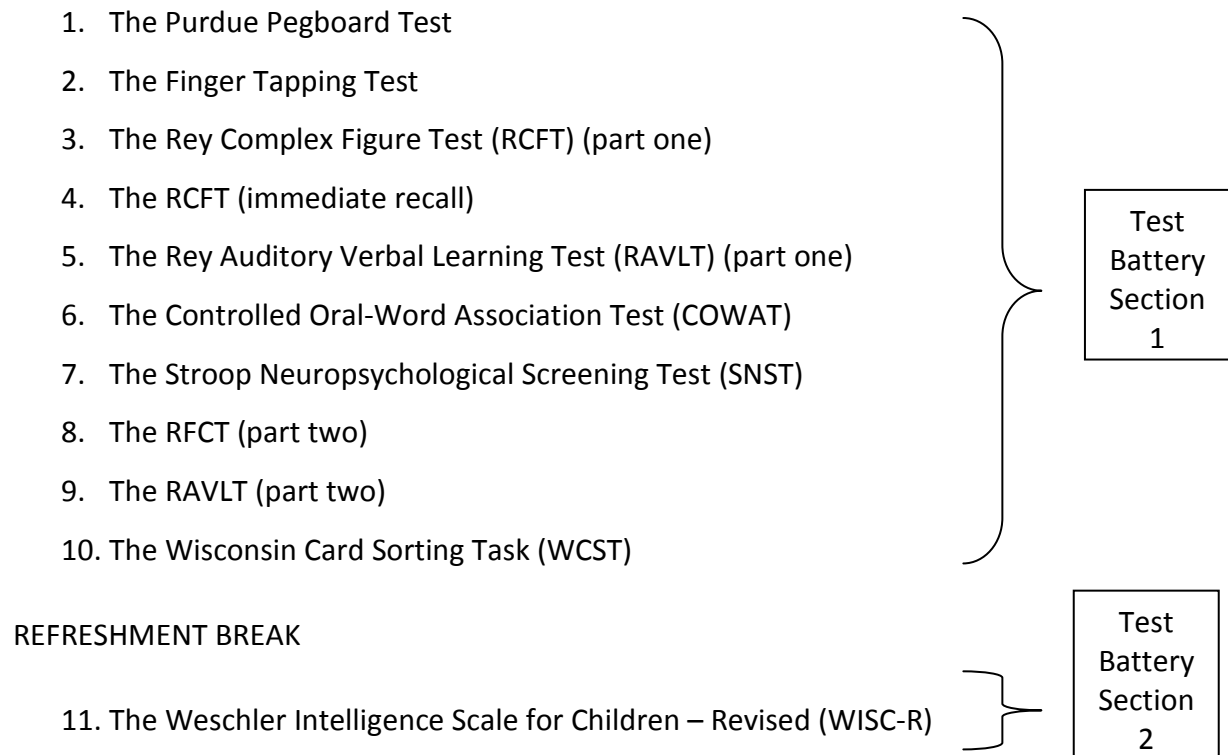
Access to the research materials in the form of the neuropsychological test battery was gained through the Emthonjeni Centre at the School of Human and Community Development at the University of the Witwatersrand. All test and research material was signed out of the test library and resource room in accordance with university policy. The researcher abided by the code of the test library and research room and did not lend research material or disclose information that is considered confidential.

4.2.2 Experimental

Data collection occurred at the Rahima Moosa Mother and Child Hospital, one of the University of the Witwatersrand Medical School's three teaching hospitals. The hospital holds clinical check-up days on Tuesdays, Wednesdays, and Thursdays. Patients who fit the inclusion criteria and assented to participate were taken for assessment directly after their regular clinical check-up. The same procedure was implemented for the data gathering of the contrast group at the school. Contrast group participants were assessed with as little disruption to the school timetable as possible in the school holidays.

Each assessment with a participant took between three and a half to four hours. As part of larger study, the assessment of language lies within the different subtests in the chosen assessment battery. The researcher provided regular opportunities for breaks throughout the assessment sessions in order to ensure a minimum of fatigue or discomfort.

The administration of the neuropsychological assessments was alternated in terms of visual and verbal assessments in order to reduce fatigue effects and will be administered as follows:



Participants were given a 15 minute break after the first section of the assessment battery was completed during which time they saw the doctor and were given light refreshments.

The first section of the test battery took approximately one and a half hours to administer, whilst the WISC-R took between one and a half to two hours to administer. The tests were administered according to a rotation system in which certain assessors would begin with the Test Battery Section 1 whilst others would begin with the Test Battery Section 2 in order to counteract possible fatigue affects of the assessment.

4.3 Assessment Instruments

Instruments essential to the assessment of language in the given study are described below in addition to the other tests in the assessment battery as a comparison of verbal and non-verbal skills provides a good indication of the individual's language abilities:

4.3.1 Controlled Oral Word Association Test (COWAT)

The COWAT assesses verbal fluency or the ease of verbal production (Lezak, 2004, p. 518). The test requires a participant to say as many words as possible, excluding proper nouns,

same words with different suffixes, and numbers, beginning with a given letter of the alphabet – traditionally 'F', 'A', and 'S' – within three one minute trials (Lezak, 2004).

Scores are adjusted for the number of years of education for specific age groups and gender (Benton, Hamsher & Sivan, 1994). Snow, Tierney, Zorzitto, Fisher, and Reid (1988) found that the COWAT had reliability coefficients between .70 and .71 for all letters and the overall score in elderly people.

4.3.2 The Wechsler Intelligence Scale for Children – Revised (WISC-R)

The Wechsler Intelligence Scale for Children Revised (WISC-R) has ten scales, and two additional supplementary scales which have been combined in such a way that the WISC-R is a measure of Verbal IQ (VIQ), Performance IQ (PIQ), and Full Scale IQ (FSIQ). VIQ is comprised of the Information, Similarities, Arithmetic, Vocabulary and Comprehension subtests and PIQ is comprised of the Picture Completion, Coding, Picture Arrangement, Block Design and Object Assembly subtests. For the purposes of the present research, the vocabulary subtest was utilised which requires the participant to 'define' or explain the meaning of a number of words or pictures presented sequentially and ranging in difficulty (Flanagan & Kaufman, 2009).

The WISC-R is an individual test that does not require the participant to engage in any reading or writing. The test administrator sits with the participant and facilitates the completion of each of the ten subtests. Within this particular study, the Vocabulary subtest was used exclusively to answer the research question. This subtest involves the assessor asking the participant for the definitions of a number of words that range in difficulty. The participant's answers are then graded on a system from 0 to 2 depending on the appropriateness of their answers.

Overall internal consistency reliability coefficients have been generated where PIQ has a reliability coefficient of 0.90, VIQ of 0.94, and FSIQ of 0.96 respectively. Correlation coefficients for the Verbal subtests range from 0.63 for Similarities to 0.80 for Digit Span, while correlation coefficients for the Performance subtests range from 0.59 for Picture Completion to 0.80 for Object Assembly (Franzen, 2000). The use of the WISC-R over the more modern WISC-IV was decided on as the WISC-R has received more use and attention

within South African research (as seen in Skuy et al., 2001) and therefore has a wider database of South African relevant normative data that can be used for comparison.

4.4 Hypotheses

A hypothesis is a hypothetical statement about the relationship between variables that is tested through observation or experimentation. A formal hypothesis is the exact formulation of a predicted relationship between or among events; in other words a testable idea (McBurney, 2001).

The **Formal and Central Hypothesis** for the proposed research is:

There are statistically significant differences in the averages of the HIV- positive and HIV- negative groups regarding verbal fluency and vocabulary.

A null hypothesis (statistical hypothesis) is a statement about the lack of difference between or among events which, after testing or experimentation, is either confirmed or rejected. It is a hypothesis of no scientific interest, otherwise known as the hypothesis of no difference (McBurney, 2001). Null hypotheses are used in research where it is difficult to prove that a relationship exists between two or more variables. It is more appropriate to state that the relationship does not exist, and then to establish, through testing, whether this is true or not. This research will primarily make use of null hypotheses, and Null Composite Hypotheses for the formal hypotheses follow.

4.4.1 Verbal Fluency

Null Composite Hypothesis 1: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT 'F' Verbal Fluency test.

Null Composite Hypothesis 2: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT 'A' Verbal Fluency test.

Null Composite Hypothesis 3: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT 'S' Verbal Fluency test.

Null Composite Hypothesis 4: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT 'Animals' Verbal Fluency test.

Null Composite Hypothesis 5: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT 'Fruit' Verbal Fluency test.

4.4.2 Vocabulary

Null Composite Hypothesis 6: There are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the Vocabulary subtest of the WISC-R.

4.5 Ethical Considerations

In terms of the National Health Act (Act No. 61 of 2003), all health research proposals and protocols require approval by an accredited health research ethics committee before the research may commence. In order to obtain ethical research approval, certain guidelines must be adhered to. These guidelines contribute to achieving responsible health research that is scientifically, ethically, and legally sound. This research was conducted in accordance with the approved research protocol and guidelines of the Health Professions Council of South Africa's (HPCSA) Ethical Guidelines in Health Research.

This protocol states that researchers conducting health research involving human participants need to consider the possible adverse impacts of their research on vulnerable groups and thus have a duty to observe the highest possible standards to protect the rights of research participants (HPCSA, 2008).

This research protected the rights of the participant through:

1. The adherence to the principle of autonomy in ethical research. This states that participants that are capable of deliberation about personal choices should be treated with respect for their capacity of self determination and be afforded the

opportunity to make informed decisions with regard to their participation in research (HPCSA, 2008). The participants and their parents or guardians in this research were informed of their right to decline to participate or withdraw from the research at any time without reason or prejudice in accordance with the Code of Research Ethics of the Professional Board for Psychology, the Health Professions Council of South Africa's General Ethical Guidelines for Health Researchers, and the Human Sciences Research Council.

2. This research will adhere to the principle of confidentiality in ethical research which states that a participant's right to both privacy and confidentiality must be protected. The researcher must ensure that where personal information about research participants is collected, stored, used or destroyed, this is done in ways that respect the privacy or confidentiality of participants and any agreements made with the participants. Confidentiality will be kept with the utmost importance and should the participant require any further information this will be done in collaboration with the medical officer consulting on the case.
3. The anonymity of the participant to the researcher and the personnel at the hospital cannot be ensured as the participants will be physically present during the assessments. Their information will be kept anonymous from personnel external to the research however, through the coding of data related to the participant and the removal of all identifying information from the material and data that may be linked to the true identity of the individual. Data and research material will be kept in the private office of the researcher in a locked filing cabinet of which the researcher is the sole holder of the key. Non-disclosure of coded information, data or other material related to the research will be the primary form of confidentiality and the researcher respects the rights of the participant not to have their information destroyed, discussed or disclosed to any group, persons or institution unless otherwise stated and agreed upon in a formal signed confidentiality agreement.
4. The participant will be provided with an information sheet that ensures the participant's right to make an informed decision about entering into the research project. The information sheet advises the purpose, expected duration, and

procedures included in the research in understandable language. As the participants are above the age of assent, but below the age of consent, they will be asked to sign an assent form to ensure their rights as a voluntary participant in the study. The signed agreement indicates that the research has been fully explained to the participant and that they fully understand their rights as a participant as written in the information sheet, what the researcher's expectations are and what their role in the research will be. Their parents or legal guardians will therefore be required to fill in a consent form.

5. The children in the HIV-positive sample attend an HIV clinic for the management of their treatment programme and are on ARV's. As such, each participant should be aware of their HIV status. However, due to the sensitivity and possible stigma surrounding HIV status in South Africa, the participant's themselves will not be informed that the research investigates the effect of treatment managed HIV and the effects of HIV itself will not be elaborated on.

All ethical research must be conducted under the principle of justice which imposes an ethical obligation to treat each person in accordance with what is right and proper. In this research this is discussed as primarily distributive justice whereby there should be equitable distribution of both burdens and benefits of research participation. It is an ethical imperative that the study should leave the participant and or community better off or no worse off. In accordance with this principle, the present research posits to uphold both the principle of non-maleficence and the principle of beneficence.

Non-maleficence is the belief that the risks and harms of research to participants must be minimised. Neuropsychological assessments of this kind do pose the risk of some psychological discomfort to the participant in that they experience test performance anxiety. The participant may not only feel anxious in their attempt to do 'well' in the assessments, but may be confronted with a possible deficit in their cognitive performance that they may have been unaware of or in denial about. This may cause further anxiety or psychological distress. In order to reduce the level of risk and harm to the participant as much as possible, the following options will be made available to counter the possible adverse effects of assessment:

1. Psychological Counselling

Referrals for pro bono counselling services will be made available to the participants if they experience distress for any reason. Use of the University's counselling centre was optioned to the participant.

Beneficence, in the present research, is illustrated through:

1. The research results will serve as a current indicator of the participant's overall language functioning. It is believed that the participants have had no such assessment performed previously and thus now have the opportunity to have them done at no direct financial cost.
2. As the assessment process may take some time, refreshments will be provided for the participants and their guardians (if present). If the participants are travelling to the hospital for the sole purpose of assessment for the research, instead of routine check-ups, their travelling costs will be reimbursed. In these instances, participants will be asked to attend testing sessions that occur during the schools holidays so that no school is missed.
3. All assessments are non-invasive, manual, pen-and-paper style tests which present no foreseeable harm to the participants through participation in the research.

The proposed research believes it has taken into consideration all possible adverse impacts of the research on the participant. The researcher will observe the highest possible ethical standards to ensure the research participant's rights.

Permission for testing the HIV group will need to be obtained from the Empilweni Clinic while permission for testing the control group will be obtained from the Department of Education and the school itself.

5. Results

This chapter will describe the findings of the study which will be presented in tabular form after which a brief description of each table will be provided. Data pertaining to verbal fluency and vocabulary was extracted from the data of the overall study and was statistically analysed using SPSS (Version 17) to determine inter-group differences. For fluency of reading, reference to Group 1 will consistently imply the Multilingual Adolescents living with HIV-1 whilst Group 2 will be considered the Multilingual HIV-Negative Adolescents.

Firstly descriptive statistics as determined by the mean, mode, median, standard deviation, minimum, and maximum for the linguistic variables of both Group 1 (HIV-positive sample) and Group 2 (HIV-negative comparison sample) will be presented. This is done to ensure the equivalency of both groups in terms of language of use in the home and school environment. No further descriptions of Group 2 will be presented as these form part of a bigger research project and limits of confidentiality are applicable to the data.

Further descriptive statistics (mean, standard deviation, minimum and maximum) for the HIV clinical information of Group 1, including the age at which HAART was commenced, the duration of ARV treatment, the World Health Organisation (WHO) stage at diagnosis, the starting and current CD4⁺ counts, and the starting and current viral loads, will be provided. Following this, descriptive statistics for Group 1 for each of the dependent variables, as operationalised by performance on the neuropsychological tests, are offered. No descriptive statistics will be offered for Group 2 due to confidentiality limits surrounding the use of the data that is presently being used in an ongoing research project.

The normality of distribution in the study was ascertained first using the Kolmogorov-Smirnov Test of Normality which assesses normality of distribution of a population where there are two independent samples. Non-normal distributions usually indicate the use of non-parametric statistical analyses, as opposed to parametric analyses. Following this, the homogeneity of the two groups in terms of demographic variables such as age and years of education will be presented as determined through the use of the Student's t-Tests.

For those tests in which the normality of distribution was assumed, parametric analysis in the form of Matched-pairs T-tests were run to compare the data for the Group 1 (HIV-positive group) with data collected from a contrast group of HIV-negative adolescents (Group 2). Non-parametric tests such as the Mann-Whitney U-test were used for those tests in which the normality of distribution could not be assumed. These are hypothesis tests where fewer assumptions about the distribution of the underlying variables are made and are preferable in any research where sample sizes are limited or if the assumption of normality does not hold.

Finally, the chapter will display the results of comparative statistical analysis of the dependent variables (as operationalised by performance on the neuropsychological tests) between the two groups as determined by either t-Tests of Variance for the two groups on those measures that displayed normality of distribution, or Mann-Whitney Non-Parametric Test of Variance for two independent samples for those measures that did not display normality of distribution. Significance in statistical analysis refers to the probability that experimental results happened by chance (McBurney, 2001). For the purposes of the present research a significance level of 0.05 applies regarding the parametric and non-parametric tests, which means that the effect was large enough that the probability the findings happened by chance was 1 in 20. Therefore, to have statistically significant results the p-value must be less than .05.

This will be followed by a presentation of correlations between the dependent variables and HIV clinical information using Pearson's Product Moment Correlations where the data was normally distributed, and Spearman's Rank Correlations where the data was not normally distributed. An interpretation of each set of results will follow each tabular result set and discussions concerning the overall findings of the results will be presented in the next chapter.

5.1 Descriptors

5.1.1 Descriptions of the Linguistic Variables of the Two Sample Groups

The linguistic variables of the two sample groups were analysed using descriptive statistical measures in SPSS to determine the equivalency of the two groups in terms of home and school language use. When considering a bi- or multilingual population it is imperative to

ensure the two population samples are linguistically comparable in order for comparisons between the two sample populations to be deemed appropriate. The present research is therefore not utilising the linguistic variables to understand the relationship between language and cognitive function, but rather to acknowledge the impact these factors may have on cognitive performance and how this must be considered when undertaking any analysis of multilingual populations. The results of the linguistic variable analyses are presented in tables 5.1 and 5.2.

Table 5.1 Descriptive Statistics for Primary Language of Instruction in School for Group 1 and Group 2

	N	% English	% Zulu	% SeSotho	% Xhosa	Mean	Median	Mode	Std. Dev.	Min	Max
Group 1	30	100.0	0.0	0.0	0.0	1.00	1.00	1	.000	1	1
Group 2	70 (Missing = 1)	76.1	20.0	1.4	1.4	1.50	1.00	1	.959	1	5

Table 5.1 illustrates that the mean language of instruction in school for is 1.00 for Group 1 and 1.50 for Group 2 with a standard deviation of .959. Despite this, the difference in sample size between the two groups and the comparable means of the two groups indicates that 76.1% of Group 2 (N = 53, 3) and 100% (N = 30) of Group 1 are instructed in the English. The Mode (1) and Median (1.00) for the two groups also indicate that English is the average language of instruction and promotes the equivalency of the two groups in terms of language of instruction in school.

Table 5.2 Descriptive Statistics for Primary Language of Use in the Home for Group 1 and Group 2

	N	% English	% Afrikaans	% Zulu	% Sotho	% Xhosa	% Venda	% Tswana	Mean	Median	Mode	Std. Dev.	Min.	Max.
Group 1	28 (Missing = 2)	10.0	10.0	26.7	16.7	20.0	3.3	6.7	3.68	3.50	3	1.63	1	7
Group 2	68 (Missing = 3)	0.0	0.0	69.0	12.7	11.3	0.0	2.8	3.49	3.00	3	.922	3	7

Table 5.2 illustrates that the Means of Group 1 (3.68) and Group 2 (3.49) are comparable in terms of primary language of use in the Home (Zulu). Additionally the Mode (3) for the two groups and the Median for Group 1 (3.50) and Group 2 (3.00) are also indicators of the equivalency of the two groups in terms of language of use in the home environment. These descriptive statistics indicate that the two groups are equivalent in terms of their primary

language of use in the home and primary language of instruction in school and comparisons between their neuropsychological performance on tests of verbal fluency and vocabulary are valid and appropriate.

5.1.2 Descriptions of the Clinical Variables of the Group 1 (HIV-positive group)

Within Group 1, the mean, standard deviation, minimum and maximum of the following clinical variables were considered and are presented below in Table 5.3.

Table 5.3 Descriptive Statistics of HIV Clinical Information for Group 1 (N = 30)

	Mean	Std. Dev.	Minimum	Maximum
Age (years) at which HAART was commenced	7.93	3.00	1	13
Length of time (years) on HAART	6.15	3.04	1	14
WHO Stage at Diagnosis (I-IV)	3.07	1.52	1	4
CD4 Count at Commencement of HAART	564.07	1106.9	16	6239
Current CD4 Count	625.82	268.83	21	1014
Viral Load at Commencement of HAART	222656.23	305965.00	25	1100000
Current Viral Load	16620.68	53014.30	25	240000

Table 5.3 illustrates that Group 1 display a mean HAART initiation age of 7.93 years (standard deviation = 3.00) with the length of time on HAART having a mean of 6.15 years (standard deviation = 3.04). This indicates noteworthy variability in the age of initiation and length of time on HAART, and furthermore that the later age at which they began HAART is also reflected in the late WHO stage (stage 3) at the time of their diagnosis, and therefore symptomatic.

The above table indicates that the majority of Group 1 benefitted from HAART treatment as their mean starting CD4+ count was 564.07 (standard deviation of 1106.91) which is at the

low end of the normal range regarding their CD4⁺ cell counts when they were started on ARV treatment. The mean current CD4⁺ count is 625.82 (standard deviation of 268.83) indicating that most participants CD4⁺ count had increased since their commencement on HAART. It appears that one or more participants had significantly higher CD4⁺ counts at the commencement of HAART (6239) than at the current CD4⁺ record. In addition to this, the mean starting viral load was 222656.23 (standard deviation of 305965.00) and the mean current viral load is 16620.68 (standard deviation of 53014.30), again indicating that most participant's viral load had decreased since their initiation onto HAART.

5.1.3 Description of the Neuropsychological Performance of Group 1

Descriptive statistics in the form of the Means ($\bar{x}$), standard deviations (SD), Mode, Median, Minimum and Maximum were calculated for the HIV-positive group for each of the neuropsychological subtests. Only the HIV-positive sample is described below, as the HIV-negative group was used solely for comparison purposes. The results are shown below in Table 5.4.

Table 5.4 Descriptive Statistics of Neuropsychological Test Results of Group 1 (N = 29 Missing = 1)

Subtest	Mean	Std. Dev.	Mode	Median	Minimum	Maximum
WISC-R Vocabulary	20.4	7.1	17.00	21.00	1.00	32.00
COWAT 'F'	6.7	3.1	3.00 ^a	6.00	2.00	14.00
COWAT 'A'	3.9	2.3	2.00 ^a	4.00	1.00	11.00
COWAT 'S'	6.7	3.5	6.00 ^a	7.00	6.00	22.00
COWAT 'FRUIT'	8.1	2.4	7.00	8.00	3.00	13.00
COWAT 'ANIMALS'	13.3	3.9	11.00 ^a	13.00	6.00	22.00

^a Multiple modes exist. The smallest value is shown.

Table 5.4 illustrates that overall Group 1 displayed a mean performance of 20.4 on the WISC-R Vocabulary subtest, whilst their performance on the COWAT 'ANIMALS' category ($\bar{x}$ = 13.3) was higher than any other COWAT category. The range for the Vocabulary subtest of the WISC-R is very wide (minimum = 1 and maximum = 32) and this is due to the presence of outliers in the sample.

Within the COWAT itself, Group 1 generated fewer Mean words in the 'A' category than in any other category whilst their performance on the 'F' and 'S' categories displayed similar trends in their Mean word generation. The highest Mean word generation is from the 'Animals' category of the COWAT, with the second highest Mean word generation noted in the 'Fruit' category. This indicates that Group 1 was more able to produce words from semantic categories than phonemic categories.

5.2 Normality

Many statistical procedures assume that the dependent variable in any investigation is normally distributed. If the sample size in research is large then the assumption of normality is not imperative (Eiselsen & Uys, 2002). The sample size (N=101) in the present research was not large enough to assume that the data was normally distributed. Consequently the Kolmogorov-Smirnov Test for Normality of distribution of data was performed on the individual subtest in the neuropsychological test battery. The results are presented in Table 5.5.

Table 5.5 Kolmogorov-Smirnov Test for Normality of Data Distribution for the Two Groups on the Neuropsychological Assessment Subtests: Vocabulary and COWAT.

Subtest	Statistic	p-Value (sig.)
WISC-R Vocabulary	0.09	0.07
COWAT 'F' Total	0.1	0.02*
COWAT 'A' Total	0.2	<0.01**
COWAT 'S' Total	0.09	0.07
COWAT 'FRUIT' Total	0.12	<0.01**
COWAT 'ANIMALS' Total	0.09	0.09

Note: *p < 0.05 **p<0.01

As can be seen in the above table, certain subtests did not display adequate normality of distribution and therefore non-parametric statistical analysis was performed on these subtests (COWAT 'F', 'A' and 'Fruit') whilst parametric analysis was performed on those subtests that displayed normal distribution (WISC-R Vocabulary, COWAT 'S', and 'Animals').

5.3 Homogeneity

In order to determine the homogeneity of Group 1 and Group 2 Student's t-tests were performed on the demographic variables of age and years of education. The results are presented below in Table 5.6.

Table 5.6. Results of the Student's t-Test for Homogeneity of Samples

Variable	Statistic	p-Value
Age	-.38	0.70
Years of Education	-1.39	0.17

Note: *p < .05

The results in Table 5.6 indicate that the two groups are not significantly different from each other in terms of age or number of years of education. The two groups can therefore be considered homogenous in terms of these variables and it is therefore appropriate to utilise these groups for comparisons.

5.4 Comparisons

The general aim of the current research study was to establish the relationship between the presentation of verbal fluency and vocabulary in English in multilingual adolescents between the ages of 13 and 16 years living with HIV-1 on a managed ARV programme in comparison to a contrast sample of HIV-negative multilingual adolescents.

Specific aims of the present research were to ascertain if there are any statistically significant differences in verbal fluency or vocabulary attributable to the adolescent's HIV-positive status as determined through a comparison of scored results from neuropsychological tests between Group 1 and Group 2.

In order to address these aims, t-Tests were run on the parametric data whilst Mann-Whitney U tests were run on non-parametric data. These tests compare the performance of the HIV-positive and the HIV-negative participants on each of the dependent variables, as operationalised as scores on the various neuropsychological tests and are delineated below.

5.4.1 Parametric

Results of the t-Test procedures for those subtests that displayed normality of distribution on the Kolmogorov-Smirnoff test of Normality are described below. Levene's test for equality of variances was performed for the WISC-R Vocabulary subtest, and COWAT 'S' and 'Animals' Total. These tests all produced a p value of 0.5 which indicates equality of variance

for each subtest and therefore the results of the t-Test of variances are presented below in table 5.7.

Table 5.7 Results of the t-Tests for the Vocabulary, COWAT 'S' and 'Animals' Neuropsychological subtests.

Subtest	Group	N	Variances (F)	Mean	Std. Dev.	t-value	Sig. (2 tailed)
WISC-R Vocabulary	Group 1	29	1.040 (Equal)	20.41	7.15	.260	.795
	Group 2	70		20.03	6.5		
COWAT 'S'	Group 1	29	.294 (Equal)	6.69	3.52	-2.21	.030*
	Group 2	70		8.30	3.21		
COWAT 'Animals'	Group 1	29	.003 (Unequal)	13.34	3.94	-.181	.857
	Group 2	70		13.50	3.72		

Table 5.7 indicates that there are no significant differences between the two groups on the WISC-R Vocabulary and COWAT 'Animals' subtests, whilst a significant difference exist between the two groups on the COWAT 'S' subtest ($p = .030$). The scored nature of the COWAT subtest indicates that a higher Mean score can be interpreted as a better performance on the tests. Even though the correlation does not suggest significant, a rough comparison of means suggests that Group 2 displayed a higher Mean score ($\bar{x} = 8.30$) on the COWAT 'S' subtest, and therefore slightly outperforms Group 1 on this measure.

Null Composite Hypothesis 3 is rejected and the alternate hypothesis is accepted which states that there **are** statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) on the COWAT 'S' Verbal Fluency test. The significance lies in favour of Group 1 for this subtest.

Null Composite Hypothesis 4 is accepted and the alternate hypothesis is rejected which state that there are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) on the COWAT 'Animals' Verbal Fluency test.

Null Composite Hypothesis 6 is accepted and the alternate hypothesis is rejected which states that there are no statistically significant differences between Group 1 (HIV-positive Bilingual Adolescents) and Group 2 (HIV-negative Bilingual Adolescents) on the Vocabulary subtest of the WISC-R.

5.4.2 Non-Parametric

The Mann–Whitney U Test is the non-parametric equivalent of the t-Test which was used to determine if there was any significance of variance in the means of the two groups for the different neuropsychological subtest performances.

Table 5.8 Results of the Mann-Whitney U Test for the COWAT ‘F’, ‘A’, and ‘Fruit’ Neuropsychological subtests.

Subtest	Group	N	Mean Rank	Sum of Ranks	Asymp. Sig (2 Tailed)
COWAT ‘F’	Group 1	29	42.02	1218.50	.074
	Group 2	70	53.31	3731.50	
COWAT ‘A’	Group 1	29	40.62	1178.00	.034*
	Group 2	70	53.89	3772.00	
COWAT ‘FRUIT’	Group 1	29	44.76	1298.00	.239
	Group 2	70	52.17	3652.00	

Table 5.8 illustrates that there are no significant differences between the two groups on the COWAT ‘F’ and ‘Fruit’ subtests, whilst significant difference exist between the two groups on the COWAT ‘A’ subtest ($p = .034$). As noted above, the scored nature of the COWAT subtest indicates that a higher Mean score can be interpreted as a better performance on the tests. Even though the correlation does not suggest significant, a rough comparison of means suggests that Group 2 displayed a higher Mean Rank score (53.89) on the COWAT ‘A’ subtest, and therefore slightly outperforms Group 1 on this measure.

Null Composite Hypothesis 1 is accepted and the alternate hypothesis is rejected which states that there are no statistically significant differences between Group 1 (HIV-positive Bilingual Adolescents) and Group 2 (HIV-negative Bilingual Adolescents) on the COWAT ‘F’ Verbal Fluency test.

Null Composite Hypothesis 2 is rejected and the alternate hypothesis is accepted which states that there **are** statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) regarding their vector of average scores on the COWAT ‘A’ Verbal Fluency test. The significance lies in favour of Group 1 for this subtest.

Null Composite Hypothesis 5 is accepted and the alternate hypothesis is rejected which states that there are no statistically significant differences between Group 1 (HIV Negative Bilingual Adolescents), and Group 2 (HIV Positive Bilingual Adolescents) on the COWAT 'Fruit' Verbal Fluency test.

5.5 Correlations

5.5.1 Parametric

Pearson's Product Moment Correlations were run only on the normally distributed data comparing the results of Group 1 on each of the dependent variables, as operationalised as scores on the various neuropsychological tests, and the HIV clinical variables. The results of these Pearson's Correlations are outlined in Table 5.9 below.

Table 5.9. Parametric Correlations to determine the effect of Clinical HIV Factors on the Neuropsychological Subtests WISC-R Vocabulary, COWAT 'S' and 'ANIMALS' subtests as determined by the Pearson's Product Moment Correlation.

Subtest	Measure	Number of Years on HAART	WHO Stage at Diagnosis	CD4 Count at Start of HAART	Viral Load at Start of HAART	Current CD4 Count	Current Viral Load
WISC-R Vocabulary	Pearson Correlation	.207	-.001	-.040	-.233	-.205	-.186
	Sig. (2-tailed)	.282	.995	.837	.225	.296	.407
COWAT 'S'	Pearson Correlation	-.029	.036	-.022	-.356	-.013	-.352
	Sig. (2-tailed)	.880	.860	.908	.058*	.947	.117
COWAT 'ANIMALS'	Pearson Correlation	.053	.009	-.198	-.242	-.079	-.078
	Sig. (2-tailed)	.784	.966	.304	.207	.688	.738

* Correlation is nearing significance at the 0.05 level (2-tailed)

Table 5.9 indicates that the COWAT 'S' subtest has a correlation that is approaching significance ($p = .058$) with the Viral Load at the start of HAART HIV clinical variable indicating that there is a near linear association between the two variables. This correlation

is an average or moderate negative correlation which indicates that the higher the participant's Viral Load at the start of HAART the lower their score on the COWAT 'S' subtest. The remainder of the correlations are not significant.

5.5.2 Non-Parametric

Spearman's Rank Correlations were run on the non-normally distributed data, comparing the HIV clinical variables on the neuropsychological results of the HIV-positive participants as operationalised as scores on the various neuropsychological tests. The results of these Spearman's Rank Correlations are outlined in Table 5.10 below.

Table 5.10. Non-Parametric Correlations between Clinical HIV Factors and the Neuropsychological Subtests COWAT 'F', 'A', and 'FRUIT' subtests as determined by the Spearmans rho Correlation.

Subtest	Measure	Number of Years on HAART	WHO Stage at Diagnosis	CD4 Count at Start of HAART	Viral Load at Start of HAART	Current CD4 Count	Current Viral Load
COWAT 'F'	Spearman rho	.160	.103	-.106	-.204	-.106	-.208
	Sig. (2-tailed)	.406	.617	.585	.289	.591	.365
COWAT 'A'	Spearman rho	-.110	.166	.111	-.354	.098	-.563
	Sig. (2-tailed)	.568	.418	.568	.060*	.619	.008**
COWAT 'FRUIT'	Spearman rho	.262	.099	-.262	-.185	-.163	-.187
	Sig. (2-tailed)	.170	.632	.170	.335	.408	.417

* Correlation is nearing significance at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Table 5.10 indicates that the COWAT 'A' subtest has a correlation that is approaching significance ($p = .060$) with the Viral Load at the start of HAART HIV clinical variable indicating that there is a near linear association between the two variables. This correlation is a weak or moderate negative correlation ($-.354$) which indicates that the higher the

participant's Viral Load at the start of HAART the lower their score on the COWAT 'A' subtest.

Furthermore, a significant correlation ($p = .008$) between the COWAT 'A' subtest and the Current Viral Load of Group 1 which can be described as averagely negative ($-.563$). This indicates that the higher the Current Viral Load of Group 1, the lower their score on the COWAT 'A' subtest.

6 Discussion

As HIV-infection has moved from being a fatal to a chronic illness, more concern has been raised surrounding the cognitive, neurological, and behavioural functioning of HIV-infected children (Jeremy et al., 2005). Infection with the Human Immunovirus (HIV) results in disruption of neuronal function by causing damage to the networks of connections between neurons that take place at dendrites and synapses. This process disrupts the highly integrated functioning of neural systems required to process information and leads to HIV-associated neurocognitive disorders (Ellis et al., 2009). Indeed, impairments in language and communication have long been associated with HIV-1 infection in both adults and children (Coplan, et al., 1998; Cysique & Brew, 2009; Wolters et al., 1997). A dearth of information was evident, however, when seeking to better understand the impact of HIV infection in adolescents and school-aged children (Martin et al., 2006).

This research undertook to examine the presentations of verbal fluency and vocabulary in English in bilingual adolescents between the ages of 13 and 16 years living with HIV-1 on a managed ARV programme as compared to an HIV- negative contrast group. This was done through an analysis of the data that resulted from the raw scores on specific neuropsychological tests – the COWAT 'F', 'A', 'S', 'Animals', and 'Fruit' subtests, and the Vocabulary subtest from the WISC-R. The performance of the HIV-positive and HIV-negative samples in verbal fluency and vocabulary in English was then compared by means t-Tests and Mann-Whitney U-tests, and further analysed for correlations between those results and the HIV clinical variables through use of Pearson Correlation Coefficients and Spearman's Rank Correlation Coefficients. This section will therefore discuss the results in terms of the theoretical, methodological and practical implications.

In the present research **significant results**, in both parametric and non-parametric comparisons run between the HIV-positive and HIV-negative samples, were found solely in the phonemic categories of 'A' and 'S' on the Controlled Oral Word Association Test (COWAT) of verbal fluency. The HIV-positive sample performed more poorly than the HIV-negative sample on the comparative measures.

The corroboration and refutation of these results is a difficult task as research on neuropsychological performance in HIV-positive adolescents is scarce (Brackis-Cott et al., 2009) and the implications of assessment in an individual's second language whilst studying language are pervasive. The current research could not conclusively state that overall verbal fluency was impaired in HIV-positive bilingual adolescent sample due to the lack of overall significance in every subscale of the COWAT.

Research performed by Marsh and McCall (1994) supports the findings of this study as they determined that HIV-infected adults often display impaired verbal fluency relative to healthy controls. Further support for the deleterious effect of HIV-infection on verbal fluency comes from Woods et al. (2010) who found a significant association with biomarkers associated with HIV-infection and deficits in verb fluency in an adult population. Additionally Milikin et al.'s (2004) study had of 217 adults with HIV found that advanced HIV-infection was related to impairment in phonemic fluency performance in comparison to normative data. This further supports the findings of the present research.

The research performed by Reger, Welsh, Razani, Martin and Boone (2002) is of note when considering the results of the present investigation. In their meta-analysis of the neuropsychological sequelae of HIV infection in seronegative, asymptomatic and symptomatic HIV-positive individuals, and individuals with AIDS, they found that the greatest neuropsychological effect sizes in asymptomatic HIV-positive individuals were not for motor dysfunction, as previously reported (Sacktor, et al., 2002), but rather in the area of language – naming in particular (Reger et al., 2002). Asymptomatic was determined by the Centre for Disease Control as a CD4+ count of over 200 and no presenting serious illnesses (Reger et al., 2002). In the present research, the mean CD4 count for the HIV-positive sample was 625.82, and any individuals with a history of tuberculosis or serious illnesses such as meningitis were excluded. This sample can therefore be labelled as

asymptomatic and the parallels drawn between this research and the current study's significant results in the categories of 'A' and 'S' of phonemic naming are appropriate.

Milikin et al. (2004) found that the effect of HAART mediated performance in the group with AIDS diagnosis, suggesting that ARV treatment and disease severity should be explored when assessing verbal fluency (Millikin et al., 2004). Disease severity and ARV treatment were clinical HIV variables which were attended to in this current study. Although no significant correlations were noted between any of the subtests and the number of years on HAART, the present study found that viral load (both current and at HAART initiation) was negatively correlated with performance in the neuropsychological function of phonemic naming as determined by performance on the COWAT 'A' and 'S' trials. As viral load is an indicator of disease progression, a higher level of viral load a person experienced upon starting HAART or current viral load in the present study, is linked to a nearly significant lower performance on the phonemic verbal fluency categories of 'A' and 'S'. Studies corroborate this finding by stipulating that neuropsychological functioning in general is significantly poorer at baseline for the HIV-infected children as compared with established norms for their age, and children with higher viral loads display poorer cognitive performances (Jeremy et al., 2005).

Research conducted by Tate (2011) suggests that recent CD4 and viral load history is an important predictor of current cognitive function across several cognitive domains which further emphasizes the importance of the correlations noted in the present research between viral loads at the start of HAART and currently and performance on the verbal fluency subtests. Jeremy et al. (2005) extend this argument by stating that a higher baseline viral load is correlated with poorer cognitive scores.

The determination of verbal fluency deficits as mild in the early stages of HIV and generally increasing in magnitude as the disease advances is also noted in research by Iudicello, Woods, Parsons, Moran, Carey and Grant (2007).

A possible hypothesis for why a correlation between phonemic verbal fluency and viral load is found in the research is noted in a study by Thames et al. (2012). They examined basal ganglia integrity in relation to lexico-semantic verbal fluency performance among older HIV infected adults, and found that phonemic verbal fluency performance predicted basal

ganglia integrity better than other neuropsychological measures that are linked to basal ganglia function. Additionally, this research found that caudate volume was also associated with phonemic word generations, whereas the putamen was more involved with task switching between categories than actual word generation (Thames et al., 2012). Despite the research being performed on older HIV-infected adults, the study by Thames et al. (2012) raises an interesting point by suggesting that subcortical structures work in concert with frontal lobe function during the performance of verbal fluency tasks, and that verbal fluency must therefore not only measure the efficacy of lexical access, but also be an important component of the executive functioning system. Additionally, it highlights a possible underlying neurological explanation for the results found in the present study, by contending that dysfunction caused by HIV infection in selective areas of the basal ganglia structures (such as the basal ganglia and caudate) can give rise to specific deficits in verbal fluency performance – specifically phonemic word generation (Thames et al., 2012). This may indicate that the adolescents in the current study have specific insult to areas of the basal ganglia which results in their lowered ability to produce phonemic word categories. This neurological insult to the basal ganglia may therefore be correlated to the HIV clinical variables of starting and current viral load as the HIV-positive sample's performance on the phonemic categories of the COWAT were negatively correlated with these.

This study therefore partially illustrates that the cognitive deficits, particularly in phonemic naming, exhibited by HIV-positive individuals increase with the disease progression. This finding is supported by existing research. Therefore, although there were not many significant differences between the HIV-positive sample and the contrast group, this is likely to due to the asymptomatic nature of the sample's HIV status. It is important to note, however, that many studies indicate the possibility of verbal fluency deficits being due to executive dysfunction in processing speed (Koekkoek et al., 2008).

No significant differences exist between the two groups on the phonemic category of 'F', and semantic categories of 'Animals' and 'Fruit' on the COWAT. This indicates that the two sample groups are equivalent in terms of their ability to generate semantic categories, and the phonemic category of 'F', whilst they are not equivalent in terms of their ability to generate the other phonemic categories of 'A' and 'S'.

When focusing on the significance of phonemic verbal fluency deficits as compared to intact semantic verbal fluency, as noted in the current research, the research of Millikin et al. (2004) supports these findings. They determined that that advanced HIV-infection was related to impairment in phonemic fluency performance, but not semantic, in comparison to normative data.

It is important to note that the majority of international literature on verbal fluency in HIV-infected samples discusses the results as a whole, and does not indicate on which categories of the measure the sample did or did not return significant results (Iudicello et al., 2008). Often the differentiation is made between category and phonemic fluency, but no within-test delineation of results is made available. As the current research has noted, the HIV-positive group performed significantly worse than that the HIV-negative group on the specific phonemic categories of 'A' and 'S', but not 'F'. If the entire function of verbal fluency were affected by HIV-infection then the entire test should show significant results. This is not the case in the present research however, and the researcher hypothesises that this may be due to a number of interrelated issues.

Firstly, it is possible that some of the trials on the verbal fluency measure utilised in this research (COWAT) are more sensitive to monolingual, and not bi- or multilingual performance than others. Studies have found that there are performance differences on verbal fluency tasks between monolingual and bilingual individuals (Gollan, Montoya & Werner, 2002; Rosselli et al., 2000). Monolinguals and bilinguals appear to perform similarly on phonetic fluency, whilst bilinguals perform relatively worse on semantic fluency (Gollan et al., 2002; Rosselli et al., 2000). In the present research, the two sample groups appear to be equivalent in terms of semantic fluency due to the lack of significant results therein. However, it may be misleading to assume that HIV-infection therefore does not affect semantic fluency in this sample. Indeed, international research indicates that HIV-infection is associated with poorer category fluency performance in comparison to seronegative individuals (Iudicello et al., 2008). Instead, the research believes it is possible that the lack of significant results is merely due to the fact that both participant samples performed equally poorly on the semantic fluency categories due to their bi- or multilingual natures as noted in previous research (Gollan et al., 2002; Rosselli et al., 2000). The effect of HIV-infection on

this variable therefore may not be noticeable as the two groups are already diminished in their capacity to perform on this test. Additionally, the question of the inappropriateness to measure this ability in English in this particular sample is raised. This may signify that the problem does not lie in a functional deficit but in the inadequate selection of the measurement tool.

Clinically, the application of this finding appears significant as it indicates that semantic fluency should not be considered when assessing cognitive functioning in bi- or multilingual HIV-infected individuals. This is due to the interference effect of their bi- or multilingual nature on the monolingual-designed test which calls into question the validity of test findings and recommendations that may be made by the clinician (Portocarrero, Burright & Donovan, 2007). Iudicello et al. (2008) suggest that alternating paradigms may be “a more useful marker of the mild neuropsychological deficits characteristic of less severe HIV disease than are standard category fluency measures” (p. 802). Therefore, methodologically it is also important to consider alternative measures of this construct in order to determine the most accurate results to guide recommendations. It would be necessary to study further the relationship between multilingualism and different measures of semantic fluency to be able to elucidate the benefit of considering these variables when assessing similar samples.

In terms of phonemic fluency, the research questions why the ‘A’ and ‘S’ categories displayed significant results, whilst the ‘F’ category did not. Research indicates that mono- and bilingual individuals display a similar performance on phonetic fluency tasks (Gollan, Montoya, & Werner, 2002; Rosselli et al., 2000). Therefore, unlike with semantic fluency, the use of two or more languages does not appear to affect performance on phonetic fluency tasks (in the trial ‘A’ and ‘S’) and therefore the significant differences between the HIV-positive and HIV-negative groups is likely due to the variable under investigation – HIV-infection.

However, it was originally thought by the researcher that the mechanism of impact for phonetic fluency and HIV-infection would most likely be due to phonetic retrieval difficulties, which relates to poorer language performance. However, an alternative hypothesis for this is related to the underlying mechanism of verbal fluency deficits as noted in previous studies. These studies indicate that, consistent with the largely frontostriatal

neuropathology of HIV-infection, HIV-associated verbal fluency deficits may be primarily as the result of impaired switching ability in the HIV-positive sample (Iudicello et al., 2008). Portocarrero et al. (2007) support this by noting that semantic fluency is associated with lexical knowledge, whilst phonemic fluency is associated with tasks of executive functioning (Portocarrero et al., 2007).

Research on the development of language in children exposed to two or more languages has demonstrated that bilingualism actually enhances the cognitive flexibility of these children (Mathur et al., 2010). Therefore bi- and multilingualism should not hinder phonetic verbal fluency ability, which further implicates the role of HIV-infection in the performance of the HIV-positive group in the current study. Indeed, cortical atrophy and calcification is noted in HIV-infection, especially in the basal ganglia and frontal cortex white matter (Belman et al., 1985; Belman et al., 1986; Civitello, 2003; Epstein, Berman, Sharer, Khademi & Desposito, 1987; Gay et al., 1995). The implications of this are that although the areas of the brain more susceptible to HIV-infection are those areas related to poorer phonemic verbal fluency, this may not be due to lexical retrieval problems but rather due to problems in executive functioning, shifting from phonemic categories in particular, which appear to have influenced the results in this research.

Therefore, the influence of HIV-infection on phonetic fluency cannot be discounted. This can, in turn, be linked to the negative correlation with viral load noted in the present research. The research hypothesises that as viral load increases and disease progression continues, greater executive dysfunction in set shifting and cognitive flexibility will be noted, and greater deficits in phonemic verbal fluency will occur. Clinically this has enormous value as phonetic fluency in a bi-or multilingual population can therefore provide important information regarding disease progression, as the greater the viral load, the poorer the performance on phonetic categories of verbal fluency are likely to be. Importantly, it must be noted that this is not due to language ability or phonetic retrieval, but instead appear to be related to the HIV-positive individual's decreased ability to shift to another phonetic category.

As much of the international research was conducted on HIV-positive adults and not adolescents as the current research focuses on, the implications of the effect sizes and their

impact on functioning are different. Reger et al. (2002) states that the deficits observed in the early stage HIV illness, such as language, are subtle and should not interfere dramatically with vocational functioning. Contrasting this is literature which states that HIV-associated verbal fluency deficits are independently predictive of dependence in instrumental activities of daily living (Heaton et al., 2004; Woods et al., 2006). However, this conclusion may not necessarily be relevant for adolescents who are still developing their language abilities and are required to verbalise their thoughts coherently in an educational environment in order to show their understanding of a particular concept. Difficulty in naming ability may therefore further hinder further scholastic achievement and reduce future occupational opportunities due to a lower level of education than competing peers.

Furthermore, no significant differences were found on the comparative analysis of performance between the HIV-positive adolescents and the HIV-negative contrast sample on the Vocabulary subtest of the WISC-R measure. The lack of significant results indicates that the two sample groups are equivalent in terms of their vocabulary use and ability in English.

This finding from the study is in direct contrast to that of Brackis-Cott et al. (2009) who examined the impact of perinatal HIV infection on adolescent's receptive language and word recognition skills. The authors found that the sample displayed poor verbal ability, including vocabulary, and a lack of basic skills needed for reading (Brackis-Cott et al., 2009). The Brackis-Cott et al. (2009) study however, did not assess vocabulary in English in bi- or multilingual speakers, and did not make use of a contrast group in the research. Instead the scores of the adolescents were compared to their age-appropriate norms to determine their current level of receptive language and word recognition ability (Brackis-Cott et al., 2009). As such, the results of the present research and that of Brackis-Cott et al. (2009) cannot be considered wholly comparable.

Additionally, in the present research, no correlations between vocabulary performance and any HIV clinical variables were noted and it is hypothesised that this may be due to the multilingual nature of the both participant samples, and the inability of the measurement tool (the Vocabulary subtest from the WISC-R) to adequately assess subtle but significant differences in language and vocabulary ability. However, literature indicates that it is likely

that the lack of significant results and correlations to HIV clinical variables may, in fact, be due to the current ARV treatment the adolescents are receiving. In support of this notion, Coplan et al.'s (1998) study determined that although children with HIV infection were observed as experiencing language deterioration, those children who began antiretroviral treatment showed a marked improvement in language ability (Coplan et al., 1998).

This is corroborated by the research of Jeremy et al. (2005) who found that after 48 weeks of treatment with ARVs the only significant improvement in cognitive functioning was in Vocabulary score – despite the relatively small effect size. This implication of the present and previous research findings is important as it demonstrates not only that language is a marker of disease severity (Brackis-Cott et al., 2009), but that treatment can result in improvement in this cognitive arena. Additionally, Coplan et al. (1998) and Jeremy et al. (2005) findings in conjunction with the present findings indicates that despite the delay in South African government policies to allow for ARV rollouts before 2004/5, the adolescents who fall within this time-frame do not appear to be negatively affected in terms of their ability to learn and master vocabulary in English. Coplan et al. (1998) also posited that because the recovery of language function sometimes preceded improvement on measures of global cognitive ability, periodic assessment of language development should be conducted as a means of monitoring disease progression and the efficacy of drug treatments. Therefore, if the adolescents in this sample are not displaying significant differences in language performance as determined by vocabulary ability, then it is possible that the ARV treatment will continue to help improve their other cognitive abilities as well. Vocabulary and language should therefore also be consistently measured as an indicator of overall neuropsychological performance on HAART.

However, it is also possible that the lack of significant results between sample groups and correlationally with the HIV clinical variables is due to another factor – the true performance of the HIV-positive and HIV-negative participants is not being adequately assessed or reflected in the assessment measure. The researcher questions whether a measurement of vocabulary developed for a monolingual population is appropriate to use on a multilingual participant sample. It is possible that this particular assessment of vocabulary may not be sensitive enough to assess vocabulary performance in HIV-positive bi- or multilingual individuals, and therefore there appears to be a lack of results attributable to HIV-infection.

Indeed, the results of bi- or multilingual individuals on monolingual-designed tests which calls into question the validity of test findings and recommendations that may be made by the clinician (Portocarrero, Burright & Donovan, 2007).

This gives rise to a second concern of the researcher – does the participant's bi- or multilingualism overrides the impact of the HIV infection on this particular construct? The research questions whether it is possible that the two groups are homogenous in terms of their performance on the vocabulary subtest, not because of a lack of deleterious effects of HIV-infection, but instead because their bi- and multilingual natures result in them performing at the same level. Whilst it is believed that bilingual language acquisition is as “effortless, efficient, and successful as monolingual acquisition” (Bialystok et al., 2009, p. 90), bi- and multilingualism often results in a unique set of logistical difficulties (Adler, 2001). For instance, bilingual children have been noted to make unequal progress in developing vocabularies (Bialystok et al., 2009), and therefore it is important to note that language skills that traditionally develop in synchrony for monolingual speakers may develop at different rates in one or both languages for bilingual children (Pearson, 2002).

As such, whilst between groups comparison in the present research may not yield significant results it is possible that these individuals are performing significantly below their age-appropriate norms in terms of vocabulary. Indeed, Portocarrero et al. (2007) found in their study of vocabulary and verbal fluency of bilingual and monolingual college students that bilingual participant's performance on standardized measures of English vocabulary was significantly lower than that of their monolingual counterparts. This could be due to either the use of a monolingually-based test, or the fact that in language of schooling, monolingual children have an average receptive vocabulary score that is consistently higher than that of their bilingual peers (Bialystok, Luk, Peets & Yang, 2010). However, it is technically and ethically difficult to determine this as the assessment measures available are not constructed for the South African context.

Additionally, it is important to consider the impact of the assessment environment on the individual's performance – particularly that of the HIV-negative contrast group. The testing environment was especially homogenous and not conducive to focused performance on neuropsychological testing and this may have caused the contrast group to have results that

mimic that of the HIV-positive group. However the causes of these result patterns may have different antecedents as Group 1's performance may be due to their HIV status whilst Group 2's performance may have been impacted by the assessment environment.

Clinically, these results have important ramifications as previous literature has consistently reported that language and speech are good indicators of overall CNS integrity as they are sensitive to a variety of neurodevelopmental insults (Coplan et al., 1998). Therefore, if an individual were to present at a clinic with no observable or testable vocabulary deficits the clinician may assume that they are currently asymptomatic in terms of their HIV-infection status. However, as has been noted, bi- and multilingual individuals display lower overall performance on monolingually-based assessments of vocabulary (Portocarrero et al., 2007). This could result in individuals being assessed and having their results compared against a culturally and linguistically inappropriate normative sample, which would profile them as performing significantly poorly on vocabulary and would give rise to possible hypotheses in clinicians about the state of their HIV-infection and related further cognitive deterioration. This would be misleading because the results could be due to either the use of an inappropriate normative sample, or the performance of the bi- or multilinguals on a monolingual test. Therefore this finding is significant as it indicates that vocabulary in a multilingual society such as South Africa must be assessed and interpreted with caution when assessing cognitive functioning in HIV-positive individuals as the results may be misleading.

The **HIV clinical information** provided an overview of how the HIV-positive sample were currently behaving in terms of their exposure to HAART, the impact of this on CD4+ count and Viral Load, and how these variables differed from the initiation of HAART to the present moment.

The present study implicated the benefit of starting ARV treatment for people with neuropsychological deficits attributable to HIV. This is because disease progression is marked by viral load and the lower the viral load, the better the neuropsychological functioning. Additionally, the sooner ARV treatment is started the less likely it is that the viral load will increase to a significant value and cause possible irreparable neuropsychological insult. Children who are placed on ARVs after presenting

symptomatically showed greater neurocognitive deficits compared to children who were placed on ARV's from birth (Laughton et al., 2010). Indeed, disease vulnerability is closely linked to neurocognitive deficits as studies show that patients with lower CD4 counts are more vulnerable to neuropsychological impairment (Cysique & Brew, 2009). It is important to note that the HIV-positive participants in the current research had a mean CD4 cell count of 625.82, which is within the normal range, and would indicate that they are in WHO Stages I – II. Singh (2009) notes that the milder forms of HIV-associated neurocognitive disorder are easily overlooked, and this may also have contributed to the many non-significant results that were obtained in this study.

Of particular note in the current research was the difference between the ranges of CD4+ Count at HAART initiation (min. = 16, max. = 6239), and currently (min. = 21, max. = 1014). These results appear to indicate that the use of HAART to treat HIV-infection can result in a decrease of CD4+ count, which is counterintuitive to ARV use which is supposed to improve CD4+ count.

Evidence does exist to suggest that patients receiving didanosine (ddI) 400 mg, tenofovir (TDF) and nevirapine (NVP), do exhibit CD4+ cell count decline despite virological suppression (Negredo et al., 2004). The current study did note the use of NVP and TDF in the HIV-positive sample. However, the mean CD4+ cell counts increased with HAART initiation which suggests that in general the participants benefitted from treatment with HAART. Additionally, an overview of the raw data indicates that the one individual whose CD4+ count was higher at HAART initiation than currently, and therefore possibly susceptible to the effects outlined by Negredo et al. (2004), is an outlier and therefore not a true reflection of the overall behaviour of the sample. Given the unusual nature of this finding, it would be relevant to perform longitudinal studies related to CD4 count. As previously noted however, many people with CD4+ counts lower than 200 are still asymptomatic, and therefore CD4+ count may not be a reliable factor when it comes to estimate health and cognitive performance. It is therefore important to investigate the effects of these clinical variations in larger sample sizes in future studies, and to formulate the contrast group on the basis of the clinical variations and not merely on HIV status.

The HIV-positive participants in the current research, based on their current mean CD4+ count of 625.82, are in WHO Stages I – II. The HIV-positive participants had been on HAART for an average of 6.15 years, nearly half the mean life-span of the participants, despite only being placed on HAART only after becoming symptomatic (Butler, 2005). Their improved CD4+ count and lowered Viral Load as noted by the differences between Current and Starting values (at HAART initiation) and WHO stage, implies that there was a benefit to starting ARV treatment for these participants, even if it was post-symptom expression. The current research therefore indicates that HAART treatment has a beneficial effect on HIV clinical variables such as viral suppression and CD4+ gains in this study, and this is consistent with international research (Hunt et al., 2003).

7. Limitations and Recommendations

It is necessary to interpret all findings in this research within identified limits. Inference techniques should be considered within adequate knowledge of the subject-matter in all research.

7.1 Sample

- **Verification of HIV Status:** Subjects in the experimental group were all deemed HIV-positive through their involvement in the HIV programme at the Empilweni Clinic at Rahima Moosa Mother and Child Clinic. The HIV-negative sample was obtained from the same schools in the Orlando area of Soweto reported on by Skuy et al. (2001). They were selected on the basis of age, gender, and socioeconomic status in order to form an appropriate contrast for the experimental group. Ethically and legally it was not possible to ascertain the true HIV status of the HIV-negative contrast sample as direct questioning surrounding this issue was prohibited. In addition to this, even if the participants believed they were HIV-negative, they could have been in the window period of HIV testing which provides a false negative, and the participants may therefore have given the research false information either knowingly or unknowingly and the results may have been compromised in this regard. This provides a direct threat to the external validity of the study.

Recommendations: Ideally the selection of an HIV-negative sample in future research should be done on the basis of blood tests both pre- and post-window period to ensure absolute authenticity of the sample allocation. However, this bears ethical considerations and it is important that in no way are the participants in the sample harmed physically or psychologically as a direct result of the research.

- **Medical History:** Comprehensive and confirmed details surrounding the medical history for the HIV-positive experimental group were acquired from the medical files of these participants. However, this information was utilized to determine exclusion criteria for the study and was not similarly determined in the HIV-negative contrast group. Information was scarce regarding any serious past or present medical illnesses, recent hospitalizations, central nervous system insults, substance abuse, medications with adverse cognitive side-effects, and any psychiatric conditions or affective disorders (Beblo et al., 2011; MacAllister & Schaffer, 2007; Merkelbach et al., 2000; Nordahl, Salo & Leamon, 2003; Vakil, 2005; Vanderploeg et al., 2001). Any of these can severely affect neuropsychological performance.

Recommendations: This study did not control these extraneous variables, and future research should examine performance in relation to the effects of these factors, or attempt to control for these factors through more rigorous adherence to exclusion criteria. This could be undertaken by utilizing the same medical history questionnaire for all participants from both sample groups. Additionally, if it is not possible to ascertain the contrast sample's medical history with any level of confidence from self-reports or take home questionnaires then it may perhaps be useful to attempt to source contrast sample participants from a day-clinic where their medical files are available. It must be taken into consideration that whatever treatment they are seeking at the clinic should not form part of the exclusion criteria of the study. Otherwise the samples should attempt to be matched for the particular extraneous variables that are unable to be controlled for such as medication, recent hospitalizations or psychiatric conditions to nullify their confounding properties.

- **Factors that Affect Neuropsychological Test Performance:** A participant's level of fatigue (Krupp & Elkins, 2000), whether they took any medication the morning of

assessment, whether they ate breakfast on the morning of the assessment, their mood before and during the assessment (Beblo et al., 2011), attitude toward the assessment and personality traits were not controlled for in this research and can all affect performance on neuropsychological assessments.

Recommendations: Future research should further examine these factors and attempt to control for them by informing parents of the need of the participants to take their medication and to have a meal before assessment. Snacks can also be provided for the participants to relieve hunger whilst regular breaks can improve their participant's fatigue levels and mood. In addition to this, measurement of these variables could be built into the research design to allow for the study of the impact of the variables on test performance helping to limit the extraneous element of their impact.

- **Gender:** Both males and females were assessed in the current study and whilst care was taken to include both genders, the dispersion of gender between the two groups was not equated. Literature indicates that male and female children and adolescents perform differently on neuropsychological tests of various functions. Females appear to display relative strengths on verbal memory tasks, in comparison to males who perform better on tests of spatial memory (Lowe, Mayfield & Reynolds, 2003). Males, in contrast, appear to perform significantly better than girls on oral verbal fluency, who in turn outperform the males on written orthographic fluency (Berninger & Fuller, 1992). The relationship between gender and neuropsychological test performance was not considered in the present research and the researcher was therefore unable to draw inferences regarding the performance of the different genders relative to their test performance and HIV status.

Recommendations: Future research should examine the effects of gender as males and females do not necessarily perform equivalently on neuropsychological tests.

- **Sampling:** The sample was a convenience sample based on the availability of candidates at the clinic and contrast catchment area. This sample therefore does not accurately reflect the South African population and decreases the generalisability of the results of the study.

Recommendations: Drawing new samples from different catchment areas and comparing those to the existing research data could aid in improving the generalisability of the results to a broader context whilst purposive sampling could be utilised in future research studies to decrease selection bias. The use of stratification samples based on the most recent census could also aid in improving sampling techniques and by extension the generalisability of the results.

- **Group Size:** The group sizes in this research are limited due to the resources required to attain the data, and the sensitive nature of the topic researched. This limits the ability to generalise the findings.

Recommendations: In order to increase the number of participants in the sample, a larger research team could be forged which operates over a greater number of sites to not only increase the sample but to improve the selection bias and therefore the generalisability of the results. If this is not feasible then perhaps the sampling method needs to be revised so that a more appropriate sample is collected in a more effective manner. Perhaps the current assessment protocol could be utilised by the clinics as part of their 'routine assessment' when patients routinely go for medical check-ups to help increase the sample size and thereby reduce the impact of potentially limiting extraneous factors. Additionally, a greater length of time could be devoted to the research in which more participants are enrolled in the study to improve the group sizes.

7.2 Experimental Environment

- **Variations in Assessment Procedure:** Despite standardized assessment protocols being undertaken by each researcher, the administration procedure and inter-examiner variability were not fully controlled for. Variations in mood, participant ability, and examiner fatigue led to differences in testing procedure which could affect the results.

Recommendations: Future research could remedy this by utilizing one assessor for all assessments, or alternatively have independent reviewers analyse videotaped footage of the assessments to determine inter-rater reliability.

- **Environmental Differences:** Significant differences existed between the assessment environments of the HIV-positive and HIV-negative groups which could play a major role in limiting the external validity and applicability of these findings to a greater population (McBurney, 2001). The HIV-positive group was assessed in offices with adequate lighting and work space whilst the HIV-negative group was assessed both in- and outdoors at a school in winter where there was no heating and space was limited.

Recommendations: Future studies should aspire to utilise the same testing environment for both samples to limit the impact of environment as an extraneous variable in this regard.

7.3 Measurement Materials

- **Appropriateness of Measures:** The neuropsychological tests were developed in foreign contexts, which can affect the psychometric qualities, including construct validity, reliability, and ecological validity, of the tool when used in other contexts, such as in South Africa.

Recommendations: In order to effectively study and determine the factors related to HIV infection in adolescents, studies must be designed that utilise age-specific, developmentally appropriate, and culturally sensitive assessment measures. Thus, the psychometric characteristics of tests used to measure neuropsychological performance in this demographic should be explored and alternative assessment measures considered before using them again in this context.

- **Validation of Assessment Measures:** Due to the extended nature of the assessment battery utilised in the present research, only one measure of verbal fluency (COWAT), and one measure of vocabulary (Vocabulary from the WISC-R) to determine the possible impact of HIV-infection on these neuropsychological variables.

Recommendations: In order to increase the face validity and reliability of the test measures and results, additional and alternative measures of each construct should be included in order to determine whether the results are due to the variable under

investigation (HIV-infection), or due to the assessment measure not adequately assessing the population samples.

- **Exposure to Materials:** It was not determined whether these participants had had previous exposure to the test materials and this could produce practice effects (McBurney, 2001) and skew the results.

Recommendations: Future studies should include safeguards to determine whether participants have been exposed to testing materials and this should perhaps form part of the exclusion criteria to help improve the validity of the results.

8. Conclusion

The present research states that within the present study, the following conclusions can be drawn based on the hypotheses of the present study and the results of the comparative and correlational analysis. The only statistical differences to exist between the HIV negative multilingual adolescent group and the HIV positive multilingual adolescent group lie within two of the three phonemic categories ('A' and 'S') of the COWAT. The study suggests that these differences may be explained by clinical factors noted in the HIV positive multilingual adolescent group. For instance, the higher the HIV-positive participant's Viral Load at the start of HAART the lower their score on the 'A' and 'S' subscales of the COWAT. The study therefore concludes that Viral Load at the start of HAART has a deleterious effect on phonemic fluency in the subscales of 'A' and 'S' of the COWAT in HIV-positive bi- or multilingual adolescents. Furthermore, the higher the HIV-positive participant's Current Viral Load, the lower their score on the COWAT 'A' subtest. The study therefore concludes that Current Viral Load has a deleterious effect on phonemic fluency in the subscale of 'A' of the COWAT in the HIV positive bi- or multilingual adolescents.

The present research presented findings which were consistent with international literature indicating that clinical variations, such as the starting and current viral loads, impact negatively on test performance. However, these clinical variables were only noted to be of significant in the 'A' and 'S' phonemic verbal fluency aspects of the neuropsychological assessments undertaken, and not in the category verbal fluency or vocabulary aspects.

This study therefore supports the writings of Jeremy et al. (2005) who purport that therapeutic strategies that include not only suppression of viral load but also optimisation of neuropsychological functioning should to be developed for HIV-infected children (Jeremy, et al., 2005). This could include the provision of supportive services for young HIV-infected children and infants, such as special education, speech therapy, and counselling, which may play a role in improvement of neuropsychological functioning (Jeremy, et al., 2005). As has been noted in the current study, certain aspects of verbal fluency ('A' and 'S') are related to HIV infection and are correlated with Current Viral Load and Viral Load at HAART initiation. If, as Jeremy et al. (2005) suggests, neuropsychological dysfunction is primarily attributable to HIV infection then modification of the age or stage at which HAART is initiated, or the development of more aggressive treatments that have greater CNS efficacy may lead to treatment approaches in children that are different from those currently recommended for adults (Jeremy, et al., 2005).

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10. Appendices

Appendix 1: Ethics Clearance Certificate



UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Miss Kelly Holland

CLEARANCE CERTIFICATE

M120268

PROJECT

Neuropsychological Profile of HIV Positive
Adolescents on Anti-retroviral Treatment in
Johannesburg, South Africa

INVESTIGATORS

Miss Kelly Holland .

DEPARTMENT

Department of Psychology

DATE CONSIDERED

24/02/2012

+DECISION OF THE COMMITTEE*

Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE

20/04/2012

CHAIRPERSON


(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : E Schutte et al

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and ONE COPY returned to the Secretary at Room 10004, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress report.

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES..

Appendix 2: Consent Form from the Empilweni Clinic

1 February 2012

Ms Urvashi Chiba, Mr Daniel Greenslade, Ms Shona Fraser, Ms Stephanie MacIlwaine, Ms Kelly Holland, Ms Cindy van Wyk

Re: Neuropsychological research on HIV positive adolescents attending the Empilweni Clinic

This letter serves to confirm that, I, Dr Ashraf Coovadia, support the study conducted by the above-mentioned MA (Neuropsychology) students.

In my capacity as head of the Wits Empilweni Clinic; access to the database of patients attending the Empilweni Clinic is granted with permission to conduct the neuropsychological research assessments on willing participants.

Regards

Dr Ashraf Coovadia

Appendix 3: Parental Consent Form (Experimental Group)



School of Human and Community Development
University of the Witwatersrand
Private Bag 3, Wits 2050, Johannesburg, South Africa

Tel: (011) 717-4500; Fax: (011) 717-4559

I, Mother/Father/Legal Guardian of

_____, give consent for my child / ward to participate in this study.

I understand that:

- There is no risk or harm that could come to my child / ward from taking part;
- Participation is voluntary;
- My child / ward, or I, may choose to stop the testing at any time, for any reason, with no penalty or loss of benefits;
- My child's / ward's results will remain confidential; and
- No positive or negative consequences will follow from choosing to, or not to, participate.

By allowing my child / ward to participate, I state that:

- My child / ward has no history of epilepsy, meningitis, or serious head injury;
- All the relevant information about this research has been explained to me and my child / ward, clearly and simply, and I understand the information; and
- The researchers have access to my child's file at the clinic in order to get the demographical and medical information they require.

Signed: _____ Date: _____

Assigned Participant Number: _____

Appendix 4: Parental Consent Form (Control Group)



School of Human and Community Development

Private Bag X3, Wits, 2050, Johannesburg, South Africa

Tel: (011) 717 4500; Fax: (011) 717 4559

I, Mother/Father/Legal Guardian of _____, give consent for my child / ward to participate in this study

I understand that:

- There is no risk or harm that could come to my child / ward from taking part;
- Participation is voluntary;
- My child / ward, or I, may choose to stop the testing at any time, for any reason, with no penalty or loss of benefits;
- My child's / ward's results will remain confidential; and
- No positive or negative consequences will follow from choosing to, or not to, participate.

By allowing my child/ward to participate I state that:

- My child / ward has no history of epilepsy, meningitis, HIV infection, neurocognitive impairment, serious head injury, nor are they taking chronic medication or live outside a nuclear family unit; and
- All the relevant information about this research has been explained to me and my child / ward, clearly and simply, and I understand the information;

Signed: _____

Date: _____

Assigned Participant Number: _____

Appendix 5: Participant Assent Form (Experimental group)



School of Human and Community Development

Private Bag X3, Wits, 2050, Johannesburg, South Africa

Tel: (011) 717 4500 Fax: (011) 717 4559

Hello,

We (Kelly, Daniel, Shona, Stephanie, Jessica, Cindy and Urvashi) are all students at Witwatersrand University and we are doing a study on adolescents attending the Empilweni Clinic for treatment. We would like you to take part in the study. If you agree to join in, you will be required to complete some drawing tasks, repeat some lists of words and numbers, identify some colours as well as try your hand with some cards.

If you are happy to take part we would like your written permission. If you decide not to, that is okay and no one will be upset. If you decide to join and then later change your mind and want to stop, this is okay too.

Would you like to participate (*Tick **one** box*)

☐ Yes, I am willing

☐ No, I do not want to

Signing at the bottom of this form means that you agree to take part in this research.

Thank you very much.

Signed (You can just write your name): _____

Date: _____

Assigned Participant Number: _____

Appendix 6: Participant Assent Form (Control group)



School of Human and Community Development

Private Bag X3, Wits, 2050, Johannesburg, South Africa

Tel: (011) 717 4500; Fax: (011) 717 4559

Hello,

We (Kelly, Daniel, Shona, Stephanie, Jessica, Cindy and Urvashi) are all students at Witwatersrand University and we are doing a study on adolescents at your school. We would like you to take part in the study but need your permission to do so. If you agree to join in you will be required to complete some drawing tasks, repeat some lists of words and numbers, identify some colours as well as try your hand with some cards.

If you are happy to take part we would like your written permission. If you decide not to, that is okay and no one will be upset. If you decide to join and then later change your mind and want to stop, this is okay too.

Would you like to participate (*Tick **one** box*)

☐ Yes, I am willing

☐ No, I do not want to

Signing at the bottom of this form means that you agree to take part in this research.

Thank you very much.

Signed (You can just write your name): _____

Date: _____

Assigned Participant Number: _____

Appendix 7: Parental Information Sheet (Experimental group)



School of Human and Community Development
Private Bag 3, Wits 2050, Johannesburg, South Africa
Tel: 27 (0)11 717 4524/5; Fax: 27 (0)11 717 4556



Dear Parent/Guardian,

Our names are Daniel Greenslade, Urvashi Chiba, Shona Fraser, Stephanie MacIlwaine, Jessica Rice, Cindy van Wyk and Kelly Holland. We are conducting research for the purpose of obtaining a Masters degree (MA[Neuropsychology]) in at the University of the Witwatersrand. Our area of focus is young adolescents attending the Empilweni Clinic for treatment.

We would like to invite your child to take part in this study.

If as the guardian/parent you agree to allow your child/ward to participate, they will be required to complete some neuropsychological tests which include some drawing tasks, repeat some lists of words and numbers, identify some colours as well as try their hand with some cards. This may take between two to three hours to complete with rests in between. Your child will be provided with light refreshments half way through the tests.

Participation is voluntary, and no individual will be advantaged or disadvantaged in any way for choosing to, or not to, participate. Please be assured that confidentiality about the results between the researcher and your child as the participant is guaranteed. The information from the test will be coded and names will not be assigned to the information. The information we receive from the tests will only be seen by us and our research supervisors. No individual feedback can be given as the participants are on a managed treatment programme therefore test results will be supplied to the medical practitioner to be used at their discretion. This grouped data may be used in publications or conference presentations, but no data that identifies your child will be used. Please note that you will

be free to stop the procedure at any time and no negative consequences will follow. Your child's participation would be greatly appreciated; the information your child provides will be kept confidential for a period of 2 years following the completion of the project.

Should you have any further questions, please feel free to contact any of us, or our supervisors at the below mentioned telephone numbers and we will be happy to assist.

This research project will be approved by the ethics committee at the University of the Witwatersrand and if you have any questions you may also contact them.

Thank You and Kind Regards,

Daniel Greenslade 0835605017, Urvashi Chiba 0829049867, Shona Fraser 0827468865, Stephanie MacIlwaine 0844449917, Jessica Rice 0823762980, Cindy van Wyk 0722797828, Kelly Holland 0834496416

Supervisors: Enid Schutte, Kate Cockcroft, Marilyn Lucas, Aline Ferreira-Correia

Appendix 8: Parental Information Sheet (Control group)



School of Human and Community Development
Private Bag 3, Wits 2050, Johannesburg, South Africa
Tel: 27 (0)11 717 4524/5; Fax: 27 (0)11 717 4556



Dear Parent/Guardian,

Our names are Daniel Greenslade, Urvashi Chiba, Shona Fraser, Stephanie MacIlwaine, Jessica Rice, Cindy van Wyk, and Kelly Holland. We are conducting research for the purpose of obtaining a Masters degree (MA[Neuropsychology]) in at the University of the Witwatersrand. Our area of focus is young adolescents.

We would like to invite your child to take part in this study.

If you, as the guardian/parent agree to allow your child/ward to participate, they will be required to complete some neuropsychological tests which include drawing tasks, repeat some lists of words and numbers, identify some colours as well as try their hand with some cards. This may take between two to three hours to complete with rests in between. Your child will be provided with light refreshments half way through the tests.

Participation is voluntary, and no individual will be advantaged or disadvantaged in any way for choosing to, or not to, participate. Please be assured that confidentiality about the results between the researcher and your child as the participant is guaranteed. The information from the test will be coded and names will not be assigned to the information. The information we receive from the tests will only be seen by us and our research supervisors. No individual feedback will be given. This grouped data may be used in publications or conference presentations, but no data that identifies you will be used. Please note that you will be free to stop the procedure at any time and no negative consequences will follow. Your child's participation would be greatly appreciated; the

information your child provides will be kept confidential for a period of 2 years following the completion of the project.

Should you have any further questions, please feel free to contact any of us, or our supervisors at the below mentioned telephone numbers and we will be happy to assist.

This research project will be approved by the ethics committee at the University of the Witwatersrand and if you have any questions you may also contact them.

Thank You and Kind Regards,

Daniel Greenslade 0835605017, Urvashi Chiba 0829049867, Shona Fraser 0827468865, Stephanie MacIlwaine 0844449917, Jessica Rice 0823762980, Cindy van Wyk 0722797828, Kelly Holland 0834496416

Supervisors: Enid Schutte, Kate Cockcroft, Marilyn Lucas , Aline Ferreira-Correia

Appendix 9: Participant Information Sheet (Experimental Group)



School of Human and Community Development
Private Bag 3, Wits 2050, Johannesburg, South Africa
Tel: 27 (0)11 717 4524/5; Fax: 27 (0)11 717 4556



Hello!

Our names are Daniel Greenslade, Urvashi Chiba, Shona Fraser, Stephanie MacIlwaine, Jessica Rice, Cindy van Wyk and Kelly Holland. We are conducting research for the purpose of obtaining a Masters degree (MA[Neuropsychology]) in at the University of the Witwatersrand. Our area of focus is young adolescents attending the Empilweni Clinic.

We would like to invite you to take part in this study.

Your parents have to give consent to let you be part of the study and you will also need to give us assent (your permission) to participate in the study.

You will be required to complete some drawing tasks, repeat some lists of words and numbers, identify some colours as well as try your hand with some cards. This may take between two to three hours to complete with rests in between. You will be provided with light refreshments half way through the tests.

Participation is voluntary, and you won't be advantaged or disadvantaged in any way for choosing to, or not to, participate. Please be assured that confidentiality about the results between the researcher and you as a participant is guaranteed. Your name will not be on any of your information from the study. The information we receive from the tests will only be seen by us and our research supervisors. No individual feedback can be given. This grouped data may be used in publications or conference presentations, but no data that

identifies you will be used. Please note that you will be free to stop the procedure at any time and no negative consequences will follow. Your participation would be greatly appreciated; the information you provide will be kept confidential for a period of 12 months following the completion of the project.

Should you have any further questions, please feel free to contact any of us, or our supervisors at the above mentioned telephone numbers and we will be happy to assist.

This research project will be approved by the ethics committee at the University of the Witwatersrand and if you have any questions you may also contact them.

Thank You and Kind Regards,

Daniel Greenslade 0835605017, Urvashi Chiba 0829049867, Shona Fraser 0827468865,
99Stephanie MacIlwaine 0844449917, Jessica Rice 0823762980, Cindy van Wyk
0722797828, Kelly Holland 0834496416

Supervisors: Enid Schutte, Kate Cockcroft, Marilyn Lucas, Ms Aline Ferreira-Correia

Appendix 10: Participant Information Sheet (Control Group)



School of Human and Community Development
Private Bag 3, Wits 2050, Johannesburg, South Africa
Tel: 27 (0)11 717 4524/5; Fax: 27 (0)11 717 4556



Hello!

Our names are Daniel Greenslade, Urvashi Chiba, Shona Fraser, Stephanie MacIlwaine, Jessica Rice, Cindy van Wyk and Kelly Holland. We are conducting research for the purpose of obtaining a Masters degree (MA[Neuropsychology]) in at the University of the Witwatersrand. Our area of focus is young adolescents.

We would like to invite you to take part in this study.

If you, as the guardian/parent agree to join in you will be required to complete some drawing tasks, repeat some lists of words and numbers, identify some colours as well as try your hand with some cards. This may take between two to three hours to complete with rests in between. You will be provided with light refreshments half way through the tests.

Participation is voluntary, and you will not be advantaged or disadvantaged in any way for choosing to, or not to, participate. Please be assured that confidentiality about the results between the researcher and you as a participant is guaranteed. The information we receive from the tests will only be seen by us and our research supervisors. No individual feedback can be given. This grouped data may be used in publications or conference presentations, but no data that identifies you will be used. Please note that you will be free to stop the procedure at any time and no negative consequences will follow. Your participation would be greatly appreciated; the information you provide will be kept confidential for a period of 12 months following the completion of the project.

Should you have any further questions, please feel free to contact any of us, or our supervisors at the above mentioned telephone numbers and we will be happy to assist.

This research project will be approved by the ethics committee at the University of the Witwatersrand and if you have any questions you may also contact them.

Thank You and Kind Regards,

Daniel Greenslade 0835605017, Urvashi Chiba 0829049867, Shona Fraser 0827468865,
Stephanie MacIlwaine 0844449917, Jessica Rice 0823762980, Cindy van Wyk 0722797828,
Kelly Holland 0834496416

Supervisors: Enid Schutte, Kate Cockcroft, Marilyn Lucas, Aline Ferreira-Correia

Appendix 11: Participant Biographical Questionnaire

Collateral/Home Information

I am going to ask you some questions about the home and family

1. Where does your ward/child live?.....

2. Can you talk about the type and number of rooms in the house?

	Yes	No
Bedroom?	1	0
If yes, how many?		
Bathroom?	1	0
Kitchen?	1	0
Living room?	1	0

3. Who lives at home with the child?

	Yes	No	
Mother ?	1	0	
Father?	1	0	
Grandmother?	1	0	
Grandfather?	1	0	
Mother's boyfriend?	1	0	
Father's girlfriend?	1	0	
Brothers?	1	0	How many?
Sisters?	1	0	How many?
Aunts?	1	0	How many?
Uncles?	1	0	How many?
Other?			

4. Who is the person that takes care of your ward/child most of the time?

Mother	1
Father	2
Grandmother	3
Grandfather	4
Aunt	5
Uncle	6
Sister	7
Brother	8
Mother's boyfriend	9
Father's girlfriend	10
Other	11.....

5. Do the parents or guardians work?

	Yes	No	If Yes: What kind of work do they do?
Mother / female guardian only	1	0	
Father /male guardian only	1	0	
Both parents (mother and father)	1	0	

		Yes	No	Don't know
17.	Have at least one of the parents/guardians passed grade 8?	1	2	3
18.	Are there more than 20 hardcover books in the home?	1	2	3
19.	Does at least one of the parents/guardians read a newspaper or magazine once a week?	1	2	3
20.	Does the child/ward usually receive a present from their parents/guardians on their birthday?	1	2	3
21.	Is the attitude of the parents/guardians towards schooling positive or at least neutral?	1	2	3
22.	Is there enough money at home for basic things like food, clothes?	1	2	3
23.	Is there enough money to buy expensive things? (e.g. plasma TV)	1	2	3

	Is there:	Yes	No
24.	a TV that is working at home?	1	0
25.	a radio that is working at home?	1	0
26.	a hot water tap inside your home?	1	0
27.	a flush toilet?	1	0
28.	a parent/guardian who has their own car?	1	0
29.	a vegetable garden at home?	1	0
30.	electricity in the home?	1	0
31.	gas at home?	1	0
32.	a fridge at home?	1	0
33.	a bed that the child/ward sleeps on by himself/herself?	1	0
34.	a bedroom that the child sleeps in?	1	0
	If not, in what room does he/she sleep in?		
35.	Is the child sleeping alone in the bedroom?	1	0
	If not, who do you share it with?		

6. Does the child eat:

	Yes	No	What does he/she usually eat?
36.1 Breakfast?	1	0	
36.2 Lunch?	1	0	
36.3. Dinner?	1	0	

		Yes	No	Don't know
37.	Did the mother have any problems during her pregnancy with the child?	1	2	3
38.	Were there any problems during the birth?	1	2	3
39.	Did the child learn to walk, talk etc at an around the right age?	1	2	3
	Comments			
		Yes	No	If so, when and for what?
	Has the child/ward ever received:			
40.	psychotherapy?	1	0	
41.	physiotherapy?	1	0	
42.	occupational therapy?	1	0	
43.	speech therapy?	1	0	
44.	had your eyes tested?	1	0	
45.	had any other forms of treatment?	1	0	
	If so, what?			

Could you tell me about the languages spoken at home.

7. Language Context Information

Languages Used	Home	School	Friends	Mom	Dad	Grandparents
English						
Afrikaans						
Zulu						
SeSotho						
Xhosa						
(Tshivenda) Venda						
(Setswana) Tswana						
Siswati						
Ndebele						
(Xitsonga) Tsonga						

(Sepedi) Northern Sotho						
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PART B: Participant Questions:

I need some background information before we start. I am going to ask you some questions about you starting with the languages you speak

8. Participant languages:

Languages	Read	Write	Speak
English			
Afrikaans			
Zulu			
SeSotho			
Xhosa			
(Tshivenda) Venda			
(Setswana) Tswana			
Siswati			
Ndebele			
(Xitsonga) Tsonga			
(Sepedi) Northern Sotho			

I'm going to ask you some questions about your school

9. What language do you learn in at school?(should be English but check)

10. What grade are you currently in?

11. Have you ever repeated a grade at school?

Yes	1	Which Grade?
No	0	

12. Have you been absent from school this year?

Yes	1	Why?
No	0	

13. What do you do straight after school?.....

14. What do you do when you get home from school?

.....

		Yes	No	Don't know
54.	Do you smoke?	1	2	
55.	Do you drink alcohol?	1	2	

56.	If so, how much in a week?			
57.	Do you take drugs?	1	2	
58.	If so, how often and what?			
59.	Do you exercise regularly?	1	2	
60.	Are you in a relationship?	1	2	

Now I'm going to ask some questions about which hand you use to do things

		Left	Right	Both	Not sure
	Which hand do you usually use...				
61.	To write a letter legibly				
62.	To throw a ball				
63.	To cut with scissors				
64.	To deal playing cards				
65.	To hammer a nail into wood				
66.	To turn a door handle				
67.	To unscrew a jar				
68.	To hold your toothbrush				
	Which foot do you use				
69.	To kick a ball				
70.	To step on a bug				
	Which eye do you use				
71.	To look through a vuvuzela				
72.	To look through a hole				

Clinical Impressions:

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