Demographic and Neuropsychological Profile of HIV-positive Children Referred for an Assessment at a Local Clinic over a 5-year Period.

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COMPULSORY DECLARATION

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

Signature: Signed by candidate **Date: 13/03/2021**

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Table of Contents

List of abbreviations

Abbreviation	Meaning	Page
LMICs	low- and middle-income countries	7
HIV	the human immunodeficiency virus	7
HICs	High-income countries	7
PNC	Pediatric neuropsychology clinic	7
RXH	Red Cross War Memorial Children's Hospital	7
ART	antiretroviral therapy	9
CNS	central nervous system	10
BBB	blood-brain barrier	11
WHO	World Health Organization	11
HIVE	HIV encephalopathy	11
ADHD	Attention-deficit/hyperactivity disorder	13
EFs	Executive functions	13
ARV	antiretroviral	15
HAART	Highly active antiretroviral therapy	15
cART	combination antiretroviral therapy	16
UCT	University of Cape Town	17
SES	Socioeconomic status	18
WASI	Wechsler Abbreviated Scale of Intelligence	20
VIQ	Verbal IQ	20
PIQ	Performance IQ	20
CMS	Children's Memory Scale	20
WRAML	Wide Range Assessment of Memory and Learning	21
TEA-Ch	Test of Everyday Attention for Children	21
NEPSY	A Developmental Neuropsychological Assessment	21
D-KEFS	Delis–Kaplan Executive Function System	21
WISC-IV	Wechsler Intelligence Scale for Children – IV	22
WAIS-II	Wechsler Individual Achievement Test II	22
WPPSI-III	Wechsler Preschool and Primary Scale of Intelligence III	22
REC	Research Ethics Committee	23
TB	Tuberculosis	29
TBI	Traumatic Brain Injury	29
FAS	Fetal Alcohol Syndrome	29
FSIQ	Full-Scale IQ	38

EID	Early infant diagnosis	48
ITC	International Test Commission	54

Abstract

Individuals in low- and middle-income countries (LMICs) are disproportionately affected by the human immunodeficiency virus (HIV) relative to high-income countries (HICs). Children are particularly vulnerable given the impact of HIV on brain development.

Neuropsychology is still in its infancy in South Africa and there are limited services dedicated to addressing neuropsychological difficulties, including the assessment of children living with HIV. At the pediatric neuropsychology clinic (PNC) at the Red Cross War Memorial Children's Hospital (RXH) in Cape Town, South Africa, free services related to neuropsychological assessments are available to those referred by health professionals, an offering that is rare in South Africa.

Considering the impact of HIV on the brain, the PNC offers services and resources to support the study of the effect of HIV (and other pathologies that result in neuropsychological impairments) on the developing brain and its influence on children more broadly in the South African context. Given how limited such services of this nature are in this context and the related opportunity for research and knowledge based on such services, I aimed to the describe the demographic, medical, developmental, and neuropsychological profiles of children referred to RXH PNC over a 5-year period (with an in depth focus on those who are HIV-positive).

I investigated a series of neuropsychological reports from the PNC, retrospectively from the year 2012 to 2016, using qualitative and quantitative methods. I report on all the children referred to the clinic within this period (N= 158) and then specifically report in depth on the proportion of children who were HIV-positive (n= 73, 45%) and describe their demographic profiles. I then compared the neuropsychological outcomes of the HIV-Positive Subsample to a separate demographically matched typically developing Control Group (n= 41) recruited from local communities.

Overall, there were no significant differences in the demographic profile between the HIV- Positive Subsample and the Control Group. However, in the neuropsychological profile there were significant differences found between these two groups in all of the neuropsychological domains except visual memory. The evidence from this study supported the association between cognitive deficits found in children with HIV often discussed in literature.

Given the dearth of specialist neuropsychological assessment facilities that are accessible to the public, this highlights the importance of clinics such as the PNC. More specifically the PNC is at the forefront of providing pediatric neuropsychology services in

South Africa. The benefits of the PNC include a hub for data of cognitive fall out seen at the clinic which can inform research and other collaborative projects with clinicians and universities. Further, having detailed neuropsychological and demographic profiles/data of children living with HIV can inform intervention-based studies. Intervention-based studies can include a practical component in assisting HIV-positive children attaining a better quality of life considering their neuropsychological difficulties.

Key words: Pediatric HIV, Neuropsychology, Cognitive domains, Red-Cross War Memorial Hospital, Pediatric Neuropsychology Clinic, South Africa

HIV is a serious public health concern, which was first reported in the 1980s. According to Statistics South Africa, (2020), in 2017 it was the fifth leading cause of mortality in South Africa. Children are unduly affected and experience both direct and indirect effects associated with the disease, seen in a range of domains including medical, developmental, psychosocial and academic spheres (Gilborn, 2002; Sherr et al., 2014; Zinyemba et al., 2020). Among the direct effects, one of the primary areas of concern is the impact of HIV on neurocognitive development and outcomes. Therefore, it is important to explore these direct and indirect effects for possible intervention.

Considering the infancy of the field of neuropsychology in South Africa, there is a lack of availability of assessments, and the very few services that are available are overburdened. Therefore, having studies of this nature are especially important as having analyses and profiles based on the neurocognitive functioning of children in general (and in this case children living with HIV), can provide invaluable information to the growing profession within South Africa. Additionally, the free clinical services provided by the PNC exclusively for children is rare and places the clinic at a leading unique position within the country, not only to provide neuropsychological assessments to children with HIV or any child experiencing cognitive difficulties, but additionally having a database of information pertaining to neuropsychological difficulties seen in the clinic over the years. Such a database can be used in a myriad of ways including for clinical research, or possible funding opportunities to expand the clinical services offered at the PNC.

Literature Review

Epidemiology

According to UNAIDS (2019), by the end of 2018, global estimates indicated that approximately 37.9 million adults and 1.7 million children (under the age of 15) were living with HIV. In the same year, approximately 1.7 million people were newly infected with HIV, including 160 000 children. Additionally in 2018, 770 000 people died of AIDS-related illnesses (UNAIDS, 2019). By the end of 2018, 23.3 million HIV-positive people globally had access to antiretroviral therapy (ART), increasing their chances of living a longer and healthier life (UNAIDS, 2019).

There are clear and long standing global disparities in the HIV epidemiology between HICs and LMICs (Cock & Weiss, 2000; Vermund & Leigh-Brown, 2012). The Sub-Saharan Africa regions disproportionately carry the largest burden of HIV and account for more than 70% of the infection rate globally (Kharsany & Karim, 2016). In 2018, approximately 25.6 million people were living with HIV in Sub-Saharan Africa, of which approximately 1.7

million were children (Avert, 2018). Within Sub-Saharan Africa, South Africa has the 4th highest infection rate (Elflein, 2019), however, South Africa has been reported as the leading country globally with highest number of HIV/AIDS cases (UNAIDS, 2018).

In South Africa, by the end of 2018, there were approximately 240,000 new infections and 71, 000 deaths due to AIDS-related illnesses. Additionally, it was estimated that 7.7 million people in South Africa were living with HIV (Avert, 2018). In South Africa those living with HIV are predominantly females in their reproductive years (15-49 years). This is particularly concerning for children, bearing in mind that a common route for HIV transmission is from mother to child during pregnancy (Jemmott et al., 2014; Puthanakit et al., 2013). There are three distinct ways in which perinatal infections can occur: during pregnancy, during labour or delivery, or during breastfeeding (Puthanakit et al., 2013).

HIV Pathogenesis

The onset of HIV is initially asymptomatic, but eventually leads to the progressive decline of the immune system resulting in susceptibility to opportunistic infections and diseases (Kourtis & Bulterys, 2010). At three months post-infection, when seroconversion occurs, in which HIV-specific antibodies can be detected, the individual starts experiencing symptoms. During primary infection, although the body may appear to be healthy, the virus duplicates in the lymph nodes and the bloodstream of infected individuals. This may result in the slow damage of the immune system through the increase of viral load in the body (Naif, 2013).

The immune system plays a role in protecting the body by identifying antigens or attacking bacteria and viruses (Kumar & Herbein, 2014). Therefore, it is weakened by HIV, which infects several immune cells, including macrophages (which are a type of white blood cell) and CD4+ T cells. There is constant communication between these cells, which facilitates the transmission of HIV (Kumar & Herbein, 2014). Typically, women who show positive results on p24 antigen tests and who have a low CD4 cell counts, show greater likelihood in the mother-to-child transmission of HIV (Lambert & Stiehm, 1993; World Health Organization (WHO), 2015).

This fundamental understanding of the pathogenesis of the central nervous system (CNS) in HIV-positive individuals is, however, built on knowledge from adult HIV studies. Although the pathogenesis of HIV in pediatric patients is thought to be like that seen in adults, there are key differences in the contraction of the virus in a newborn or child compared to the acquisition at a later life stage. This may have implications for the course of the neurologic disease (Crowell et al., 2014). Crowell et al. (2014) explain that although the

blood-brain barrier (BBB) may be functioning and include tight junctions that limit protein diffusion into the CNS in developing children, there also is a higher white blood cell count in the cerebral spinal fluid of newborns as compared to adults. With this, there is a greater chance of these infected white blood cells crossing the BBB in newborns. In addition, viral replication has been seen in HIV-infected neural progenitor cells (similar to a stem cell) in the brain tissue of HIV-positive children (Crowell et al., 2014). Researchers have found that the virus negatively affects the growth of a child's brain, and that the brain's white matter is particularly vulnerable to the effects of HIV infection (Jankiewicz et al., 2017). Longitudinal studies have demonstrated how the volume of grey matter also reduces in children with HIV (mainly occurring after a year of being infected). The grey matter areas most vulnerable to volume reduction are the prefrontal regions, parietal lobe, the sensorimotor cortex and limbic system (Yu et al., 2019). The progression of the pathogenesis then leads to the manifestation of what is known as the clinical stages of HIV.

Clinical Stages of HIV

The development of HIV across the lifespan proceeds through 4 stages, which is based on a combination of clinical and biological parameters, according to the World Health Organization (WHO, 2005). By the time the 4th clinical stage is reached, this is indicative of long standing HIV, which poses the risk of developing HIV encephalopathy (HIVE) (WHO, 2005). HIVE is associated with neuropathology in the basal ganglia in which calcification is commonly found (Hoare et al., 2015). The areas around the ventricles are most vulnerable as there is an easy viral penetration of the HIV-infected cells through the cerebrospinal fluid and white matter loss is found in the advanced stages of the disease (Andronikou et al., 2014). The diagnosis of HIVE usually requires two of three criteria: the acquired cortical motor deficit, impaired brain growth, and/or failure to attain or loss of developmental milestones (Innes et al., 2017).

Notwithstanding the clinical stage that an individual may exhibit, there is a range of resultant neurodevelopmental and neuropsychological sequelae associated with HIV. These sequelae might be considered direct effects of CNS damage and can take the form of cognitive, behavioural, and emotional / psychiatric effects. There are also a range of indirect effects of HIV, such as psychosocial and academic problems, which may be secondary to the neuropsychological and developmental problems (Smith et al., 2006).

Neurodevelopmental Effects of HIV in Children

With pediatric infections (e.g., in perinatally-infected children), the effects (such as the disruption of the growth trajectory of the brain) not only impact a child's physical growth,

but can also have an impact on their psychological health and neurodevelopment (Laughton et al., 2013c; Smith et al., 2006). Developmental delays and neurological complications (such as apoptosis and calcification of the basal ganglia) are frequently seen in children with HIV, especially in children who were infected perinatally (Potterton et al., 2009). Apoptosis is a process in which unwanted cells are eliminated in the developmental process (Potterton et al., 2009).

From as young as four months of age, neurodevelopmental delays in mental and motor functioning are prominent and continue into the pre-school years (Smith et al., 2006). Govender et al. (2011) expanded on two South African studies in which motor deficits and neurological impairments were characteristic in children with HIV. In these studies, they reported that 59% of the children aged one month to 12 years had abnormal neurological examinations, 41% had global pyramidal long tract signs, and 16% had cortical visual impairments. These are some of the significant effects HIV has on developing children which have knock on effects on their cognitive functioning.

Neuropsychological Effects of HIV in Children

There are many more studies on the neuropsychological outcomes and the effects of HIV on the adult brain as compared to the developing brain. However, the effects of HIV on children cannot be extrapolated from adult studies, given the different routes and time course of infection across the developmental stages in children as compared to adults (Andronikou et al., 2014). This age-specific information is important in terms of planning effective age-appropriate services, including treatment, intervention and care (Sherr et al., 2014).

Neuropsychological impairment in children with HIV is frequently reported in various domains. Neuropsychological profiles of children with HIV are often broad and include deficits in general intellectual functioning, language, attention, memory (both visual spatial memory and verbal memory), executive functions (examples include sequencing, planning, inhibition, working memory), and information processing speed (Boivin et al., 2010; Cohen et al., 2015; Crowell et al., 2014; Keller et al., 2004; Laughton et al., 2013b; Phillips et al., 2016; Puthanakit et al., 2010; Van Rie et al., 2007). The current study looks at the performance of children with HIV with a specific focus on each of these domains.

General Intellectual Functioning

Studies have often found significant disparities between the general intellectual functioning of HIV-positive children compared to controls, in that that children with HIV often perform significantly lower than the control groups on tests measuring this outcome (Cohen et al., 2015; Koekkoek et al., 2008). For example, a study by Hoare et al. (2016)

demonstrated these results with a sample of HIV-positive and HIV-negative South African children. The results indicated that with both the verbal and performance IQ, the HIV positive group performed significantly more poorly in comparison to the HIV negative group.

Language

In relation to language, studies have reported an increased risk in language impairment associated with HIV progression. The greater the immunosuppression, the greater the impairment in expressive and receptive language functioning has been observed (M. L. Rice et al., 2012; Van Rie et al., 2008). It is however not clear as to whether the language impairment is a direct effect of the generalized global deficits that occurs (which would include deficits in non-verbal and verbal communication) or whether the impairment is specifically a language deficit. Further, within research in this area, alternative sources associated with language difficulties such as hearing loss which occurs in children with HIV, have been discussed (Rice et al., 2012).

Attention

Deficits in attentional processing often appear prominently in literature on the effects of HIV in children. It is a hallmark characteristic frequently associated with children who are both symptomatic and asymptomatic (Rice et al., 2014; Watkins et al., 2000). Watkins et al. (2000) reports that clinical impairment was specifically found in settings in which attention needed to be sustained. Additionally Attention-deficit/hyperactivity disorder (ADHD) (which has an attentional deficit component) has been found to be one of the most common psychiatric disorders to be comorbid amongst children with HIV (Mpango et al., 2017).

Memory

The cognitive domain of memory is known to be at risk in children with HIV. Studies have demonstrated that children with HIV typically have difficulties in verbal and visual recall compared to their non-infected counterparts (Nichols et al., 2016; Phillips et al., 2018). Additionally, HIV-positive children have demonstrated a pattern of worse recall than recognition memory, which then suggested that the deficits experienced are related to spontaneously retrieving learned information and not necessarily the acquisition of the information (Nichols et al., 2016).

Executive Functions

Executive functions (EFs) are a multifaceted domain that encompasses a wide range of subfunctions which include planning, problem solving, inhibition, sequencing, decision making, self-regulation and processing information (Cohen et al., 2015; Diamond, 2013; Nichols et al., 2015). Considering the wide range of subfunctions, it is not surprising the

impact that EFs would have on an individual who may have deficits in this domain. Studies have shown that the deficits in EFs identified in children may have an impact on the acquisition of skills necessary for transitioning into adulthood. Such effects may result in an increased likelihood of risk behaviours which are sexual or substance abuse related (Nichols et al., 2015). However according to Nichols et al. (2015) the few studies that discuss EFs in children with HIV, discuss these deficits in relation to the effects that the deficits may illicit as the children transition from adolescence to adulthood.

Information Processing Speed

Deficits in information processing often manifest as a slowing of mental output. This is typical in children with HIV due to the neuropathology of HIV which shows white matter damage which results in slowed processing speed (Haase et al., 2014). In a meta-analysis performed by Phillips et al. (2016) the results indicated that many studies demonstrated that children with HIV have significant impairments in their processing speed compared to HIV uninfected and unexposed controls.

Thus, the potential effect of HIV on the CNS of children can be detrimental as it can affect their ongoing cognitive development. Besides the associated neurocognitive deficits, children with HIV also often face behavioural effects, and emotional and psychiatric difficulties. All of these sequelae can often then have knock-on effects in terms of psychosocial and academic outcomes (Puthanakit et al., 2010).

Behavioural Effects of HIV in Children

HIV-positive children also often exhibit behavioural impairments. Examples include impulsivity and hyperactivity, which, together with attentional deficits, have been linked to ADHD (Nozyce et al., 2006). Externalizing behavioural problems such as rule breaking, anti-social and aggressive behavior are commonly found in children with HIV (Prashantha Kumar & Kumaravel, 2019). Behavioural issues observed in children with HIV cannot be analyzed in isolation as there are additional psychosocial factors that can often contribute to such behavioural and also to psychiatric issues (Vranda & Mothi, 2013).

Emotional and Psychiatric Effects

HIV/AIDS frequently results in emotional-related sequelae in children (Malee et al., 2011). Yadav et al. (2017) discuss that areas such as the subcortical white matter and fronto-striatal systems tend to grow abnormally in children with HIV. These areas regulate emotion and behaviour, making those who are infected vulnerable to mental health problems. Additionally, HIV-positive children have a higher chance of experiencing the death of a guardian, which may contribute to added psychological distress and result in additional

family responsibilities (Gilbert & Walker, 2010; Gilborn, 2002). Emotional consequences associated with these early challenging experiences often manifest in the form of anxiety disorders. Separation anxiety, in particular, is common among children with HIV because of parental loss due to HIV/AIDS, which results in some children being orphaned (Benjet, 2010). These adverse situations can lead to mood disorders, such as depression, anxiety disorders, or violent behaviours (Joshi et al., 2017).

The neuropsychological, behavioural, and emotional effects, either individually or compounded, in turn can have a negative impact on a child's academic performance. Problems pertaining to academia or schooling are prevalent among HIV-positive children.

Academic Effects

As mentioned, there are often direct knock-on effects of the cognitive, psychiatric/emotional, and behavioural sequelae of HIV on school performance. For example, children living with HIV often perform poorly due to specific neuropsychological domains being affected such as attention and memory, which directly impact the way in which a child can learn in their school subjects. Further, psychiatric challenges such as depression can also impact of effective learning. Further, there are also common psychosocial school-related problems that arise in children living with HIV that include high absenteeism and lack of schoolwork completion due to the illness or scheduled hospital / clinic appointments. Other issues include disclosing their HIV status to relevant staff members in the school, and stigma from classmates (which can be associated with bullying) and teachers that could affect attendance and performance at school (Chuong & Operario, 2012; Gilborn, 2002; Guo et al., 2012). There are also issues with late enrollment at schools, which is related to issues with placement and living stability in their early years (given that a vast number of HIV-positive children are orphaned; (Lowenthal et al., 2014)).

It is therefore imperative for early learning opportunities to be implemented, because delays in such opportunities may lead to a loss of developmental potential (Walker et al., 2011). In these cases, adherence to treatment is important for a child to be successful during their schooling years.

Treatment and Psychosocial Issues

The purpose of ART is to suppress HIV from further progression (WHO, 2015). South Africa leads in having the largest ART program globally. In 2018 it was reported that there were approximately 4.8 million people receiving some form of antiretroviral (ARV) treatment (this accounts for 71% of adults living with HIV and 47% of children living with HIV) (UNAIDS, 2020). Highly active antiretroviral therapy (HAART) is a treatment that

usually has a combination of three or more ARV drugs (and it is also interchangeably called ART or combination antiretroviral therapy (cART)) (Eggleton & Nagalli, 2020). The importance of HAART is the combination of the different drugs and its effectiveness in inhibiting viral replication; therefore, the adherence of medication is key in stopping rapid disease progression.

Adherence to ARVs is an important aspect of ensuring slow progression and preventing onward transmission of HIV. This is due to ARVs having the ability to penetrate the CNS to reduce viral replication. This penetration however increases the risk of ARV-related neurotoxicity, which could have a negative impact on neurocognition as any form of neurotoxicity poses the risk of damaging the brain which leads to neurocognitive impairment. Researches however argue that the negative effects of neurotoxicity are unclear and must be weighed against the benefits of CNS viral control (Vreeman et al., 2015).

Although there have been large improvements in ART rollout in South Africa, there are certain barriers that hinder adherence. One of the key barriers that is associated with lack of adherence is stigma (Jones et al., 2020). Jones et al. (2020) discuss how their participants self-reported their lack of adherence due to the community or internal stigma that they would face. Additionally Haberer et al. (2019) discuss that in their cohort it was those who were in the early stages of infection who were more likely to be adherent compared to those who were pregnant or were diagnosed at the late stages of infection.

There are different sets of challenges with adherence in children. In some cases, it may be difficult as parents are often afraid to disclose to their children that they are HIV positive (due to stigma).

Additionally, research has demonstrated that EFs are especially important in maintaining ARV adherence. Due to EFs being needed for complex cognitive tasks to be done (including planning and prospective memory), if there is executive dysfunction this in turn affects how one may carry out their ARV regimen. Frontal lobe damage and EF dysfunction are often seen in children with HIV and this could affect how they adhere to their ARV regimen (Panos et al., 2014)

However, despite room for improvement, the implementation of ART has resulted in a decline in the mortality rates in children living with HIV, quickly changing the status of HIV from fatal to a chronic disease (Coovadia et al., 2015). This outcome, however, relies on the timing of ARV initiation. A delay in ARV initiation slows down immunologic reconstitution and therefore timing of the ART is critical for optimizing neurodevelopment and cognitive performance (Donald et al., 2012). The administration of ART typically before

1 year of age is associated with a significantly better neurodevelopmental outcome in children (Violari et al., 2008). The longer the period between diagnosis and ART initiation, the lower the cognitive scores in perinatally-infected children and adolescents (De Baets et al., 2007; Donald et al., 2012). Not only do ARVs promote relatively normal growth, but they also prolong the survival rate of individuals with HIV, and improves quality of life (Smith et al., 2006).

In sum, HIV remains a serious public health problem in South Africa. There is a range of associated neuropsychological, behavioural, academic, psychiatric, and emotional problems that may ensue. To understand the needs of a child who is infected with HIV, one needs to understand the child in the context of all of these domains. There are both HIV and non-HIV etiological factors that contribute to the poor neurocognitive outcomes seen in children with HIV (that have been discussed above). The HIV-related etiological factors include the direct effects of the virus such as atrophy, neurotoxins, calcification, and HIV progression/complications such as HIVE. Non-HIV-related etiological factors include socioeconomic status (SES), quality of education, psychiatric disorders, and comorbid diseases. Given their direct or indirect effects on these outcomes, all of these factors need to be considered to better understand the neuropsychological functioning of a child with HIV.

Although treatment in the form of ARVs is now more readily available, there are psychosocial issues that impact access and adherence. Although broader epidemiological data are available, a more nuanced detailed profile (touching on interrelated neuropsychological and psycho-social issues) are needed for intervention.

Neuropsychology in South Africa

Formal neuropsychological assessments can inform such interventions. Given the status of neuropsychology in South Africa, not all children have access to such assessments due to services being few and far between. In Cape Town, there is a free PNC; however, due to the rare offering the services are limited and cannot cater for all neuropsychological difficulties that present within the Western Cape, let alone the South African context. Despite its utility, the clinic has its limitations of using neuropsychological assessments with Western normative data that often undermines the performance of those being assessed as the information can be culturally inappropriate, as has been noted extensively in research (Laher & Cockcroft, 2018; Lucas, 2013; Truter et al., 2018a; Watts & Shuttleworth-Edwards, 2016). Despite these challenges, the PNC does assist children presenting with neuropsychological difficulties (i.e., children living with HIV) and is partnered with the University of Cape Town (UCT) Neuropsychology MA program in training student neuropsychologists and providing

resources for research to be done. No previous publications have been based on assessments done at the PNC. Such publications are however useful as they inform clinic specific information, increase credibility of the clinic, and provide opportunities for collaborators of local and international neuropsychology clinicians.

Aims

This study had two main aims. The first aim of the study focused on all the children that were referred to RXH PNC. For this aim, I include a description of a demographic profile of all the children referred to the RXH PNC, over a 5-year (2012-2016) period. The main objective of the first aim was to gauge the proportion of those who are HIV-positive vs those who are not, amongst all the children referred to the PNC. This group is called the All Referred Group. The second aim of the of the study focused specifically on the HIV positive children from the All Referred group. Part of this aim was to describe the demographic profile of children diagnosed with HIV, specifically. The objective was to identify and report on common trends amongst this group called the HIV-Positive Subsample. Another part of this aim was to describe the neuropsychological profile of the HIV-Positive Subsample and compare them to a sample of demographically matched typically developing controls (Control Group), and in doing so, to gauge their performance in this area of functioning.

Methods

Design and Setting

The current study involved the review of medical records (neuropsychological reports specifically), over a 5-year period (2012-2016). Therefore, the study involved a retrospective component. I also included a typically developing Control Group against which the neuropsychological test scores from the reports of those children who were in the HIV-Positive Subsample, were compared. This component of the study was cross-sectional. The typically developing Control Group was matched demographically to the children referred to the PNC who are HIV-positive.

The current study design is both qualitative and quantitative as the results include both a content analysis of the neuropsychological case reports as well as statistical analyses of the demographic profile and neuropsychological test scores. Hussein (2015) discusses how using both qualitative and quantitative research methods in the same study has resulted in many debates where various researchers argue that the two paradigms differ epistemologically and ontologically; however, the combination of these differences can bring value to research. Using mixed methods can increase study credibility. Combining these

research methods has increased in popularity as it has the prospect of a multifaceted observation based on the subject matter (Creswell, 2013).

The retrospective data was stored at RXH; hence it being a study site. Additionally, the Control Group participants were recruited from and tested in communities around Cape Town. As noted, the clinic from which the neuropsychological information was obtained, is the PNC based at RXH. The PNC offers comprehensive neuropsychological assessments free of charge, for children aged 2yrs and up. This clinic forms part of the master's degree of Neuropsychology training program at UCT, and most cases are seen, under direct supervision from faculty members, by second year master's students or interns. A range of cognitive domains are assessed (including attention, memory, language, visuospatial function, executive function, and IQ, among others) and assessments are tailored to answer specific referral questions. Full and redacted reports are provided to the referring Drs and the family, regarding neurocognitive and behavioral strengths and weaknesses, the consistency of these findings with pathology, and recommendations regarding supportive interventions. An additional offering is the tracking of neurocognitive functioning pre-and post-surgically,in order to track functioning and to provide recommendations on interventions. The Control Group participants were recruited from and tested in communities around Cape Town.

Participants

Participants included the children whose neuropsychological reports will be reported on in this study, i.e., children referred to the PNC from 2012 to 2016. The participants included both boys and girls, 12 years and under, as the RXH admits children up to this age. Additionally, RXH typically services families from low SES communities. I included all children admitted to the clinic for 2012-2016 in terms of the first aim. However, for the second aim, I focused on children referred who are HIV-positive (who make up the group the HIV-Positive Subsample).

The Control Group was individually matched to the HIV-Positive Subsample in terms of language, age, grade, sex and SES. I used area of residence and school system quintiles to determine the SES of the participants. The quintile system is the South African's public-school ranking system which is contingent on the wealth of the community to determine a learner's subsidization (with 1 being the poorest to 5 being the wealthiest) (Ogbonnaya & Awuah, 2019).

A purposive sampling strategy was employed to recruit the control participants. Although I aimed to recruit control participants in a case-control manner, in the end I recruited n=41 Control Group participants in a stratified manner where at least 50% of the

HIV-Positive Subsample's demographics were represented in each age group of the Control Group. For example, if the HIV-Positive Subsample had 8 participants in grade 1. I made sure I recruited at least half of the number of grade 1s for the Control Group that represented to the HIV-Positive Subsample's demographics across age, sex, language, and SES.

In terms of the exclusion criteria for the Control Group, learners with a formal diagnosis of HIV, ADHD, epilepsy, learning disability, or any other formally diagnosed neurodevelopmental or neurological illness were excluded. In addition to the above exclusion criteria, those who had sustained a traumatic brain injury that resulted in loss of consciousness and hospitalization were not eligible to participate in this study. The reason for these exclusion criteria was to ensure that the data obtained from the Control Group is from typically developing children, as any of the neurodevelopmental or neurological illnesses could confound the results of the neuropsychological assessments.

Measures

Demographic Questionnaire

The purpose of this questionnaire (see Appendix A) was to capture the demographic information of the parent or caregiver of Control Group participants (this in-depth measure is not routinely obtained at the PNC; therefore, this kind of information was not readily available for the All Referred Group and HIV-Positive Subsample); it includes the parents' education, occupation, income, and details about the environment in which they live. Additionally, the questionnaire includes a traditional asset index which includes the description of other living conditions such having running water or a flushing toilet in their household and whether the family members have access to bank accounts or credit cards (Myer et al., 2008).

Developmental Questionnaire

This questionnaire (see Appendix B) was used to investigate the developmental history of the Control Group participants in relation to pregnancy, developmental milestones, previous neurological and/or neurodevelopmental diagnoses, and head injuries. This is a shortened version of the developmental questionnaire used at the PNC RXH. This form assisted in terms of the exclusion criteria.

Neuropsychological Measures

The measures for this study included a variety of subtests from standardized neuropsychological batteries, commonly used at the PNC. These measures are outlined below and formed the basis of the neuropsychological outcomes described.

General Intellectual Functioning. The Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999) was developed for individuals aged 6-89 and measures general intellectual functioning. This test battery includes four subtests: Vocabulary and Similarities, which together form the Verbal IQ, and Block Design and Matrix Reasoning, which together form the Performance IQ. The Vocabulary subtest is used to assess a participants' word knowledge and their language skills and the Similarities subtest to assess their construction of concepts and abstract reasoning (Wechsler, 1999). The Block Design subtest is used to assess perceptual organization and Matrix Reasoning to test nonverbal fluid reasoning (Wechsler, 1999). Test-retest reliability ranges from .92 to .95 for VIQ and PIQ subtests. Content validity of the WASI was demonstrated by inspecting IQ scales, which were comparable to the WASI subtests.

Memory and learning. The Children's Memory Scale (CMS) is a battery designed to assess learning and memory functioning in children aged 5 to 16 years (Cohen, 1997). The Dot Locations subtest of this battery is used to assess visuospatial memory (through recalling positions of blue dots on a grid) in three phases: a learning phase, distractor phase with an immediate recall, and a delayed memory phase after 25-30 minutes (Cohen, 1997). The reliability coefficients for this specific subtest range from.61 to .82 (Cohen, 1997).

The Wide Range Assessment of Memory and Learning (WRAML) is a test battery designed to test memory and learning in individuals aged 5-90. There is a verbal memory component to this battery which is used to test the same domain. The verbal memory component includes learning, delayed and recognition trials. Test–retest reliability coefficients for this battery range from .59 to .77 (Sheslow & Adams, 1990).

Attention and Working memory. The Numbers subtest of the CMS is used to assess a participants' basic concentration (forward span) and working memory (backward span) (Cohen, 1997). Trials of digits of increasing length are read to participants and they are required to either repeat the numbers as they are (forward span) or to reverse the order of the digits and then repeat them (backward span). The reliability coefficients for the forward component ranges from .71 to .73 and for the backward component from .66 to .82. Structure and content validity ranges from .06 to .96, for all ages (Cohen, 1997).

In the Test of Everyday Attention for Children (TEA-Ch), the Sky Search subtest is used to assess selective attention. The subtest involves participants locating target spaceship pairs amidst distraction (Manly et al., 1999). Test-retest reliability coefficients for this subtest range from .75 to .80.

Language. The Comprehension of Instruction is a subtest from the battery A Developmental Neuropsychological Assessment (NEPSY-II). This subtest is designed for children aged 5-16 and is used to assess comprehension through visual and audio stimuli. The task requires the participant to point to the correct picture in response to an examiner's commands. The commands increase in syntactic complexity as the participants move further along in the test (Korkman et al., 2007). Test–retest reliability coefficients for this battery range from 0.71-.84 across ages (Brooks et al., 2010).

Executive Functions. The Inhibition subtest is from the NEPSY-II as well, and is used to assess automatic responses and the ability to shift between responses (Korkman et al., 2007). There are two components (shapes and arrows) with 3 conditions (Naming, Inhibition and Switching) in each component. For the NEPSY- II battery, reliability coefficients range from .62 to .89 (Korkman et al., 2007). Content and structure validity were demonstrated by research done on clinical samples (Korkman et al., 2007).

The Tower subtest of the Delis–Kaplan Executive Function System (D-KEFS; Delis et al., 2001) is used to assess a participant's spatial planning, rule learning and impulsivity (Delis et al., 2001). This subtest requires the participant to arrange the discs on the pegs of a board in a specific order in as few moves as possible while adhering to specific rules. The test-retest reliability coefficient for this subtest is .89 (Lowe & Rabbitt, 1998).

Information Processing Speed. The Wechsler Intelligence Scale for Children – IV (WISC-IV) is used to assess children aged 6 to 16 years (Wechsler, 2004). The Coding subtest, which forms part of this battery, is used to assess processing speed. Coding tests the ability to focus attention in order to scan, differentiate and order visual information (Wechsler, 2004). Reliability was measured through internal consistency, test-retest stability, and inter-rater reliability and the coefficients score for coding was .84 across all age groups. Validity was established by comparing the WISC-IV battery with the WAIS-II (Wechsler Individual Achievement Test II) and WPPSI-III (Weschsler Preschool and Primary Scale of Intelligence III) battery (Wechsler, 2004).

The neuropsychological batteries above are regularly used in clinical settings and for research that have been published within South Africa (Chernoff et al., 2018; Truter et al., 2018b). These Western neuropsychological batteries are used due to the lack of South African neuropsychological batteries that are available. See the scores of everyone in the HIV-Positive Subsample (Appendix I) and the Control Group (Appendix J)

Procedure

Retrospective case records review

After ethical approval was obtained, I accessed the password protected digital neuropsychological reports overseen by the clinic coordinator and supervisors for the study period and tallied up the number of referrals for the children who are HIV-positive vs. those who are not and separated the reports into these two batches. Additionally, any demographic information from this sample was recorded. In depth information regarding socioeconomic details are not routinely collected, for example, salary bands or financial resources; however, basic information (such as level of education and employment status) is often mentioned in the neuropsychological report as part of the families' social backgrounds. The neuropsychology reports of the HIV-Positive Subsample were then analyzed in more depth for meaningful trends within the medical, developmental, social, and academic histories for each child. I also looked at trends in the parent and/or teacher concerns noted in the reports, in the neuropsychological test performances, and in the conclusions and recommendations for each child.

Recruitment of Control Group

Once the HIV-Positive Subsample was identified, the recruitment of matched control participants took place. Firstly, schools within lower SES areas such Khayelistsha, Langa and Mitchell's Plain were contacted for consent to collect data (both demographic and neuropsychological) of typically developing children that would form part of the Control Group. The reason for recruitment in these areas is that the children referred to the PNC are generally from lower SES communities such as the areas mentioned above. It was important to ensure that the All Referred Group's demographic information matched that of the HIV-Positive Subsample to eliminate any group differences other than the HIV status. Additionally, these areas were selected due to the convenience of being able to access the schools (in terms of travelling distance).

It was rather challenging to recruit participants through schools as recruiting did not happen as timeously as expected; therefore, the recruitment strategy changed to recruiting through communities with the assistance of people I personally knew. This change in recruitment strategy was approved by the Psychology department's Research Ethics Committee (REC).

Members of the community were given demographic details of the children that needed to be recruited according to their age, sex, grade and language (that matched the HIV-Positive Subsample). If the community members knew of a parent who had a child that matched the specified demographics, they gave those parents the forms to review and to consent to, if they were interested in their child participating in the study. These forms

included information letters which briefly outlined what the study entailed and inviting their child's participation (See Appendix C), demographic and developmental history forms (See Appendices A and B) and informed consent forms (See Appendix D). Once these were completed, the parents returned the forms to the community members (who then returned the forms to me) and the community members would schedule a time during which the neuropsychological assessment could be done with the participant. The forms were scanned prior to the scheduled meeting to ensure that the child met the inclusion criteria and was able to participate.

Testing commenced in three main homes depending on the area. These were the homes of the community members I personally knew. Testing commenced in a quiet room and lasted on average 1.5 hours to 2 hours per participant. Both the English and isiXhosa assessments were conducted by me; however, the Afrikaans assessments were done with an interpreter. Before testing there was an assent form for the participants (see Appendix E), which I read through with the participant. The participant was given the option to participate or not and if they were not interested, no testing was done. In this study there were no participants who refused to participate. After each participant in the Control Group completed the testing, they received R50 to thank them for participating in the study. The three community members were also equally financially compensated for their assistance in recruiting participants.

Data Analysis

Qualitative component: Content analysis

This method as a research strategy is useful in understanding complex social phenomena because it allows researchers to maintain a holistic and meaningful picture of real-life events thus forming an essential part of social science inquiry (Kohlbacher, 2006; Yin, 2011). There are three main steps in content analysis (Kohlbacher, 2006).

Step 1: Collecting evidence. According to Kohlbacher (2006) there are six possible sources of evidence for content analysis: documents, archival records, interviews, direct observation, participant observation, and physical artifacts. The benefits from these six sources can be maximized if three principles are followed (Yin, 2011) : 1) using several sources of evidence, 2) creating a case study database, and 3) maintaining a chain of evidence. In this study I collected evidence by using archival records obtained from RXH which includes information from multiple sources.

Step 2: Analyzing case study evidence. In this step, I went through meaningful information needed for analyzing the data under each of the case report sections: reason for

referral, medical, developmental, social and academic history, parent and/or teacher concerns at the time of the assessment, the neuropsychological test scores, and the impression and conclusion sections. I generated key themes for all pieces of relevant information identified in the case reports and determined the most appropriate themes and how these align with the overall research aims.

Step 3: Reporting content. In this final step, the results and the findings of the analyzed information from the previous step needs to be concluded and reported on. As a final step in my data analysis, I documented the findings of the cases reviewed found in the results.

Quantitative component

For this component, I used IBM SPSS Statistics (Version 26) to analyze the demographic and neuropsychological data. I began with a descriptive analysis of the demographic information for the All Referred Group, the HIV-Positive Subsample and the Control Group. In addition, I ran a between-groups analysis of the neuropsychological test scores and reported on how the HIV-Positive Subsample of children performed across domains in comparison to the Control Group.

Between-groups analysis. In terms of the neuropsychological outcomes data, there were many dependent variables resulting from the subtest scores across the domains and the fact that the test batteries for the various participants who were seen at the PNC overlapped but were not uniform. Therefore, as opposed to reporting on all the dependent variables, certain dependent variables were reported on as some of the HIV-Positive Subsample's results were also incomplete, therefore it would have been difficult to compare results. In analyzing the results of the HIV-Positive Subsample neuropsychological scores, if at least 40% of HIV-Positive Subsample (n=73) had completed a specific test that test would be used to test the Control Group. Additionally, the dependent variables that were reported on within these tests would be those that did not have significant amounts of missing data in which these two groups' results could be compared. After the neuropsychological scores of the Control Group were finalized, the mean scores for each subtest were calculated for each of the groups (i.e., the HIV-Positive Subsample and the Control Group). Then an independent sample t-test was done to calculate if there were significant differences in the mean scores of each of the dependent variables in each of domains tested.

Ethical Considerations

Ethical approval was sought from the Department of Psychology's REC (see Appendix G). Ethical approval was also sought from the Faculty of Health Sciences Human REC (HREC REF: 444/2016) (Appendix H).

Informed consent/assent and voluntary participation

In terms of informed consent, parents/caregivers of children assessed at the PNC (All Referred Group and HIV-Positive Subsample) are routinely asked for their consent that their data be used for research purposes. Hence, I only included the data where parents provided such consent (see Appendix F for consent form used at the PNC). Additionally, parents of children in the Control Group were asked to sign forms to consent to their child participating in the study. Lastly before each assessment, the children provided assent in which it was explained to them that their participation was completely voluntary and that they could withdraw at any point without penalty.

Confidentiality and anonymity

This includes the non-disclosure of the case report information, as well as anonymity, which entails not including the patients' names or any explicit identifiers in my analyses or write-up. This was also upheld for the children whose data was collected from the Control Group. In relation to the Control Group, I conducted assessments in quiet rooms that preserved the confidentiality of the participant.

Potential risks and benefits

In terms of the review of the PNC reports, there were no risks as there was no direct contact with the patients. There were also no direct benefits, although findings from the current study may serve to inform future interventions. For the Control Group there was a risk of fatigue for the children during the assessment (which some children exhibited); however, regular breaks and refreshments were given.

Results

The results are divided into two parts, in line with the aims of the study. Part one will describe the demographic profile of, and number of children referred annually to, the PNC for the All Referred Group (that included all children referred to RXH PNC over the study period, 2012-2016). Part two will focus on results concerning the HIV-Positive Subsample in the first instance and then the comparison between the HIV-Positive Subsample and Control Group, in the second. First, I will report on the annual number of admissions for the HIV-Positive Subsample as well as the associated clinical data regarding age at diagnosis and ARV initiation. Thereafter, I will report on the comparison between these two groups

concerning the demographic outcomes, followed by a comparison of their neuropsychological profiles.

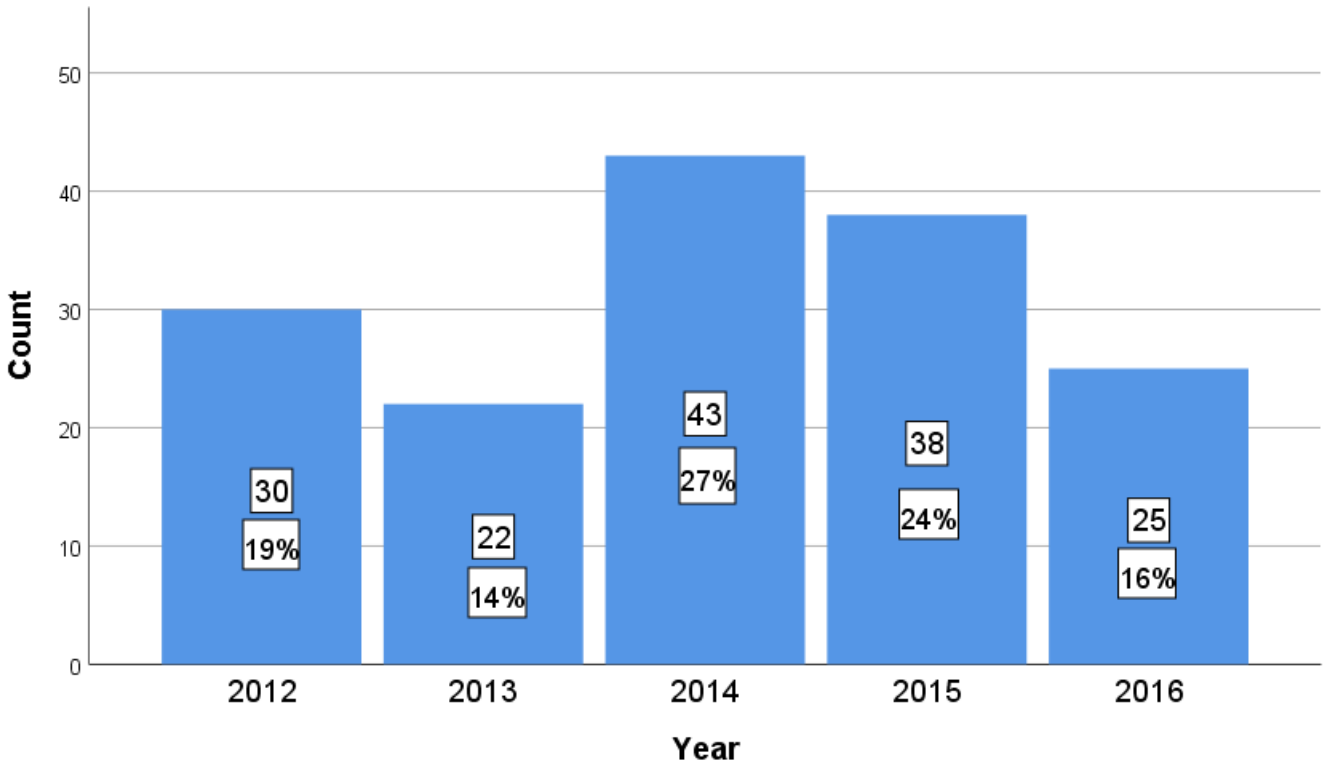
Part one: Demographic Profile of the All Referred group

Annual Number of Referrals

The number of children referred to the RXH PNC during 2012-2016 was *N*= 158. In each year, the months included were from February to November as this is when the PNC service runs. Figure 1 shows the number children that were referred in each year. As shown, there were varying numbers of referrals per year with 2014 having the highest number of referrals. A Chi-square test of independence revealed that there is a significant difference in the number of referrals per year, X^2 (4, N = 158) = 9.78, p = 0.04. An analysis of the standardized residuals revealed that the significance lies predominantly in the years 2013 and 2014. In 2013 there were significantly less referrals and in 2014 there were significantly more referrals, to the PNC.

Figure 1

Bar Graph Indicating the Proportions of Referrals Per Year (N= 158)



Age

The mean age for the All Referred Group was *M*= 9.5 years (*SD*= 2.7, range= 2.5-16.4 years old). The mean ages for each of the study years are presented in Table 1. A one-way ANOVA was calculated to establish whether there were any significant differences in terms of the mean ages of children referred per year. There was no significant effect [*F*(4, 153) =1.97, *p*= 0.10].

Table 1

Mean, Standard Deviation and Range for Ages of the Patients Per Year (N=158)

	2012	2013	2014	2015	2016
Mean	8.7	9.7	9.0	10.1	10.2
Standard deviation	2.6	2.6	2.6	2.9	2.3
*Range (years)	2.5- 14.5	4.2- 14.5	3.0-14.9	4.5-16.4	5.1-14.0

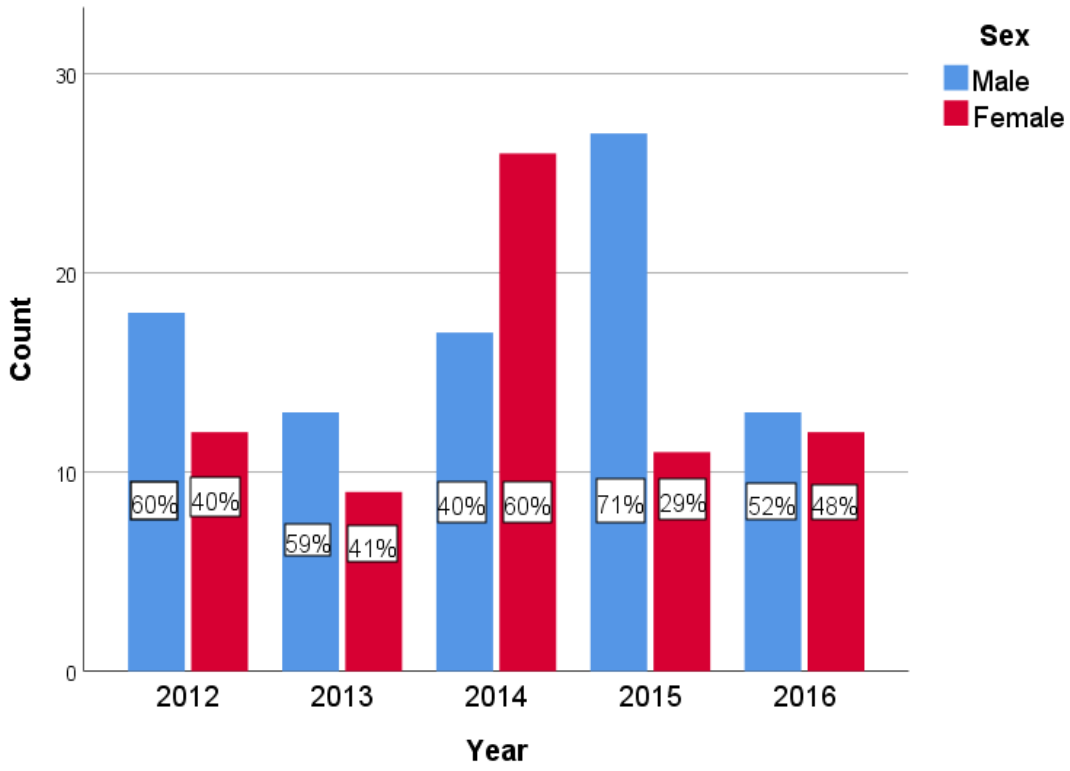
Note. RXH typically admits children 12 years and under. There are exceptions in which children over 13 years old may be admitted or referred.

Sex

There were more males (*n*= 88) than females (*n*= 70) in the All Referred Group. Figure 2 shows the proportions of males and females referred to the clinic per year. In most years there were more males than females referred, except in 2014. A Chi-square test of independence was done to examine the relationship between sex and the years of referrals. The relationship between these variables indicated no significant differences between the number of males and females referred over the study period, X^2 (4, N = 158) = 8.65, p = 0.7.

Figure 2

Clustered Bar Graph Showing the Number of Male and Female Referrals Throughout the Study Period (N=158)



Language

Table 2 shows that there were four different languages recorded for patients in this sample. The languages represent the participants' language of schooling and therefore also the language in which the neuropsychological assessments were done.

Table 2

Language Frequency Within the All Referred Group (N=158)

	Frequency	Percent
isiXhosa	75	47.5
English	49	31.0
Afrikaans	18	11.4
Sesotho	1	0.6
Missing	15	9.5
Total	158	100.0

Note. The Missing row represents the number of reports that did not contain information about language of assessment, home language or language used at school. It is typical for language to be reported in the neuropsychological reports, however there are instances when this information is missing or not stated explicitly.

Part two: Comparison of Demographic, Developmental and Neuropsychological profile of HIV-Positive Subsample and Control Group, and Medical Profile of HIV-Positive Subsample

In this section the focus will be on the results of the HIV-Positive Subsample (including a medical profile) and, where relevant, there will be a comparison of the results of the HIV-Positive Subsample with the demographically matched Control Group.

The reason for referral to the PNC vary throughout the years of the study period. Some of the medical reasons for referral include HIV, TB, Traumatic Brain Injury (TBI) Fetal Alcohol Syndrome (FAS) and epilepsy. Approximately 46% (*n*=73/158) of the All Referred Group in 2012-2016, as described in Part one, was HIV positive. I recruited *n*=41 control participants in a stratified manner.

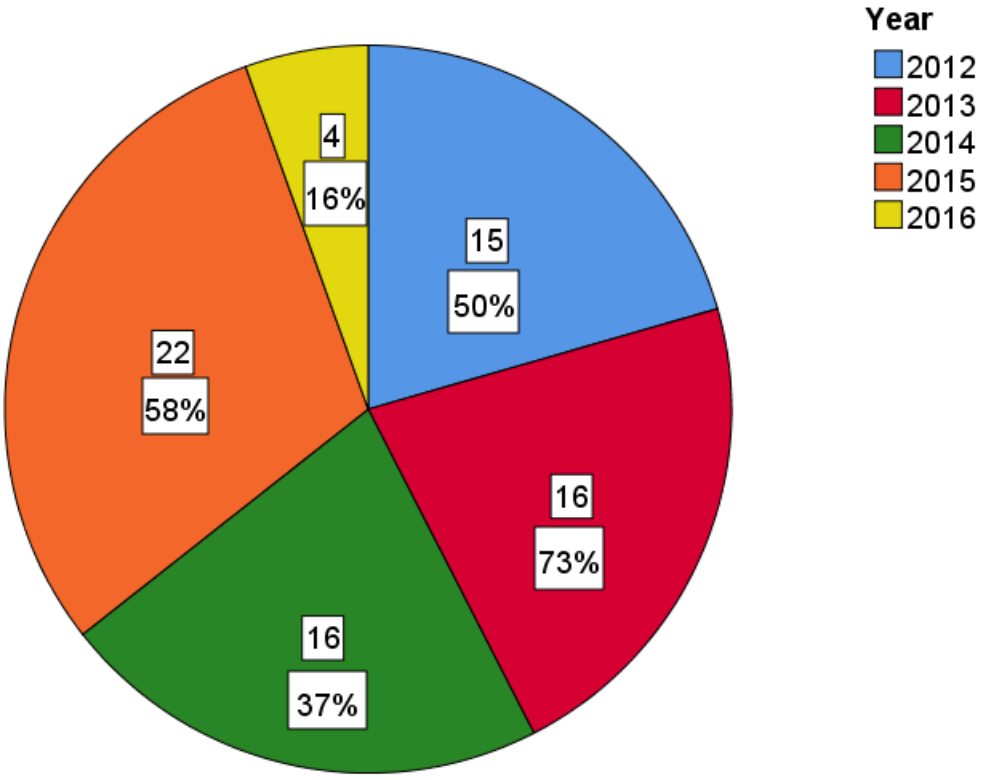
Annual Number of Referrals

Figure 3 shows the number of children (and percentage) referred to the RXH PNC who were HIV positive over the study period, by year. In 2012, 15/30 (50%) children referred to the PNC in that year were HIV positive. In 2013, 2014, 2015, and 2016 these figures were 16/22 (73%), 16/43 (37%), 22/38 (58%), and 4/25 (16%), respectively. Between 2012-2014 there was a consistent trend in the actual number of the referrals to the RXH PNC for children who were HIV positive, but not for the proportion of referrals, relative to the

overall number for those years. There was also a significant decrease in the frequency and proportion of children referred to the PNC who were HIV positive in 2016. A chi-square test of independence revealed a significant difference in the number of HIV positive children referred per year, X^2 (4, N = 73) = 11.73, p = 0.02. An analysis of the standardized residuals revealed that the significance lies predominantly in the years 2015 and 2016.

Figure 3

Number of Referrals and Percentages Per Year for HIV-Positive Subsample (n=73).



Medical History of HIV-Positive Subsample

The PNC reports usually include a brief medical history of the patients referred over and above the neuropsychological difficulties they may be experiencing. The most common comorbidity that was reported was TB (*n*=36/73; 49%). There were also some children who presented with HIVE (*n*= 19/73; 26%).

Age of HIV Diagnosis and Antiretroviral Initiation. Of the 73 participants who made up the HIV-Positive Subsample, the age of diagnosis was reported for 47 (64%) participants. For those participants, the mean age of diagnosis in months was *M* = 22.30 months (*SD* = 31.06, range: 1 week – 144 months).

Additionally, the age of ARV initiation was reported for 44 (60%) participants with the average being *M* = 35.93 months (SD = 37.90, range: 1 week – 125 months). Table 3 shows the frequencies of: 1) how many children were diagnosed with HIV at different age intervals, and 2) how many children were started on ARVs at different age intervals, before they were a year old, between 1 and 2 years old, and 2 years and older.

Table 3

Frequency Table showing the Ages at which Children Were Diagnosed with HIV and ARVs were Initiated (n=73)

Age at:	Younger than 1 year	Between 1 and 2 years	Older than /= 2 years	Missing data	Total
HIV diagnosis	22 (30%)	16 (22%)	9 (12%)	26 (36%)	73
ARV initiation	14 (19%)	16 (22%)	14 (19%)	29 (40%)	73

Note. The range of the children who initiated their ARVs after 24 months (2 years) is 60-125 months. The abbreviation HIV stands for human immunodeficiency virus and ARV stands for antiretrovirals.

Comparison of Demographic profile of HIV-Positive Subsample and Control Group

Table 4 indicates the comparison of age, sex, language and school quintile between the HIV-Positive Subsample and the Control Group. The results indicate that there are no significant differences in each of the categories between the two groups. These categories will be discussed in more detail below.

Table 4

Table Showing the Differences in Age, Sex, Language and School Quintile between the HIV-Positive Subsample and Control Group

	HIV-Positive Subsample (*n*= 73)		Control Group (*n*= 41)		Test statistics		
	n	*M* (*SD*)/ count[b]	*n*	M (SD)/ count	t/X^2	*p*	*ESE*[a]

Age (years)	73	9.8 (1.87)	41	10.2 (1.90)	1.20	0.23	-0.21
Sex (M: F)	73	40:33	41	21:20	1.92	0.16	0.12
Language (X: E: A) *	73	57:11:5	41	29:9:3	5.76	0.22	0.14
School quintile (1-5)	73	3.12 (0.93)	41	3.61 (1.05)	1.86	0.07	-0.50

Note. * Xhosa: English: Afrikaans. Means are presented with standard deviations in parentheses. *ESE*[a] is Cohen's d for independent sample t-test (0.2- small, 0.5- medium, 0.8- large) and Cramer's V for chi-square test of contingency. M (SD)/ count b- Age and Quintile have mean scores and standard deviations, Sex and Language have counts.

Age

Table 5 displays the mean ages for the HIV-Positive Subsample for each year. A one-way ANOVA showed no significant differences in terms of the mean age of the HIV-Positive Subsample per year [F (4, 68) = 0.86, p= 0.48].

Table 5

Mean, Standard Deviation and Range of Ages of the Patients Per Year (n=73)

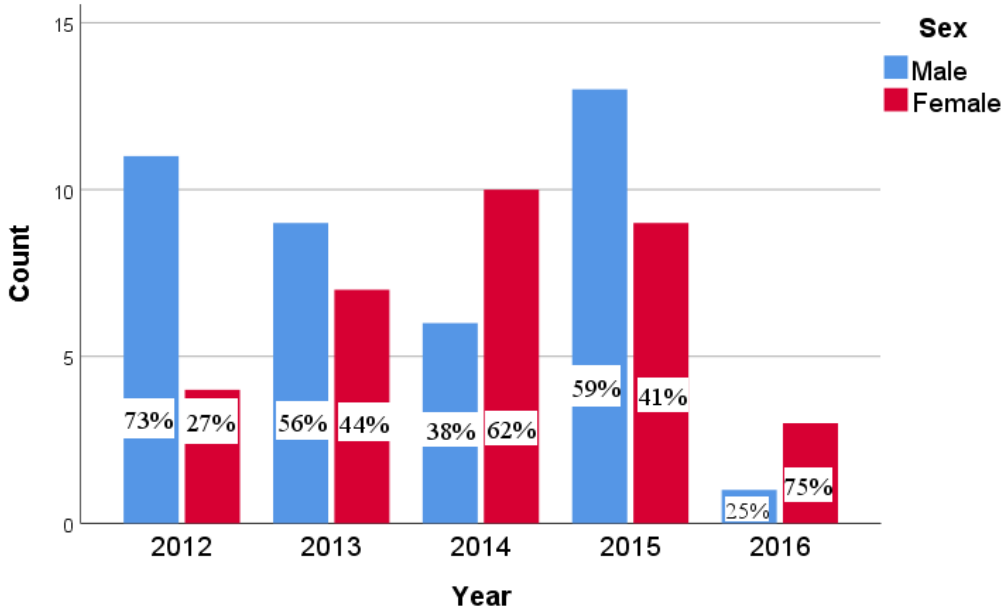
	2012	2013	2014	2015	2016
Mean	9.9	9.7	9.2	10.1	10.7
Standard deviation	1.8	1.9	1.7	1.9	1.5
Range (years)	7.4- 13.8	7.0- 12.7	6.0- 12.3	6.3- 13.1	9.2- 12.4

Sex

With regards to sex for the HIV-Positive Subsample, Figure 4 presents a clustered bar graph of the number of male: female referrals within each year. There were more males (*n*=40) relative to females (*n*=33) across the study period. However, a Chi-square test of independence indicated no significant effect, X^2 (4, N = 73) = 5.62, p = 0.23. There was no significant difference between the number of males and females referred over the study period, although there were some differences in these ratios within specific years, at least descriptively.

Figure 4

Clustered Bar of Male and Female Count in the HIV-Positive Subsample (n=73).



In terms of the Control Group there was approximately an equal ratio of males and females recruited, with *n*=21 males and *n*=20 females. Table 4 also indicates no significant difference in the male: female ratio between the HIV-Positive Subsample and Control Group.

Language

Most children in both the HIV-Positive Subsample and Control Group spoke isiXhosa (78%; 71% respectively), followed by English (15%; 22% respectively) and then Afrikaans (7%; 7% respectively). For both the HIV-Positive Subsample and the Control Group, the languages reported indicated the language of their schooling and the language in which their neuropsychological assessment was carried out.

Social History

Detailed data on SES is not collected routinely at the RXH PNC, therefore there was only limited data available on the HIV-Positive Subsample in terms of SES-related information. The HIV-Positive Subsample mainly lived in residential areas that included Khayelitsha, Gugulethu, Nyanga, Langa, Mitchell's Plain, and Phillipi, suburbs considered to be of low SES. The average school quintile of the HIV-Positive Subsample was *M*=3.12 (*SD*= 0.93, range: 2-5).

In terms of the Control Group more detailed information could be obtained regarding their SES. Table 6 shows information collected on SES and asset index data for the Control Group. There is however a substantial amount of missing data (46%) for this group as many parents felt uncomfortable completing the form. For parental information, information of only the mother was included (in all of the forms none of the father's details were included). The areas in which the Control Group participants were recruited from included Gugulethu, Langa, Mitchell's Plain and Lavender Hill. The school quintile average was *M*= 3.61 (*SD*= 1.05, range: 2-5) as per Table 4. These SES factors are consistent with the HIV-Positive Subsample.

Table 6

Table Showing the Socioeconomic Status and Asset Index Data of the Control Group (n=41)

Variable	(*n* = 41)	Percentage
Household income per year [a]		
0		
1 - 5 000	17	41
5 001 - 25 000	4	0.1
25 001 - 100 000	1	0.02
100 001 +		
Unknown/ incomplete	19	46.3
Parental education (mother)		
0 years	4	0.1
1-6 years	2	0.05
7 years	1	0.02
8-11 years	6	0.15
12 years	7	0.17
13 years +	2	0.05
Unknown/incomplete	19	46.3
Parental employment (mother)		
Higher executives, major professionals		
Business managers of medium businesses,	3	
Administrative personnel, managers,		
Clerical and sales, technicians, small	1	0.02
Skilled manual (with training)	1	0.02
Semi-skilled	2	0.05
Unskilled, unemployed	4	0.1
Homemaker	6	0.15
Student, no occupation	5	0.12
Unknown/incomplete	19	46.3
Material and financial resources (Asset		
0-5 assets (low)	2	0.05
6-12 assets (medium)	18	44
13-17 assets (high)	2	0.05

Unknown/Incomplete	19	46.3

Note. [a]Presented in South African Rands (ZAR).

Developmental History

Table 7 shows that the age-appropriate milestones discussed by Peterson (2013) indicate that there is delayed development of language and gross motor milestones for most of the HIV-Positive Subsample. Table 6 also shows the comparison of the HIV-Positive Subsample and the Control Group in terms of mean ages (in months) for the different developmental milestones. There were significant differences for most of the milestones (except buttoning of clothes, dressing and writing) between the two groups. The Control Group averages for most of the developmental milestones are on par with the appropriate mean age for reaching developmental milestones according to Peterson (2013), whereas those reported for the HIV-Positive Subsample are delayed. It should be noted that the average age for tying of shoelaces and dressing are delayed for both groups in terms of the age-appropriate milestones provided from Peterson (2013).

Table 7

Developmental Milestones Comparing the Mean Age of Developmental Achievement between the HIV-Positive Subsample and Control Group

	HIV-Positive Subsample					Control Group				T statistic	
	Appropriate mean age for milestones (months)*	*n (reported milestones)*	*M (SD)*	*Min (months)*	*Max (months)*	*n (reported milestones)*	*M (SD)*	*Min (months)*	*Max (months)*	*t*	*p*
First words	9	28	17.36 (9.85)	7	48	17	10.94 (6.57)	8	36	-2.38	0.02
Two words	18	10	29.40 (9.14)	18	48	18	17.67 (10.57)	9	36	-2.96	0.01
Talking in sentences	24	27	41.70 (16.29)	12	72	18	22.89 (13.42)	12	60	4.06	<0.01
Sitting	8	16	7.69 (2.52)	4	12	18	6.17 (1.29)	4	9	-2.25	0.03
Crawling	9	17	11.59 (6.93)	6	36	19	6.68 (1.11)	4	8	-2.88	0.01
Walking	14	32	19.69 (7.74)	9	48	18	15.06 (4.45)	9	24	2.32	0.02
Tying shoelaces	48	10	91.20 (22.76)	60	120	18	69.33 (9.70)	48	84	-10.04	<0.01
Buttoning clothing	60	9	74.67 (30.46)	24	120	18	65.33 (11.80)	36	84	-1.16	0.26
Dressing	48	14	62.57 (29.08)	24	108	18	57.33 (16.23)	24	84	-0.65	0.52
Writing	60	11	69.82 (9.01)	60	84	18	67.33 (9.33)	36	72	-0.70	0.49

Note. *The appropriate age for milestones according to Peterson (2013).

Neuropsychological profile of HIV-Positive Subsample and Control Group

Neuropsychological outcomes for the HIV-Positive Subsample and the Control Group were compared. Table 8 indicates the general intellectual functioning outcomes for these two groups. There were significant differences found between the HIV-Positive Subsample and Control Group in the VIQ, PIQ and FSIQ scores with the Control Group on average performing significantly better than the HIV-Positive Subsample.

Table 9 shows a comparison of the neuropsychology outcomes between the HIV-Positive Subsample and the Control Group. In terms of other neuropsychological domains, with the exception of delayed visual memory (where there was no significant difference between the two groups), there were significant differences found across all the neuropsychological functioning outcomes (including attention, memory (verbal), information processing, language, cognitive flexibility and goal setting) in which the HIV-Positive Subsample performed significantly poorer on these assessments compared to the Control Group of typically developing children.

Table 8

IQ Variables: Independent Group Comparisons for Between HIV-Positive Subsample (n=51) and Control Group (n=41)

	HIV-Positive Subsample				Control group				Test statistic		
	n	*M (SD)*	*Range*	*Qualitative description*[1]	*n*	*M (SD)*	*Range*	*Qualitative description*[1]	*t*	*p*	*ESE*[a]
VIQ	51	65.86 (9.86)	45-101	Extremely Low	41	77.31 (12.82)	46-106	Borderline	4.84	<0.01	-1.01
PIQ	*51	74.13 (10.66)	55-97	Borderline	41	85.63 (12.98)	66-114	Low average	4.70	<0.01	-0.98
FSIQ	51	67.89 (10.25)	44-99	Extremely low	41	85.90 (27.72)	63-104	Low average	4.21	<0.01	-0.90

Note. Means are presented with their standard deviations in parentheses. PIQ: Performance intelligence quotient; VIQ: Verbal intelligence quotient; FSIQ: Full scale intelligence quotient. Qualitive descriptions[1] of the test outcome scores. *Only 51/73 participants in the HIV- Positive Subsample did the WASI IQ test. The remainder of the participants either completed the children's version of the Weschler tests being the WPPSI (Wechsler Preschool & Primary Scale of Intelligence) or WISC (Wechsler Intelligence Scale for Children) due to extreme developmental delays that hindered their performance, or they did not complete any of the tests. It is typical in the PNC for the instructor to substitute tests or batteries if they suspect that a participant has reach a ceiling and their results would not give enough information about their level of function and the WISC or WPPSI would be administered. In these batteries there are more instructions that would scaffold a child's understanding and the results would give information about the age at which the participant is performing. ESE[a] is Cohen's d. There is also a significant difference between PIQ and VIQ for the HIV-Positive Subsample, $t(101) = 4.08$, $p = <0.01$

Table 9

Neuropsychological Variables: Independent Group Comparisons of HIV-Positive Subsample (n=73) and Control Group (n=41)

	HIV-Positive Subsample				Control group				Test statistic		
Variable	**n*	*M (SD)*	*Range*	*Qualitative description*[1]	*n*	*M (SD)*	*Range*	*Qualitative description*[1]	*t*	*p*	*ESE*[a]
Attention											
Numbers forwards	62	5.01 (2.55)	1-13	Borderline	41	6.77 (2.71)	3-13	Low average	2.91	<*0.01*	-0.67
Memory											
Delayed visual memory	51	9.21 (2.47)	5-14	Average	41	10.31 (2.52)	5-14	Average	1.97	0.05	-0.44
Delayed verbal learning	38	7.98 (2.39)	3-16	Low Average	41	10.56 (2.46)	6-17	Average	5.03	<0.01	-1.06
Information processing											
Coding	38	5.03 (1.88)	2-10	Borderline	41	7.39 (2.42)	3-14	Low average	4.81	<0.01	-1.08
Language											
Comprehension	30	3.20 (2.09)	1-7	Extremely low	41	5.98 (2.27)	1-10	Borderline	5.25	<0.01	-1.26
Executive functions											
Numbers backwards	46	4.91 (2.82)	0-10	Borderline	41	7.59 (3.34)	2-15	Low average	4.04	<0.01	-0.87
Similarities	51	3.20 (2.51)	0-12	Extremely low	41	6.04 (3.04)	1-13	Low average	4.82	<0.01	-1.03
Matrix Reasoning	51	4.88 (3.06)	0-13	Borderline	41	6.08 (3.22)	1-15	Low average	2.91	<0.01	-0.38
Tower: Achievement score	21	7.19 (2.75)	1-12	Low average	37	10.03 (1.84)	6-13	Average	4.31	<0.01	-1.29
Tower: Time per move ratio	21	7.18 (4.40)	1-12	Low average	37	11.24 (1.99)	6-14	Average	4.37	<0.01	-1.32

Note. Means are presented with standard deviations in parentheses For Tower: Achievement and time per move ratio, 4 participants were not within age range to complete the Towers test. Qualitive descriptions[1] of the test outcome scores. The **n* for HIV for each test is dependent on whether the patient was able to complete the test or if the test was part of the retrospective test plan. ESE[a] is Cohen's d.

Discussion

HIV in South Africa is a serious public health concern that unduly affects children. Previous research largely focuses on the experience and effects of HIV on adults, but less research in comparison focuses on a more detailed and nuanced understanding of the impact that HIV has on children, especially where this includes a neuropsychological profile of children in a LMIC context. There is a large amount of information on pediatric HIV, however it lacks a multifaceted approach in how HIV affects children. Considering the information above, RXH is in a unique position being the only tertiary hospital for children, in sub-Saharan Africa. The hospital offers a range of services for / to children, including a referral system to a Neuropsychology clinic – a rare offering in South Africa.

Neuropsychology in South Africa is still a relatively young field compared to HICs and is being developed as a profession (Wilson et al., 2017). The PNC at RXH receives referrals from many departments in the hospital and assessments are done to aid in a collaborative, multidisciplinary process of assisting children. What this assistance often entails is a detailed report about the patient's medical, developmental, social, academic, and neuropsychological information. Often the reports would have recommendations to assist children, given their neuropsychological outcomes. Additionally, the PNC regularly receives referrals for children who are HIV positive, which is relevant to this study.

Due to this clinic offering being a rare and specialist service, the PNC becomes a site of interest as it offers an opportunity for the growth of the profession of Neuropsychology in South Africa, specifically with a pediatric focus. Additionally, data collected at the PNC can be informative in relation to the cognitive fallout seen amongst children at the clinic. This kind of data can inform research and potentially lead to ecologically valid interventions aimed at the improvement of children seen at the PNC with their various neuropsychological impairments. This data can also be helpful in collaborating with other universities regarding research, with other clinicians regarding the range of neuropsychological issues seen at the clinic, or with the Department of Education as recommendations often involve school placement.

Against this background, the first aim of this study was to establish the number of children who were referred to the RXH PNC over a specified period of time (2012-2016). Coupled with this objective, was a detailed look at the demographic profile of all the children (the All Referred Group) referred to the PNC during this study period. This was then followed by the second aim, which included a closer look at the proportion of children who were HIV positive (the HIV-Positive Subsample) within this All Referred Group, and to

report on the number of referrals and the medical history for this specific group. A comparison of the demographic and the neuropsychological profiles of the HIV-Positive Subsample to a demographically matched Control Group was included in this aim.

The first part of the results showed the referral trends and the demographic profile of the All Referred Group. The referral trends revealed an inconsistent number of referrals to the PNC for the All Referred Group. And in extension to that, a significant increase in HIV referrals in 2015 and then a significant decrease in 2016. Additionally, the results indicated information on age, sex, language, and SES. The little information obtained on SES revealed that majority of the children came from low SES backgrounds, which is consistent with the profile of children typically referred to the RXH. The second part of the results demonstrated that there were no significant differences found between HIV-Positive Subsample and Control Group in terms of demographic outcomes. However, in terms of the neuropsychological profile comparison between the HIV-Positive Subsample and the Control Group, there were significant differences for most of the neuropsychological measures.

In the remainder of this discussion, I will firstly speak on the relevance of collecting data at clinics in general and how this relates to the PNC. Then I will highlight the key findings which are salient to the overall results found in relation to the aims of this study. I will then give a more detailed account of the results of the current study (which elaborates on the key findings mentioned), namely the results of the demographic outcomes, followed by the results of the neuropsychological outcomes. These results will also be compared to previously reported results in the literature. In addition, I will discuss why using a control group is important and the significance of these findings for potential intervention. Finally, I will discuss the limitations of this research and recommendations for future research.

The Relevance of Collecting Data at the PNC

Since its opening, RXH has made huge contributions to the development of pediatric care in South Africa. The hospital provides services and specialties that are dedicated to the overall institution of child health care. It is the only hospital in South Africa dedicated solely to children (Argent et al., 2014).

In South Africa the implementation of registering neuropsychologists has been an ongoing process for many years (Truter et al., 2018a), however the growth and registration of the field of neuropsychology has begun. The PNC at RXH is at the forefront of detailed and nuanced information regarding children with HIV and their neuropsychological outcomes.

According to WHO (2008), there are a number of benefits to monitoring systems within a clinical setting. Firstly, collecting quality data improves the efficiency and services

given by the clinic. Secondly, monitoring systems allows for longitudinal information to be observed and tracked for any changes over time. Additionally, clinics can often be centralized repositories of data for all patients who have obtained services from the clinic, and that information can be used for research purposes or for general population information. Considering these benefits, the PNC can help pave the way in research and clinical work on pediatric neuropsychology, and the neuropsychology of pediatric HIV more specifically, in South Africa. Additionally, having a demographic profile of patients spanning a few years, gives insight into the variations of referrals received.

It is also possible to create strategies and interventions for children living with HIV who have been seen at the PNC that extends beyond assessments. These strategies and interventions can be tailored specifically to the children seen at the clinic. With the growth of neuropsychology in South Africa, opportunities for potential growth in capacity and increased resources can become available at the PNC. This can lead to the PNC becoming an important clinical and research site for pediatric neuropsychology moving forward.

Key Findings

The main purpose of this study was to examine the demographic and neuropsychological profile of a sample of children who are HIV positive who presented at the PNC over the period of 2012-2016. In determining this profile, the aim was also to determine any differences in how children with HIV perform on neuropsychological batteries in comparison to healthy controls who have been demographically matched.

A purposive sampling strategy was employed to ensure that in terms of the demographical information, there were no significant differences between the HIV-positive subsample and Control Group that could potentially impact the neuropsychological scores. There are some limitations to this strategy which will be discussed in the limitations section.

The key findings indicate that the HIV-positive subsample scored significantly worse than the demographically matched healthy Control Group in most of the neuropsychological tests used. These findings align with most literature on the neuropsychological functioning of children with HIV with the exception of the domain of memory. A more detailed discussion follows, which will expand on each of the sections presented in the results.

Referral Trends for All Referred Group and HIV-Positive Subsample

The referrals to the PNC will depend on the frequency in which patients are referred from other departments within RXH. Between 2012-2014 there was a consistent trend in the number of the referrals to the RXH PNC for children who were HIV positive, but not for the proportion of the overall referrals. A somewhat unusual trend was the significant increase in

HIV referrals in 2015 and then a significant decrease in HIV referrals in 2016. Reasons for this sudden drop in HIV referrals to the PNC is not clear in literature. Isaacs-Long et al. (2017) discuss a decrease in HIV- related admissions at RXH over their study period (2008 to 2013) however this does not explain the significant increase in HIV referrals followed by a significant decrease. Future research could elaborate on admission trends at RXH, which may potentially shed light on the trend seen in this study.

Demographic Profile of all Three Groups (All Referred Group, HIV-Positive Subsample and Control Group)

Age

With reference to the All Referred Sample and the HIV-Positive Subsample, the children referred to the RXH PNC were between the ages of 2-16 years, with a mean age of approximately nine years old. RXH is a government teaching hospital that provides services up to tertiary level for children up to the age of 13 years old (Isaacs-Long et al., 2017). There are, however, some exceptions in which children over 13 years old may be admitted or referred across departments depending on the circumstance (Department of Health Western Cape, 2014). This was the case for the current study, as there was a small number of children (n= 2) who were referred to the PNC that were older than 13. At the PNC, the reason for referrals of children 13 and above would be to follow up on a patient previously seen or a neuropsychological assessment is required to determine level of functioning (due to developmental delays).

Sex

The results indicated that there were no significant between-group differences in the male to female ratio within the All Referred Group and within the HIV-Positive Subsample. With specific reference to the global and local pediatric HIV population, sex differences in prevalence rates is not widely discussed. UNICEF (2019) mentions that when prevalence rates are compared between boys and girls, due to there being minor differences in prevalence rates, boys and girls are not discussed separately. Therefore it is a common occurrence in literature (for example; Dorrington, Bradshaw, & Budlender, 2002; Pufall et al., 2014; UNAIDS/WHO, 2004; Zuma et al., 2016) that when children are discussed, they are discussed as a single group rather in terms of their age group aged 0-14 as opposed to sex differences in prevalence rates. Sex difference are at times discussed for older groups. For example, the age group of 15-24-year-olds is well discussed in literature, as HIV infection disproportionately affects young women of that age with their infection rate being twice as high as that of young men; however, this is not the case for children.

Language

According the StatsSA (2018), in the Western Cape, the three main first languages spoken are Afrikaans (46.6%), isiXhosa (31.1%), and English (19.6%). Although most people speak Afrikaans in terms of the population within the Western Cape, in this current study's sample specifically, there were more isiXhosa-speaking children (in the All Referred Group and the HIV-Positive Subsample), followed by Afrikaans, and then English-speaking children. Therefore, the three main languages spoken in the Western Cape are represented in this sample, but not in the same proportions. The reason for this is that the main areas of residence for the majority of the All Referred Group and by extension, the HIV-Positive Subsample, were Langa, Gugulethu and Khayelitsha. Therefore, it is not surprising that majority of the participants spoke isiXhosa as opposed to Afrikaans, due to residents mainly speaking isiXhosa in these areas (Hurst, 2008).

Information about language spoken is vital as the neuropsychological batteries were administered based on participants' language of schooling. The dominant language of neuropsychological batteries typically used in the clinic is English, as most test batteries used at the clinic were developed in HICs. According to Chernoff et al. (2018) using Western neuropsychological tests is a common practice in sub Saharan Africa (and the issues regarding the use of these tests locally will be expanded on later). Therefore, the interpretation of these tests using an interpreter or translator to communicate test instructions (which in most cases was me) was necessary for administration and clear understanding of the tasks. Even though the context and demographics of the children seen at the PNC necessitates the use of an interpreter or a translator, the limitations around the use of such services in neuropsychological testing is recognized.

Developmental History

Within the HIV-Positive Subsample, it was found that developmental delays were a common occurrence compared to a typically developing sample of children in the Control Group. The results of this study are not unusual as developmental delays often occur in children with HIV (McHenry et al., 2019; Potterton et al., 2009). Although most of the developmental milestones for the HIV-Positive Subsample were delayed, sitting and crawling were reached timeously and there were no delays on average for these two milestones. This is somewhat unusual as most developmental milestones in children with HIV are delayed (McHenry et al., 2019). The results of the developmental milestones in general were based on self-reports from the parents or caregivers. Reports were therefore reliant on their memory which at times, they themselves noted, might be prone to error.

Additionally, many children with HIV in South Africa tend to reside in low SES areas where poverty and low parental educational levels are correlated with the negative outcomes associated with a child's developmental progress (Potterton et al., 2009). Therefore, social circumstances can impact a child's development and could be a factor in the case of the study sample.

The PNC reports also mention delays across motor and language domains which are also common within pediatric HIV (Cohen et al., 2015; Van Rie et al., 2007). These developmental milestones not being reached during the critical periods can become problematic as it forms the basis for a child's potential to thrive socially and academically (Peterson, 2013). Some studies have demonstrated that neurodevelopmental impairments start as early as infancy and may have knock on effects that can result in neurocognitive deficits in preschool and school-aged children (Koekkoek et al., 2008b; Ravindran et al., 2014). Some of the neurodevelopmental impairments discussed by Wedderburn et al. (2019) include receptive and expressive language difficulties, fine and gross motor difficulties.

The developmental history of the Control Group indicated that on average the participants of this group reached most of their milestones timeously according to Peterson (2013), as they comprised of typically developing children. There were however two milestones (tying shoelaces and dressing) in which reports of their milestones suggested delays. Although delays in typically developing children are somewhat unusual, Yaghini et al. (2015) note that factors such as poverty, malnutrition, poor hygiene and health increase the risk of developmental delay.

Social History

SES. Most of the information regarding SES was obtained from the Control Group; however, there were a few SES details obtained from the All Referred Group and HIV-Positive Subsample. Results showed that based on the information available, most of the HIV-Positive Subsample resided in low SES areas. The Control Group also resided in similar areas, as the aim was to have a group that matched the HIV-Positive Subsample demographically.

Arentoft et al. (2015) argues that SES has a strong positive correlation to neuropsychological outcomes. This correlation stipulates that those from lower SES backgrounds would most likely perform more poorly in neuropsychological assessments compared to those of a higher SES. The relationship between SES and neuropsychological outcomes is well documented (Burneo-Garcés et al., 2019; da Rosa Piccolo et al., 2016; Katz & Shah, 2017). Researchers such as Brickman et al. (2006) have suggested that children from

a socioeconomically disadvantaged backgrounds are at higher risk of poorer nutrition and lack of access to health care. This in turn has an influence on the development of the brain and its functioning. Consequently, such influences can affect how a child will perform on neuropsychological assessments. Additionally, infectious diseases such as HIV/AIDS and meningitis, as well as malnutrition, exposure to drugs and alcohol, and head injuries, for example, are rife throughout South Africa and lower SES areas, which can also influence cognition thus impacting neuropsychological outcomes (Foxcroft & Roodt, 2006). These factors are important in understanding the neuropsychological performance of children from lower SES backgrounds.

Quintile. In the South African context, the quintile system forms part of a measure of SES to allocate funds to schools in low SES areas. These funds would be allocated towards attaining resources for better quality of education. Badat and Sayed (2014) argue that it is not the most accurate measure of SES; however, it is still utilized in this way. For both the HIV-Positive Subsample and the Control Group it was found that the average quintile category was three. This forms part of the non-paying category. Most children in the HIV-Positive Subsample attended schools that rank between quintile one to three. This indicates that the quality of the education could be potentially poorer than schools ranked in quintile four or five (van Dyk & White, 2019). This is consistent with the overall SES of the participants and their parents.

According to Ogbonnaya and Awuah (2019), learners who attend affluent schools (also known as quintile four or five schools) outperform learners in less affluent schools (quintile one, two or three) academically. They argue that this occurrence could be due to fee paying schools having the funds to acquire additional support and resources to enhance the students' learning despite receiving government funding (Ogbonnaya & Awuah, 2019).

Schools located in low SES communities often face constraints and obstacles in relation to resources, for example, physical resources such as computers or access to the internet. Additionally, the teacher to learner ratio is often not ideal. An example according to Amnesty International (2020) is that there would often be a high volume of students (e.g., up to 70) per teacher. Schools in these settings are often associated with poor academic performances (Aikens & Barbarin, 2008; Muijs et al., 2004; Ogbonnaya & Awuah, 2019).

Research has consistently shown that lower quality of education has a negative impact on neuropsychological performance particularly when western-based assessments are used. This is due to quality of education having an influence on cognitive development and skills which will impact neuropsychological outcomes (Crowe et al., 2013; Ferrett et al., 2014; J. J.

Manly, 2008). Borghans et al. (2015) further this argument by stating that the quality of education has important implications for stimulating cognitive development in children and has consequences throughout life. Therefore, it was necessary to consider the effects SES would have on neuropsychological outcomes and ensure that the HIV-Positive Subsample and Control Group came from similar SES backgrounds.

Medical History

All Referred Group. In the PNC, important information about the medical history of the patient is often included in the reports. The most common medical conditions mentioned in their medical reports included TBI, FAS, epilepsy, HIV or Tuberculosis (TB). These medical conditions are sometimes also seen as a reason for admission at RXH. Isaacs-Long et al. (2017) describe the admission trends at RXH and indicate that the common medical conditions that led to admission included diarrhoea, epilepsy or seizure disorders, meningitis, upper respiratory diseases and injuries, or conditions caused by external causes (which could include TBI).

HIV-Positive Subsample. Within the current study many of the participants within the HIV-Positive Subsample also presented with TB. Generally, TB is a common coinfection with HIV (Vasilyeva et al., 2018). According to Bates et al. (2015), in the last two decades, the HIV epidemic has fueled a fivefold increase in TB infection rate and twentyfold increase in TB risk of infection. With the African continent being the epicentre of the HIV epidemic, up to 77% of TB patients in this context are also coinfected with HIV. In the HIV-Positive Subsample there were some patients who were also diagnosed with HIVE, which is fourth clinical stage of HIV (WHO, 2005). Although ART rollout has improved significantly and many children have benefitted from ARVs (and this has improved the rate of HIVE), there are a substantial number of children who have not initiated ART early enough to avoid being diagnosed HIVE. This still presents as significant clinical problem in South Africa (Donald et al., 2015).

Other than the medical history that is reported, information about age of diagnosis and age of ARV initiation is also included for the HIV-Positive Subsample. These kinds of details often have implications for the neuropsychological outcomes.

In terms of the age of diagnosis, majority of the children in the HIV-Positive Subsample for which this was reported for (64%) on average were diagnosed at approximately 1 year and 10 months. Additionally, the age of ARV initiation on average was initiated at approximately 2 years 11 months (and this was reported for 60% of the children in the sample)

Early infant diagnosis (EID) for HIV is an important service in South Africa to reduce mortality, morbidity or any other HIV-related difficulties found in children. (Hsiao et al., 2013). According to Kalawan et al. (2020) an EID programme ran in Kwa-Zulu Natal saw an increase in the number of tests for diagnoses of HIV (from 20.7% to 85.7%) within the first four weeks of birth. This kind of strategy is important as early diagnosis in perinatally infected children promotes early ARV intervention. Literature suggests that administering ARVs before 12 months of age has been associated with significantly better neurodevelopment and improves the quality of life in children (Pandhi & Ailawadi, 2014). Therefore, the earlier a child is diagnosed with HIV, the quicker ARV initiation can begin. A delay in ARV initiation (in which case this would be more than 12 months if a child is born HIV positive) has been associated with dire consequences. These consequences could include slow immunologic reconstitution and difficulties in neurodevelopment and cognitive performance (that particularly manifests in academic performance) (Donald et al., 2012). The World Health Organizaton (2008) also recommends that ART initiation should occur as early as possible in infants. Research has shown that those who receive ARV treatment later, typically after one year, will respond more poorly in neurodevelopment and cognitive domains. Therefore, it is vital that continuous effort is placed on the initiation and management of ARV through a focus on early diagnosis, successful referral and maintenance in care (Porter, 2015).

The aim of this study did not include an in depth look at the neuropsychological outcomes of children who initiated ARV before 12 months or after therefore conclusive results could not be expanded on. Although Pandhi and Ailawadi (2014) argue that early ART initiation is associated with better neuropsychological outcomes, it should be noted that factors such as SES, quality of education and disease progression would all contribute to how an individual performs on a neuropsychological test battery though.

Neuropsychological Profile

Across literature it is widely known that children who are HIV positive are at a higher risk of experiencing neurocognitive impairment (Cohen et al., 2015; Hoare et al., 2012; Nichols et al., 2016; Phillips et al., 2018; Ravindran et al., 2014). The general cognitive difficulties commonly found in children with HIV are within the domains of general intellectual functioning, attention, memory, language comprehension difficulties, processing speed, and executive functions (Boivin et al., 2010; Crowell et al., 2014; Laughton et al., 2013a). The results of the current study revealed that the HIV-Positive Subsample performed significantly more poorly than the Control Group across all neurocognitive domains (except

visual memory). Each of the neuropsychological domains and its respective results within the current study, will be discussed in relation to existing literature.

General Intellectual Functioning

For the components that make up general intellectual functioning, VIQ, PIQ and FSIQ, the HIV-Positive Subsample performed significantly poorer than the Control Group. Although the Control Group performed in the below average range when compared to Western norms, the average range seen in typically developing children from disadvantaged backgrounds is still significantly above the average when compared to children in the HIV-Positive Subsample. This demonstrates that despite the Control Group being demographically matched, the HIV-Positive Subsample is still performing poorly.

The current study had similar findings to Boyede et al. (2013), and Cohen et al. (2015). In their respective studies, the outcomes were that the HIV-negative group performed significantly better than the HIV-positive group in general intellectual functioning. Puthanakit et al. (2010) further note in their study, a significant decrease in the VIQ scores relative to the PIQ scores with their HIV positive cohort. In their study they discuss that when the participants did the VIQ test for the second time, the difficulty in the questions may have increased as the cohort got older. This suggests that perhaps older children with HIV may struggle more with the VIQ subtest as the complexity in language increases. In the current, the HIV-Positive Subsample scored significantly lower in the VIQ compared to the PIQ (see note in table 8). What Puthanakit et al. (2010) have proposed could explain why there is a significant difference seen in the VIQ and PIQ scores within the HIV-Positive Subsample. Neuroimaging has also shown research has shown that in children with HIV, structural abnormalities (specifically cortical atrophy and white matter damage) is a common occurrence (Laughton et al., 2013b; Sarma et al., 2014). These authors argue that this could be a possible explanation of the poor general intellectual functioning seen in the general HIV pediatric population amongst other neurocognitive difficulties, which will be discussed.

Attention

In relation the domain of attention, the HIV-Positive Subsample also performed significantly poorer than the Control Group. Although a formal diagnosis of ADHD was not common in this specific sample (where there were only six participants (8%) who were formally diagnosed with ADHD) there were many reports (*n*= 43; 59%) of attentional problems that had been reported in the PNC history component. This was further confirmed in the neuropsychological assessments. The accounts of attentional difficulties found within

the PNC reports often came from concerned parents/guardians or teachers of the participants in the sample.

Many studies have shown that children with HIV present with attentional deficits (Donald et al., 2012; Laughton, Cornell, Boivin, & Van Rie, 2013b; Phillips et al., 2016). In addition to the research stated above, Zeegers et al. (2009) discuss the comorbidity of Attention Deficit Hyperactivity Disorder (ADHD), often with the hyperactivity component, in children with HIV. Mpango et al. (2017) offer some possible reasons as to why ADHD and attentional deficits more generally may be prevalent in children with HIV. They suggested that factors such as heritability, and stressful home and social environments were common antecedents for the onset of ADHD type symptoms. Additionally, they reported that orphanhood, due to loss of both parents in many cases due to HIV, could contribute to behavioural and mental health issues. The increase of psychological distress and the social issues that often are associated with living with HIV has in turn been associated with many mental health disorders and often ADHD (Mpango et al., 2017; Salisbury et al., 2020).

The pathogenesis of HIV can also account for attentional difficulties beyond the socio-biological factors mentioned above. Hong and Banks (2015) discuss the role of the HIV infection disrupting attention networks found in the frontal brain region. Depending on the clinical stage of HIV, the neuroinflammation that occurs which can impair attentional networks, varies across individuals (Hong & Banks, 2015).

Memory

Attention is not the only neuropsychological domain that is impaired in children with HIV. Many studies have shown memory to be generally poor (both in visual and verbal domains) amongst children with HIV (Nichols et al., 2016; Puthanakit et al., 2013; Smith et al., 2006). In their systematic review Laughton et al. (2013b) have found varied results on the outcomes of memory in children with HIV, which is also seen in across literature. In some instances, authors such as Blanchette et al. (2002) found no significant difference in verbal memory between HIV positive group and HIV negative group. These findings were also reported by Cohen et al. (2015). However, Hoare et al. (2012) demonstrated that children with HIV performed significantly worse than their control group regarding visual memory. Additionally Nichols et al. (2016) and Phillips et al. (2018) found significant differences in both verbal and visual memory where the HIV negative group performed significantly better in both domains. Across literature, over the years, there seem to be discrepant results regarding visual and verbal memory.

In the current study it was found that there was no significant difference between the HIV-Positive Subsample and the Control Group in relation to visual memory specifically. However, there was a significant difference between these two groups pertaining to verbal memory (in which the HIV-Subsample performed significantly more poorly). These findings are discrepant to some of the literature mentioned above. However, Cohen et al. (2015) argue that the construct of memory is understudied in samples of children with HIV, therefore reaching definitive conclusions is often a challenge.

In the impression section of the reports written at the PNC, assessors typically make qualitative impressions about the performance of the participant. It was often stated that in the verbal word list memory tasks, the participants seemed to struggle due to the attentional load that the task required. Additionally, they observed that children would struggle more with the verbal memory task compared to the visual memory task. Researchers have previously reported that audio-verbal tasks may be more prone to effects of attentional difficulties than visuospatial tasks (Craik, 2014).This may suggest that HIV may not have direct effects on memory systems, but that poor performance on memory tasks may in fact be a result of attentional deficits. Future research can be done to investigate the validity of this association.

Information Processing Speed

Difficulties in processing speed was evident in the HIV-Positive Subsample and a significant difference was found between this group and the Control Group.

This outcome is common within the vast literature in which slowed processing speed is reported for HIV positive children (Cohen et al., 2015; Hasse et al., 2014; Malee et al., 2011; Phillips et al., 2016; Puthanakit et al., 2013; Van Rie et al., 2007). These findings are not surprising. The neuropathology associated with the HIV infection involves white matter damage, which is instrumental in maintaining normal levels of processing speed (Puthanakit et al., 2013).

Language Comprehension

Language development in children with HIV has been reported to be delayed. This study assessed receptive language as measured by the Comprehension of Instructions subtest from the NEPSY-II. Outcomes on this subtest fell within the below average range for participants of both the HIV-Positive Subsample and the Control Group, however the HIV-Positive Subsample had scored significantly lower than the Control Group.

Some authors have found expressive language to be significantly poorer than receptive language in children with HIV (Van Rie et al., 2007, 2008), while others have

found receptive language to be more delayed than expressive language (Hutchings & Potterton, 2014). Wedderburn et al. (2019) reported delays in both expressive and receptive language for children who are HIV positive. Suggestions as to why there is this discrepancy has not been fully discussed in literature. Early literature suggested that expressive language becomes more vulnerable with HIV encephalopathy (Wolters et al., 1995). Hutchings and Potterton (2014) do mention that their findings were discrepant to the known literature in which expressive language is reported to be more vulnerable than receptive language. However, they argued that perhaps previous literature had focused on older samples of children in which expressive language was a greater demand in assessments. Further investigation into the differences in expressive and receptive language need to be done.

Delays in language development (both expressive and receptive) is common in children with HIV and it often occurs before any noticeable neurological abnormalities in neurological examinations or CNS imaging (Van Rie et al., 2007). It is however not clear as to whether the language impairments include both expressive and receptive functions as a pure language deficit or whether it includes non-verbal language abilities, which would be indicative of deficits in global functioning beyond language. A frequently cited reason for the language delay is firstly that children with HIV are prone to developing ear infections, which in turn could affect their hearing and interfere with the development and function of language (Rice et al., 2012; Van Rie et al., 2007). This is a possible explanation for the poor receptive language performance in the HIV-Positive Subsample. The consequences of delays in language development can increase the risk of continuous language impairment and can affect the way in which a child communicates with family and peers. These effects can also extend to their overall emotional wellbeing, ability to succeed academically, and being accepted in society (Kritzinger, 2019).

Executive functions

Executive functions cover a wide array of sub functions and there are varying outcomes in terms of the performance of children with HIV. On the one hand, Van Rie et al. (2007) and Ezeamama et al. (2016) demonstrated that their HIV samples performed significantly poorly compared to a HIV negative sample in executive functions related to attentional flexibility and cognitive manipulation. Additionally, Ezeamama et al. (2016) add that executive function deficits can persist during a child's school going years despite the treatment they may receive, and they mention that the reasons for this are unclear.

On the other hand, Cohen et al. (2015) found small differences in the scores between the HIV-infected group and healthy control group, in some of the executive function

assessments they employed. They found no significant difference in working memory (the Digit Backward Span), set shifting and cognitive flexibility (in the Trail Making Task). However, it was found that there were significant differences in other subdomains of executive functions i.e., goal setting, planning and frustration tolerance (Cohen et al., 2015).

The results of this study echo the general findings of executive dysfunction in children with HIV. In all facets of executive functions that were assessed, including working memory, fluid reasoning, verbal concept formation and reasoning and planning, the HIV-Positive Subsample performed significantly more poorly compared to the Control Group.

In terms of the HIV-Positive Subsample performing poorly, it has been hypothesized that the harmful effects that the HIV infection has on a developing CNS has been attributed to the neurotoxins released by the monocytes-macrophages, which are the main carriers of the infection to the brain. The infection also affects the frontal lobes and prefrontal areas which are the regions that subserve higher order functionality typically described as the executive functions (Kumar & Herbein, 2014; Llorente et al., 2014). In children the development of these executive skills can be disrupted by pathogenesis of the infection to the frontal lobes, which can result in cognitive deficits such as executive dysfunction (Llorente et al., 2014).

Considering all of the neuropsychological tests that were done, it is widely known that in any given population there is a need for normative data that is relevant to that population to ensure the accuracy, validity and reliability of the outcomes (Kanmogne et al., 2018). Thus, it is important to discuss the use and relevance of Western norms in non-western countries and its relevance to the current study.

Western norms and the relevance of using control groups

With neuropsychological testing, there are major concerns regarding the use of internationally developed assessments for testing outcomes in South African local contexts. The Western-based neuropsychological batteries, that are typically used at the PNC, do not appropriately take into consideration the sociodemographic factors that affect neuropsychological outcomes in children in South Africa. These Western-based neuropsychological batteries were not designed to take into consideration contexts of LMICs. Therefore, the test scores tend to undermine an individual's performance within the contexts other than the norming or similar contexts. Much research has demonstrated that individuals in South Africa who are acclimated to Western culture tend to perform better in neuropsychological testing based on international tests; however, this accounts for the minority of South Africans (Ferrett et al., 2014). In some instances, in South Africa,

individuals considered to be healthy and typically developing within the context of the country, are considered cognitively impaired according to the normative data from Western countries. Therefore in some cases those who are healthy and those with neuropsychological impairment due to disease burden, according to normative data based on the West, would fall in the range of clinical dysfunction (Ferrett et al., 2014; Manly, 2008; Uzzell et al., 2007). This becomes problematic in terms of the interpretation of test scores.

The International Test Commission (ITC) states in its guidelines that it is important to use normative data to characterize the cultural and demographic profiles of those who make up the samples being tested to accurately interpret test scores (Ferrett et al., 2014). In this sense the use of a control group becomes an important aspect of any study using Western norms in non-western contexts (including the current study). Truter et al. (2018) mention that in South Africa, there is a lack of normative data and a lack of local neuropsychological tests, therefore using control groups of typically developing children can provide an estimate of the normative data within this context.

Limitations and Future directions

One of the limitations of this study is the small sample size of both the HIV-Positive Subsample and Control Group. Considering that the estimated number of children living with HIV in South Africa is 260 000 (Avert, 2018), to have a larger sample size (that would be randomly selected from across the country) would be a more accurate representation of the demographic and neuropsychological profiles of children living with HIV in South Africa. Future recommendations would include having a larger sample size of children with HIV and from multiple settings or parts of the country. Due to time and financial constraints, the number of participants in the Control Group were also limited. However, having a larger Control Group against which to compare the neuropsychological outcomes, would be beneficial as well.

A second limitation was the self-reporting of information for the Control Group with regards to the exclusion criteria. The was no verification process of the information that was self-reported, therefore there was no objective measure to confirm that children in the Control Group were indeed all HIV negative. Additionally, there was no way to verify that the children's mothers in the control group were HIV negative either. Future research could make use of clinical methods or further verification processes to ensure that participants that are part of the control group are confirmed to meet all exclusion criteria. This was not possible given the scope of the current study as the children making up the HIV-subsample

had a confirmed status upon referral to the PNC and therefore no formal testing of this nature was done.

Another limitation of this study is the retrospective nature of the HIV-Positive Subsample data. Usually, these types of study designs can be considered limited, due to the lack of additional outcomes or long-term follow ups one can acquire. However, for the purpose of this study and its aim, retrospective data was appropriate. A future recommendation would be to have a prospective, longitudinal study that followed up on a group of children living with HIV to continuously track the demographic and neuropsychological profiles. This could inform interventions with a greater amount of detail.

An additional limitation was the lack of an in-depth analysis at how comorbid neurological impairments of the HIV-Subsample could also impact the way in which they performed in their neuropsychological tests. Future research could have a more detailed analysis of how such comorbid diagnoses may affect a child's neuropsychological functioning.

Lastly, another limitation was missing data. This was in the case for both the HIV-Positive Subsample and the Control Group. In the case of the HIV-Positive Subsample, due to the information being retrospectively sought from the neuropsychological reports, additional information could not be obtained, e.g., in the case of socioeconomic information. In some instances, there was missing data regarding the neuropsychological scores. Participants were either unable to complete the test or the test was not done as they were functioning at a lower developmental age. In this instance a test for younger children would be administered instead. In the case of the Control Group, some data on SES was missing. This was due to some parents not feeling comfortable completing the SES questionnaire. For future research, as previously stated, a longitudinal study can be done where one is able to contact participants if more information is needed. Additionally, participants can be excluded if full information is not obtained, if one has a larger sample. Despite these limitations this study still offers valuable information about this sample which could be the preliminary data for a potentially larger study.

Conclusion

HIV infection in children presents with a wide range of concomitant issues (including neuropsychological, neurodevelopmental, social, emotional, psychological, academic, etc.). The aim of this study was to capture some of the detailed information of children living with HIV referred to the PNC. This was done by looking at the demographic details of the All Referred Group and by extension the HIV-Positive Subsample. Additionally, an important

aspect of this study was to capture information regarding the neuropsychological outcomes of the HIV-Positive Subsample compared to a demographically matched Control Group. The addition of the Control Group was to assess the contrast in neuropsychological functioning between the HIV-Positive Subsample and typically developing children.

The results revealed that the neuropsychological deficits that were detected amongst the HIV-Positive Subsample have serious implications for their daily functioning as they continue to develop. Due to the level of impairment, they may experience challenges such as maintaining complex ARV regimens, self-care or in the future, managing full-time jobs (Siva et al., 2015).

The significance of this study was to add knowledge to the existing demographic and neuropsychological profiles highlighting specific areas of strengths and weaknesses of children in our local community. This is of great significance when designing and implementing intervention strategies for HIV-positive children. This is especially important in assisting children succeed in the academic sphere. Another important aspect of this study is the normative data from the Control Group. Although the sample size is small, there is some indication of how children in low SES areas perform neuropsychologically. Lastly, being able to compare children with HIV to typically developing children (within the same context), is a more accurate representation of how the HIV-positive children are performing cognitively, whether they are performing significantly differently to typically developing children or not, rather than a comparison to the normative data found in the Western neuropsychological batteries typically used.

With the growth of Neuropsychology in South Africa, clinic specific studies such as this one can inform next steps in the creation of interventions for children with neurocognitive difficulties. The PNC is a site the in which more research into the mechanism of HIV and its relation to cognitive deficits could assist in providing information for intervention that could have meaningful outcomes in real life situations (Siva et al., 2015). This will assist in alleviating the burden the infection has. Understanding the multifaceted way in which the infection impacts a child is the first step towards creating creative solutions that will begin to assist in a better outcome.

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Appendix A

Demographic questionnaire and asset index

PARENT QUESTIONNAIRE AND ASSET INDEX

GENERAL INFORMATION

Full name (Parent):	
Telephone:	Work: ( ) Home: ( ) Cell:
Home Language:	
Full name (Child):	
Gender:	M F
Date of Birth:	
Grade:	

HOUSEHOLD INCOME: (Please circle appropriate number)

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

PARENTAL EDUCATION: (Please circle appropriate number)

	Biological mother	Biological father	Guardian
Highest level of education reached? Mark one response for each person as follows:			
1. 0 years (No Grades / Standards) = No formal education (never went to school)	1.	1.	1.
2. 1-6 years (Grades 1-6 / Sub A-Std 4) = Less than primary education (didn't complete primary school)	2.	2.	2.

3. 7 years (Grade 7 / Std 5) = Primary education (completed primary school)	3.	3.	3.
4. 8-11 years (Grades 8-11 / Stds 6-9) = Some secondary education (didn't complete high school)	4.	4.	4.
5. 12 years (Grade 12 / Std 10) = Secondary education (completed senior school)	5.	5.	5.
6. 13+ years = Tertiary education (completed university / technikon / college)	6.	6.	6.
7. Don't know	7.	7.	7.

PARENTAL EMPLOYMENT: (Please circle appropriate number)

Hollingstead categories:	Biological mother	Biological father	Guardian
1. Higher executives, major professionals, owners of large businesses)	1.	1.	1.
2. Business managers of medium sized businesses, lesser professions (e.g. nurses, opticians, pharmacists, social workers, teachers)	2.	2.	2.
3. Administrative personnel, managers, minor professionals, owners / proprietors of small businesses (e.g. bakery, car dealership, engraving business, plumbing business, florist, decorator, actor, reporter, travel agent)	3.	3.	3.
4. Clerical and sales, technicians, small businesses (e.g. bank teller, bookkeeper, clerk, draftsperson, timekeeper, secretary)	4.	4.	4.
5. Skilled manual – usually having had training (e.g. baker, barber, chef, electrician, fireman, machinist, mechanic, painter, welder, police, plumber, electrician)	5.	5.	5.
6. Semi-skilled (e.g. hospital aide, painter, bartender, bus driver, cook, garage guard, checker, waiter, machine operator)	6.	6.	6.
7. Unskilled (e.g. attendant, janitor, construction helper, unspedified labour, porter, unemployed)	7.	7.	7.

8. Homemaker	8.	8.	8.
9. Student, disabled, no occupation	9.	9.	9.

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

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

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

Which of the following do you have in your home?

Items	Yes	No
1. Running water	1.	1.
2. A domestic servant	2.	2.
3. At least one car	3.	3.

4. A flush toilet	4.	4.
5. A built-in kitchen sink	5.	5.
6. An electric stove or hotplate	6.	6.
7. A working telephone	7.	7.

Do you personally do any of the following?

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

Appendix B

Developmental history questionnaire

Child's Name: _____ Date of Birth: _____Age:_____

PREGNANCY AND BIRTH

Were there any complications during the *pregnancy*?

Did you take any medicine during pregnancy? Prescribed or over the counter?

Did you smoke cigarettes while you were pregnant? How many?

How much did you drink when you were pregnant?

Anything else, like dagga? Any drugs?

Was the birth on time?

Was it a natural birth or via C-section/Caesarian? Was labor induced?

Were there any complications during the birth?

What was your baby's birthweight? _____

Were there any complications in the *newborn period*?

DEVELOPMENT

At what age did your child:

sit unaided? _____
crawl or 'scoot' on his bottom? _____
walk without help? _____
dress and undress without help? _____
button own clothes? _____
tie shoe laces? _____
start babbling/baby talk _____
say their first word? _____
use 2 words together? _____
talk in sentences? _____
write own name? _____

Was your child slow to walk, or run? Did s/he have any problems with co-ordination or fine motor control?

At what age was your child *dry by day*? _____
At what age was your child *dry by night*? _____

Were there any early *separations* from you? (when and for how long)

Please list any *illnesses* and problems with *hearing* or *vision* that your child has/had.

Has your child ever been referred to a *Psychologist/Psychiatry* service?

Have there been any *emotionally difficult* experiences for your child?

Does your child have any neurological or neurodevelopmental disorder (such as Attention Deficit Hyperactivity Disorder or Epilepsy)?

Has your child sustained any head injury?

If yes, did he/she lose consciousness and for how long?

Did your child attend crèche? (what ages)

How old was your child in Grade R? What year was that?

MEDICATIONS

Is your child currently receiving any *medication*?

Please feel free to mention anything else you would like to bring to our attention.

Completed by: _____ Date: _____ Signed: _____

Appendix C

Information letter to parents

Dear parent / guardian,

I, Limpho Mokoena, am currently my master's degree Neuropsychology at the University of Cape Town. I would like to invite your child to participate in my research study.

The main purpose of my research is to collect data of typically developing children and test their thinking and learning abilities through tests that will measure some of your child's thinking and learning skills like how they remember, pay attention, the speed at which your child thinks, for example. The results of this data will then be used to compare to children (of the same age, sex, race and socio-economic status) who have been diagnosed with HIV to see if they are performing differently from the children who are typically developing.

If you allow your child to participate in this research, cognitive tests (i.e., thinking and learning skills like how they remember, pay attention, the speed at which your child thinks) will be carried out with your child, in two sessions of 60-90mins. You, as the parent/caregiver, will also be asked to complete two forms so that the investigator can know more about your child's background and development.

The study will not cost you anything and will be conducted at the school.

The consent form attached, gives you more details about this study. If you would like your child to participate in this study, please sign and return that form. **Please also provide your contact details so that we can get in touch with you.**

Thank you for taking the time to read this letter.

Regards,

Limpho Mokoena

Appendix D

Parent/Guardian's Informed Consent Form

UNIVERSITY OF CAPE TOWN

DEPARTMENT OF PSYCHOLOGY

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

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

1. Title of Research Study

Demographic and Neuropsychological Profile of HIV-positive Children Referred for an Assessment at a Local Clinic over a 5-year Period.

2.
Principal Investigator and Telephone Number(s)

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mokoena.limpho3@gmail.
com

3. What is the purpose of this research study? The aim of this study is to collect data on neurocognitive tests of typically developing children and compare them to children diagnosed with HIV to assess if children with HIV are performing differently from typically developing children in terms of their thinking and learning skills.

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

In this study, a series of cognitive tests will be administered. The tests measure some of your child's thinking and learning skills like how they remember, pay attention, the speed at which your child thinks, for example.

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

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

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

100

6. What are the possible discomforts and risks?

There are no known risks associated with participation in this study. A possible discomfort your child may experience is slight fatigue. If they become tired during any of the tests, they can take a break. They will be allowed to take breaks whenever they want to. At the end of the assessment, we will describe how each of the participants did in testing in a short report and the results can be fully explained to parents, should they require it.

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

7. What are the possible benefits to your child?

Feedback from your child's assessment will be made available to you. This is, however, a research study and therefore the data obtained will only be used for research purposes and not on a clinical basis. Feedback will therefore only indicate a general range of performance of the population that participated in the study. Any further queries regarding participants' cognitive functioning should be referred to a clinician.

8. What are the possible benefits to others?

Information from this study will be able to help us recognize the strengths and weaknesses of children with HIV in our local community. This can then help when designing and implementing intervention strategies in order to help children with HIV.

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

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

10. Can your child withdraw from this research study?

You are free to withdraw your consent and to stop your child participating in this research study at any time. If you do withdraw your consent, there will be no penalty.
If you have any questions regarding the rights of a research subject, you may phone Rosalind Adams in the Psychology Department at 021-650-3417.

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

Information already collected may be used.

12. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect you and your child's privacy?
Information collected will be stored in locked filing cabinets or in computers with security passwords. Only certain people have the right to review these research records. These people include the researchers for this study and certain University of Cape Town officials. Your child's research records will not be released without your permission unless required by law or a court order.

13. What information about your child may be collected, used and shared with others?
The information gathered from your child will be demographic information and records of his/her performance on cognitive tests. If you agree that your child can be in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set may only include information that does not directly identify you or your child. For example, the limited data set cannot include your or your child's name, address, telephone number, ID number, or any other photographs, numbers, codes, or so forth that link you or your child to the information in the limited data set.

The results of the research will be presented as part of a master's degree research project for the University of Cape Town. Also, the results may be submitted for publication in a peer-reviewed journal. In both instances neither you nor your child will be identified in any way.

14. What should you tell your child?
You may wish to discuss the study with your child to find out determine whether he/she feels comfortable taking part. Your child should know that he/she can choose not to participate in the study. Your child should also know that if he/she does choose to participate, he/she can withdraw at any time during the study with no negative consequences.

15. How will the researcher(s) benefit from your child being in the study?
In general, presenting research results helps the career of a scientist. Therefore, the Principal Investigator and others attached to this research project may benefit if the results of this study are presented at scientific meetings or in scientific journals.

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

_____ _____
Signature of Person Obtaining Consent and Authorization Date

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

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

_____ _____
Signature of Person Consenting and Authorizing Date

_____ _____
Name of Child Age

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

Method of contact:

Phone number: _____

E-mail address: _____

Mailing address: _____

_____

_____

Appendix E

Assent Form for Participants

You are going to be asked to play some games and do some puzzles. The person who is going to ask you the questions has told you that you can stop if you are feeling tired and need to take a break, and that nobody else will be told your answers to the questions.

Signing this paper means that you want to be in the study. If you don't want to be in the study, you don't have to sign the paper. No one will be angry if you don't sign this paper, and no one will be angry if you change your mind later and want to stop.

You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can call me on (relevant number to be inserted) or ask me next time.

_____ _____

Signature of Child Date

_____ _____

Signature of Researcher Date

Name of Participant ("Study Subject")

_____

Appendix F

Informed consent

UNIVERSITY OF CAPE TOWN

Enquiries: Susan Malcolm-Smith

Telephone: 021 650 4605

Fax: 021 650 4104

Departement van Gesondheid
Department of Health
iSebe lezeMpilo

NEUROPSYCHOLOGY CLINIC

RESEARCH, TEACHING AND TRAINING

Name of Child:

The Neuropsychology Clinic is part of a Regional Pediatric Neurology Service at Red Cross Children's Hospital which is a teaching hospital with links to the University of Cape Town and is therefore involved in teaching, training and research in child neurology and neuropsychology. All information is treated in confidence. Patient anonymity is assured in any research. I give permission for the assessment to be used for teaching, training or research purposes.

Signed: .....

Name .....

Parent / Guardian / Other (please state)

Date .....

RONDEBOSCH
7700 / 7701

RONDEBOSCH
7700 / 7701

Appendix G

Ethical approval Department of Psychology

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

27 June 2017

Limpho Mokoena
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Limpho

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, *HIV-related referrals to a local pediatric neuropsychology clinic: A 5year demographic/ neuropsychological profile*. The reference number is PSY2017-021.

I wish you all the best for your study.

Yours sincerely

University of Cape Town
PSYCHOLOGY DEPARTMENT
Upper Campus
Rondebosch

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

Appendix H

Ethical Approval Faculty of Health Sciences Human

UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

Form FHS006: Protocol Amendment

HREC office use only (FWA00001637; IRB00001938)			
☑ Approved	☐ Type of review: Expedited	☐ Full committee	
This serves as notification that all changes and documentation described below are approved.			
Signature Chairperson of the HREC		Date	2/9/2017

Note: All major amendments must include a local **PI Synopsis** justifying the changes for the amendment. Please note that incomplete amendment submissions will not be reviewed.

Comments from the HREC to the Principal Investigator:
Note: The approval of this protocol amendment does not grant annual approval. Please complete the FHS016 / FHS017 form for annual approval at least one month before study expiration.

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	01 September 2017
HREC REF Number	444/2016
Protocol title	HIV-related referrals to a local pediatric neuropsychology clinic: A 5-year demographic / neuropsychological profile
Protocol number (if applicable)	
Principal Investigator	Dr Leigh Schrieff-Elson
Department / Office Internal Mail Address	Psychology department

1.1 Is this a major or a minor amendment? (see FHS006hlp) Major (tick box) Minor (tick box)	☐ Major	x Minor
1.2 Does this protocol receive US Federal funding?	☐ Yes	x No
1.3 If the amendment is a major amendment and receives US Federal Funding, does the amendment require full committee approval?	☐ Yes	☐ No

HUMAN RESEARCH ETHICS COMMITTEE
01 SEP 2017
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

2. List of Proposed Amendments with Revised Version Numbers and Dates

Please itemise on the page below, all amendments with revised version numbers and dates, which need approval. This page will be detached, signed and returned to the PI as notification of approval. Please add extra pages if necessary.
1. Extension of case review period from 1 year (2015) to 5 years (2012-2016). We would like to strengthen the study results and generalizability by increasing the sample size. 2. Addition of typically developing matched control group. Given the known difficulties with using internationally normed tests on local populations, we would like to include a locally tested control group to strengthen the validity of our results.

3. Protocol status (tick ✓)

☐	Open to enrolment
x	No participants have been enrolled – The study design is a retrospective case record review
☐	Closed to enrolment (tick ✓)
☐	Research-related activities are ongoing
☐	Research-related activities are complete, long-term follow-up only
☐	Research-related activities are complete, data analysis only

4. Proposed changes will affect: (tick ✓ all the categories that apply)

	Protocol
x	Study objectives, design (including investigator's brochure, clinical activities, study length)
☐	Study instruments, questionnaires, interview schedules
x	Sample size
☐	Recruitment methods
x	Eligibility criteria (inclusion and exclusion criteria)
☐	Drug/device (composition, amount, schedule, route of administration, combination with other drugs/devices, safety information)
x	Data collection/ analysis
☐	Principal Investigator. (Please attach revised conflict of interest and PI declaration statements. Refer: sections 7 and 8.4 in the New Protocol Application Form FHS013)
x	Consent form and information sheet
☐	Recruitment materials (e.g. advertisements)
☐	Administrative (e.g. change in sponsor's name, change in contact information)

☐	Other. Please specify:

4.1 In your opinion, will there be any **increase** in risk, discomfort or inconvenience to participants?	☐ Yes	x No
If yes, please provide a detailed justification/explanation:		

4.2 What follow-up action do you propose for participants who are already enrolled in the study?	
☐	Inform current participants as soon as possible
☐	Re-consent current participants with revised consent/assent forms (append)
x	No action required
☐	Other. Please describe:

5. Detailed description of the change(s)

Please attach, for each amendment, a summary of all changes which clearly indicates:

i. Old wording (e.g. ~~strikethrough~~ text, CHANGED FROM and CHANGED TO)

ii. New wording (e.g. *italicized*, **bold**, tracked)

iii. Detailed rationale/ justification/ explanation for each change

6. Ethics Review Levy – cost including vat

Cost for Major Amendments - R3 659.10

(Protocols funded by UCT (e.g. departmental funding / student research) and by certain grant funding organizations (e.g. MRC, NRF, CANSA,) are exempt from charges)

For invoicing purposes, please provide:	
Sponsor's name	
Contact person	
Address	
Telephone number	
Email Address	

7. Signature

My signature certifies that I will maintain the anonymity and/ or confidentiality of information collected in this research. If at any time I want to share or re-use the information for purposes other than those disclosed in the original approval, I will seek further approval from the HREC.

Signature of PI		Date	01 September 2017

Appendix I

Raw Neuropsychological Test Data – HIV-Positive Subsample (*n*=73)

Numbers f	Numbers b	Numbers total	Sky_Search_targets	Sky_Search_time_per_target	Sky_Search_attention_score	Dot locations learning	Dot_locations immediate	Dot locations delayed	WRAML learning
10.00 average	10.00 average	10.00 average							
5.00 low average	3.00 low average					5.00 borderline	6.00 low average	10.00 average	2.00 extremely low
3.00 extremely low	2.00					6.00 low average	too complex	too complex	2.00 extremely low
3.00 extremely low	7.00 low average					11.00 average	11.00 average	13.00 high average	
3.00 extremely low	0.00 extremely low								3.00 extremely low
		8.00 average							
5.00 borderline	3.00 extremely low					7.00 low average	7.00 low average	9.00 average	7.00 low average
3.00 extremely low	7.00 low average					8.00 average		10.00 average	12.00 high average
10.00 average	5.00 borderline					4.00 borderline		6.00 low average	8.00 average
						11.00 average	11.00 average	14.00 superior	
						11.00 average	11.00 average	10.00 average	8.00 average
						5.00 borderline	6.00 low average	7.00 low average	9.00 average
8.00 average	7.00 low average					9.00 average	7.00 low average	6.00 low average	2.00 extremely low
7.00 low average	too complex					7.00 low average		10.00 average	
1.00 extremely low	1.00 extremely low	1.00 extremely low							
2.00 extremely low	2.00 extremely low	1.00 extremely low				6.00 low average	5.00 borderline	5.00 borderline	10.00 average
4.00 borderline	2.00 extremely low	3.00 extremely low				4.00 borderline	3.00 extremely low	6.00 low average	6.00 low average
9.00 average	8.00 average	8.00 average				11.00 average	14.00 superior	13.00 high average	10.00 average
7.00 low average	too complex	3.00 extremely low				5.00 borderline	7.00 low average	9.00 average	4.00 borderline
3.00 borderline	3.00 borderline	2.00 extremely low				2.00 extremely low	6.00 low average	7.00 low average	6.00 low average
4.00 borderline	6.00 low average	4.00 borderline				6.00 low average	4.00 borderline	9.00 average	10.00 average
2.00 extremely low	2.00 extremely low	2.00 extremely low				9.00 average	11.00 average	10.00 average	10.00 average
3.00 extremely low	3.00 extremely low	1.00 extremely low				5.00 borderline	4.00 borderline	8.00 average	4.00 borderline
6.00 low average	7.00 low average	6.00 low average				10.00 average	10.00 average	10.00 average	6.00 low average
7.00 low average	5.00 borderline	5.00 borderline							
						*could not be scored because he was making patterns			
5.00 borderline	*too complex	2.00 extremely low							8.00 average
7.00 low average	2.00 extremely low	3.00 extremely low				7.00 low average	10.00 average	10.00 average	10.00 average
		1.00 extremely low							
		6.00 low average	14.00 superior	2.00 extremely low					11.00 average
4.00 borderline	1.00 extremely low			2.00 extremely low	4.00 borderline				6.00 low average
4.00 borderline									
3.00 extremely low	2.00 extremely low	1.00 extremely low	11.00 average	3.00 extremely low	3.00 extremely low	7.00 low average	8.00 average	10.00 average	11.00 average
4.00 borderline	4.00 borderline		7.00 low average	1.00 extremely low	1.00 extremely low	6.00 low average	6.00 low average	8.00 average	7.00 low average
3.00 extremely low	5.00 borderline	2.00 extremely low		1.00 extremely low	1.00 extremely low				
4.00 borderline	unable								8.00 average
7.00 low average	unable								
7.00 low average									
2.00 extremely low	unable					too complex			could only do 4HO
5.00 borderline	unable					9.00 average	10.00 average	11.00 average	6.00 low average
		2.00 extremely low							11.00 average
3.00 extremely low	unable								
3.00 extremely low	unable								
		5.00 borderline							8.00 average
2.00 extremely low	5.00 borderline	2.00 extremely low	2.00 extremely low	1.00 extremely low	1.00 extremely low	7.00 low average	7.00 low average		5.00 borderline
6.00 low average	1.00 extremely low								
4.00 Borderline									9.00 Average
4.00 Borderline	9.00 Average						9.00 Average	10.00 Average	10.00 Average
4.00 Borderline									4.00 Borderline
9.00 Average	4.00 Borderline		11.00 Average	1.00 Extremely Low	1.00 Extremely Low	8.00 Average	6.00 Low Average	8.00 Average	11.00 Average
13.00 High Average	9.00 Average					8.00 Average	11.00 Average	10.00 Average	9.00 Average
4.00 Borderline			5.00 Borderline	10.00 Average	11.00 Average	10.00 Average	13.00 High Average	12.00 High Average	10.00 Average
3.00 Extremely Low									8.00 Average
7.00 Low Average	5.00 Borderline								10.00 Average
7.00 Low Average	6.00 Low Average		2.00 Extremely Low	1.00 Extremely Low		5.00 Borderline	10.00 Average	10.00 Average	11.00 Average
8.00 Average	10.00 Average						7.00 Low Average	7.00 Low Average	10.00 Average
7.00 Low Average	10.00 Average		13.00 High Average	2.00 Extremely Low	10.00 Average	6.00 Low Average	11.00 Average	5.00 Borderline	10.00 Average
3.00 Extremely Low						5.00 Borderline	4.00 Borderline	5.00 Borderline	9.00 Average
9.00 Average	9.00 Average		7.00 Low Average	5.00 Borderline	6.00 Low Average	11.00 Average	14.00 Superior	14.00 Superior	10.00 Average
4.00 Borderline	2.00 Extremely Low		7.00 Low Average	3.00 Extremely Low	3.00 Extremely Low	9.00 Average	10.00 Average	8.00 Average	8.00 Average
4.00 Borderline	5.00 Borderline								5.00 Borderline
10.00 Average	9.00 Average								
3.00 Extremely Low	4.00 Borderline					12.00 High Average	13.00 High Average	13.00 High Average	7.00 Low Average
		7.00 low average							
10.00 average	10.00 average	10.00 average							
3.00 Extremely Low	7.00 Low Average		1.00 Extremely Low	1.00 Extremely Low		9.00 Average	11.00 Average	11.00 Average	9.00 Average
6.00 Low Average	4.00 Borderline								5.00 Borderline
3.00 Extremely Low	3.00 Extremely Low								11.00 Average
4.00 boderline	3.00 extremely low		11.00 average	2.00 extremely low	2.00 extremely low	9.00 average	12.00 high average	10.00 average	10.00 average
3.00 extremely low	5.00 borderline		7.00 low average	1.00 extremely low	1.00 extremely low	6.00 low average	5.00 borderline	6.00 low average	7.00 low average
6.00 low average	5.00 borderline		6.00 low average	3.00 extremely low	5.00 borderline				7.00 low average
4.00 borderline	4.00 borderline		14.00 high average	1.00 extremely low	1.00 extremely low	8.00 average	8.00 average	10.00 average	11.00 average

WRAML delayed	WRAML recognition	COI	Coding	WASI_Vocab	WASI_BD	WASI_Sims	WASI_MR	WASI_VIQ	WASI_PIQ	WASI_FSIQ
		6.00 low average		10.00 average	4.00 borderline	0.00 extremely low	8.00 average	69.00 extremely low	72.00 borderline	67.00 extremely low
6.00 low average			3.00 extremely low	1.00 extremely low	2.00 extremely low	1.00 extremely low	5.00 borderline	68.00 extremely low	55.00 extremely low	59.00 extremely low
5.00 borderline				1.00 extremely low	5.00 borderline	1.00 extremely low	2.00 extremely low	67.00 extremely lo	55.00 extremely low	59.00 extremely low
										84.00 low average
				7.00 low average	3.00 extremely low	2.00 extremely low	0.00 extremely low	58.00 extremely low	68.00 extremely low	60.00 extremely low
5.00 borderline		1.00 extremely low		2.00 extremely low	4.00 borderline	2.00 extremely low	6.00 low average	61.00 extremely low	74.00 borderline	65.00 extremely low
				3.00 extremely low						
9.00 average				5.00 borderline	5.00 borderline	4.00 borderline	7.00 low average	73.00 borderline	80.00 low average	74.00 borderline
10.00 average			7.00 low average	4.00 borderline	6.00 low average	3.00 extremely low	4.00 borderline	71.00 borderline	74.00 borderline	70.00 borderline
8.00 average				8.00 average	6.00 low average	3.00 extremely low	1.00 extremely low	78.00 borderline	69.00 extremely low	72.00 borderline
				4.00 borderline	7.00 low average	1.00 extremely low	9.00 average	65.00 extremely low	91.00 average	75.00 borderline
10.00 average				3.00 extremely low	7.00 low average	3.00 extremely low	3.00 extremely low	67.00 extremely low	77.00 borderline	69.00 extremely low
9.00 average				4.00 borderline	5.00 borderline	3.00 extremely low	5.00 borderline	69.00 extremely low	75.00 borderline	69.00 extremely low
4.00 borderline		1.00 extremely low		1.00 extremely low	7.00 low average	1.00 extremely low	9.00 average	55.00 extremely low	89.00 low average	71.00 borderline
				1.00 extremely low	7.00 low average	2.00 extremely low	4.00 borderline	60.00 extremely low	77.00 boderline	67.00 extrememly low
12.00 high average	6.00 low average		4.00 borderline	3.00 extremely low	5.00 borderline	1.00 extremely low	1.00 extremely low	64.00 extremely low	61.00 extremely low	61.00 extremely low
7.00 low average	5.00 borderline		3.00 extremely low	6.00 low average	7.00 low average	6.00 low average	8.00 average	80.00 low average	87.00 low average	82.00 low average
12.00 high average	10.00 average			2.00 extremely low	9.00 average	5.00 borderline	4.00 borderline			
6.00 low average	8.00 average		6.00 low average							
5.00 borderline	5.00 borderline			2.00 extremely low	4.00 borderline	2.00 extremely low	3.00 extremely low	60.00 extremely low	67.00 extremely low	61.00 extremely low
8.00 average	7.00 low average			5.00 borderline	8.00 average	5.00 borderline	7.00 low average	75.00 borderline	86.00 low average	78.00 borderline
10.00 average	10.00 average		4.00 borderline	4.00 borderline	4.00 borderline	1.00 extremely low	8.00 average	66.00 extremely low	73.00 borderline	67.00 extremely low
6.00 low average	8.00 average			7.00 low average	5.00 borderline	1.00 extremely low	3.00 extremely low	73.00 borderline	71.00 borderline	70.00 borderline
6.00 low average			7.00 low average	3.00 extremely low	6.00 low average	4.00 borderline	3.00 extremely low	70.00 borderline	74.00 borderline	69.00 extremely low
				2.00 extremely low	7.00 low average			64.00 extremely low	82.00 low average	71.00 borderline
		1.00 extremely low						70.00 borderline	70.00 borderline	62.00 extremely low
9.00 average	1.00 extremely low	1.00 extremely low		5.00 borderline	0.00 extremely low	1.00 extremely low	0.00 extremely low	62.00 extremely low	68.00 extremely low	62.00 extremely low
10.00 average	7.00 low average		3.00 extremely low	1.00 extremely low	4.00 borderline	2.00 extremely low	3.00 extremely low	59.00 extremely low	67.00 extremely low	60.00 extremely low
		1.00 extremely low	5.00 borderline	1.00 extremely low	1.00 extremely low	5.00 borderline	1.00 extremely low	55.00 extremely low	55.00 extremely low	48.00 extremely low
10.00 average	14.00 superior		8.00 average	8.00 average	8.00 average	12.00 high average	10.00 average	101.00 average	96.00 average	99.00 average
5.00 borderline	8.00 average		5.00 borderline	1.00 extremely low	6.00 low average	1.00 extremely low	1.00 extremely low	55.00 extremely low	70.00 borderline	60.00 extremely low
12.00 high average	11.00 average	6.00 low average								
8.00 average	8.00 average	4.00 borderline	3.00 extremely low	1.00 extremely low	6.00 low average	6.00 low average	8.00 average	71.00 borderline	84.00 low average	74.00 borderline
8.00 average	4.00 bordeline	6.00 low average								
		perfoming at level of 3yo								
		1.00 extremely low								
		1.00 extremely low								
didnt recall any words	1.00 extremely low		5.00 borderline	1.00 extremely low	5.00 borderline	3.00 extremely low	7.00 low average	62.00 extremely low	81.00 low average	
8.00 average	6.00 low average	2.00 extremely low	4.00 borderline							
		1.00 extremely low								
		3.00 extremely low						64.00 extremely low	59.00 etremely low	57.00 extremely low
8.00 average	11.00 average	3.00 extremely low	10.00 average	4.00 borderline	6.00 low average	6.00 low average	6.00 low average	67.00 extremely low	84.00 low average	71.00 borderline
7.00 low average	7.00 low average	1.00 extremely low	2.00 extremely low	1.00 extremely low	6.00 low average	1.00 extremely low	5.00 borderline	55.00 extremely low	78.00 borderline	66.00 extremely low
		5.00 borderline	7.00 low average	4.00 borderline	5.00 borderline	4.00 borderline	4.00 borderline		59.00 extremely low	
6.00 Low Average	1.00 Extremely Low			2.00 Extremely Low	6.00 Low Average		2.00 Extremely Low	53.00 Extremely Low	70.00 Borderline	61.00 Extremely Low
8.00 Avergae	8.00 Average	4.00 Borderline	6.00 Low Average	2.00 Extremely Low	7.00 Low Average	5.00 Borderline	10.00 Average	70.00 Borderline	92.00 Average	78.00 Borderline
5.00 Bordeline	1.00 Extremely Low									
7.00 Low Average	7.00 Low Average		6.00 Low Average	5.00 Borderline	4.00 Borderline	4.00 Borderline	4.00 Borderline	73.00 Borderline	70.00 Borderline	69.00 Extremely Low
8.00 Average	7.00 Low Average		4.00 Borderline	3.00 Extremely Low	6.00 Low Average	5.00 Borderline	7.00 Low Average	73.00 Borderline	83.00 Low Average	75.00 Borderline
10.00 Average	10.00 Average		5.00 Borderline							
8.00 Average	1.00 Extremely Low		3.00 Extremely Low	3.00 Extremely Low	6.00 Low Average		3.00 Extremely Low	61.00 Extremely Low	63.00 Extremely Low	58.00 Extremely Low
8.00 Average	7.00 Low Average	4.00 Borderline	9.00 Average	1.00 Extremely Low	7.00 Low Average	1.00 Extremely Low	8.00 Average	57.00 Extremely Low	87.00 Average	70.00 Borderline
6.00 Low Average	5.00 Borderline	1.00 Extremely Low	7.00 Low Average							
16.00 Very Superior	10.00 Average	6.00 Low Average	6.00 Low Average							
10.00 Average	9.00 Average	5.00 Borderline	5.00 Borderline	1.00 Extremely Low	5.00 Borderline	2.00 Extremely Low	8.00 Extremely Low	60.00 Average	76.00 Borderline	69.00 Extremely Low
7.00 Low Average	7.00 Low Average									
10.00 Average	8.00 Average		7.00 Low Average	7.00 Low Average	6.00 Low Average	8.00 Average	13.00 Low Average	87.00 High Average	97.00 Average	90.00 Average
7.00 Low Average	7.00 Low Average		3.00 Extremely Low	3.00 Extremely Low	6.00 Low Average	5.00 Borderline	2.00 Borderline	73.00 Extremely Low	68.00 Extremely Low	69.00 Extremely Low
7.00 Low Average	5.00 Low Average	2.00 Extremely Low	5.00 Borderline	1.00 Extremely Low	3.00 Borderline	1.00 Extremely Low	2.00 Extremely Low	45.00 Extremely Low	62.00 Extremely Low	44.00 Extremely Low
		7.00 Low Average	3.00 Extremely Low	7.00 Low Average	8.00 Average	7.00 Low Average	5.00 Average	86.00 Borderline	82.00 Low Average	86.00 Average
8.00 Average	7.00 Low Average	6.00 Low Average	5.00 Borderline	1.00 Extremely Low	6.00 Low Average	5.00 Borderline	10.00 Extremely Low	69.00 Average	89.00 Low Average	76.00 Borderline
		1.00 extremely low								
		3.00 extremely low	6.00 low average	2.00 extremely low	4.00 borderline	2.00 extremely low	5.00 borderline	64.00 extremely low	72.00 borderline	65.00 extremely loq
10.00 Average	9.00 Average	6.00 Low Average	6.00 Low Average	0.00 Extremely Low	3.00 Extremely Low	9.00 Average	4.00 Borderline	72.00 Borderline	78.00 Borderline	73.00 Borderline
3.00 Extremely Low	4.00 Borderline		2.00 Extremely Low	1.00 Extremely Low	4.00 Borderline	1.00 Extremely Low	1.00 Extremely Low	58.00 Extremely Low	63.00 Extremely Low	57.00 Extremely Low
9.00 Average	9.00 Average		5.00 Borderline	3.00 Extremelty Low	3.00 Extremely Low	4.00 Borderline	3.00 Extremely Low	59.00 Extremely Low	62.00 Extremely Low	52.00 Extremely Low
8.00 average	5.00 borderline	4.00 borderline	3.00 extremely low	1.00 extremely low	6.00 low average	1.00 extremely low	5.00 borderline	55.00 extremely low	76.00 borderline	
6.00 low average	7.00 low average		4.00 borderline	1.00 extremely low	4.00 borderline	1.00 extremely low	1.00 extremely low	55.00 extremely low	62.00 extremely low	56.00 extremely low
6.00 low average	4.00 borderline	3.00 extremely low								
11.00 average	9.00 average		5.00 borderline	1.00 extremely low	5.00 borderline	1.00 extremely low	6.00 low average	55.00 extremely low	75.00 borderline	

INN Completion time	INI Completeion time	INS Completion Time	IN Total Erros	Tower_Total_achievement_score	Tower_time_per_move_ratio	Tower_move_accuracy_ratio	Tower_rule_violation
				5.00 borderline			10.00 average
6.00 Low Average	5.00 Low Average	7.00 Low Average	8.00 Average	1.00 extremely low	too complex	too complex	too complex
1.00 Extremeley low			1.00 Extremely Low				
				8.00 average			
				7.00 low average			
				11.00 average			10.00 average
				6.00 low average			8.00 average
				5.00 borderline	1.00 extremely low		
				7.00 low average			
				7.00 low average		6.00 low average	1.00 extremely low
				8.00 average			
				8.00 average			3.00 extremely low
				12.00 High Average	12.00 High Average	7.00 Low Average	
				12.00 High Average	12.00 High Average	5.00 Borderline	11.00 Average
				8.00 Average	11.00 Average	5.00 Borderline	11.00 Average
				5.00 Borderline	1.00 Extremely Low	11.00 Average	1.00 Extremely Low
				8.00 Average	7.00 Low Average	8.00 Average	9.00 Average
				8.00 Average	10.00 Average	9.00 Average	10.00 Average
8.00 Average	8.00 Average	6.00 Low Average	4.00 Borderline				
				8.00 average	10.00 average	7.00 low average	4.00 borderline
				6.00 Low Average	8.00 Average	9.00 Average	11.00 Average
				9.00 Average	6.00 Low Average	9.00 Average	8.00 Average
				2.00 extremely low	1.00 extremely low		4.00 borderline

Appendix J

Raw Neuropsychological Test Data – Control Group (*n*=41)

Numbers F		Numbers B		Numbers total		Sky search targets found		Sky search time per target		Sky search attention score		Dots location learning score	
7	Low Average	4	Borderline	5	Borderline	6	Low Average	2	Extremely Low	1	Extremely Low	9	Average
5	Borderline	8	Average	6	Low Average	13	High Average	6	Low Average	5	Borderline	11	Average
9	Average	13	High Average	11	Average	9	Average	4	Borderline	6	Low Average	7	Low Average
10	Average	11	Average	10	Average	11	Average	2	Extremely Low	2	Extremely Low	5	Borderline
4	Borderline	6	Low Average	3	Extremeley Low	11	Average	2	Extremely Low	1	Extremely Low	12	High Average
7	Low Average	10	Average	8	Average	11	Average	7	Low Average	4	Borderline	6	Low Average
4	Borderline	6	Low Average	4	Borderline	14	Superior	5	Borderline	4	Borderline	8	Average
4	Borderline	8	Average	5	Borderline	9	Average	5	Borderline	5	Borderline	12	High Average
7	Low Average	8	Average	6	Low Average	14	Superior	6	Low Average	7	Low Average	8	Average
7	Low Average	2	Extrememly Low	5	Borderline	14	Superior	8	Average	11	Average	7	Low Average
9	Average	8	Average	8	Average	4	Borderline	8	Average	10	Average	14	Superior
6	Low Average	5	Borderline	4	Borderline	8	Average	3	Extremely Low	4	Borderline	13	High Average
6	Low Average	7	Low Average	5	Borderline	8	Average	2	Extremely Low	4	Borderline	6	Low Average
11	Average	15	Superior	13	High Average	11	Average	6	Low Average	6	Low Average	13	High Average
7	Low Average	8	Average	6	Low Average	14	Superior	6	Low Average	7	Low Average	8	Average
8	Average	10	Average	10	Average	9	Average	4	Borderline	5	Borderline	10	Average
6	Low Average	7	Low Average	7	Low Average	13	High Average	13	High Average	14	Superior	11	Average
6	Low Average	10	Average	7	Low Average	13	High Average	2	Extremely Low	3	Extremely Low	8	Average
6	Low Average	7	Low Average	5	Borderline	10	Average	8	Average	9	Average	8	Average
4	Borderline	7	Low Average	4	Borderline	11	Average	5	Borderline	7	Low Average	9	Average
8	Average	7	Low Average	7	Low Average	10	Average	8	Average	12	High Average	11	Average
13	High Average	13	High Average	14	Superior	13	High Average	10	Average	13	High Average	13	High Average
5	Borderline	7	Low Average	4	Borderline	11	Average	5	Borderline	7	Low Average	9	Average
6	Low Average	7	Low Average	5	Borderline	14	Superior	5	Borderline	7	Low Average	11	Average
11	Average	11	Average	11	Average	9	Average	8	Average	7	Low Average	11	Average
6	Low Average	9	Average	7	Low Average	14	Superior	3	Extremely Low	6	Low Average	11	Average
12	High Average	2	Extrememly Low	2	Extremeley Low	13	High Average	10	Average	14	Superior	13	High Average
10	Average	12	High Average	11	Average	14	Superior	11	Average	12	High Average	11	Average
8	Average	11	Average	9	Average	11	Average	8	Average	11	Average	5	Borderline
4	Borderline	2	Extrememly Low	3	Extremeley Low	8	Average	8	Average	11	Average	7	Low Average
5	Borderline	2	Extrememly Low	4	Borderline	9	Average	6	Low Average	7	Low Average	12	High Average
4	Borderline	10	Average	6	Low Average	9	Average	9	Average	11	Average	14	Superior
3	Extremely Low	4	Borderline	2	Extremeley Low	11	Average	8	Average	11	Average	8	Average
4	Borderline	2	Extrememly Low	3	Extremeley Low	4	Borderline	7	Low Average	9	Average	11	Average
5	Borderline	5	Borderline	5	Borderline	14	Superior	1	Extremely Low	2	Extremely Low	10	Average
5	Borderline	5	Borderline	5	Borderline	9	Average	7	Low Average	7	Low Average	13	High Average
10	Average	10	Average	9	Average	14	Superior	12	High Average	16	Very Superior	11	Average
5	Borderline	5	Borderline	5	Borderline	14	Superior	1	Extremely Low	2	Extremely Low	10	Average
3	Extremely Low	7	Low Average	4	Borderline	10	Average	4	Borderline	5	Borderline	11	Average
12	High Average	13	High Average	13	High Average	10	Average	10	Average	10	Average	9	Average
3	Extremely Low	7	Low Average	4	Borderline	10	Average	4	Borderline	5	Borderline	11	Average

Dots location total score		Dots location delay		WRAML learning		WRAML delay		WRAML recognition		COI		Coding		WASI Vocab	
9	Average	8	Average	9	Average	10	Average	9	Average	7	Low Average	9	Average	3	Extremely Low
12	High Average	14	Superior	11	Average	9	Average	7	Low Average	5	Borderline	6	Low Average	3	Extremely Low
7	Low Average	9	Average	13	High Average	11	Average	8	Average	10	Average	7	Low Average	5	Borderline
5	Borderline	9	Average	13	High Average	10	Average	11	Average	6	Low Average	6	Low Average	5	Borderline
13	High Average	12	High Average	13	High Average	16	Very Superior	9	Average	6	Low Average	6	Low Average	4	Borderline
7	Low Average	10	Average	10	Average	11	Average	10	Average	7	Low Average	7	Low Average	6	Low Average
9	Average	10	Average	9	Average	11	Average	7	Low Average	6	Low Average	7	Low Average	2	Extremely Low
13	High Average	12	High Average	7	Low Average	8	Average	11	Average	9	Average	7	Low Average	4	Borderline
10	Average	12	High Average	10	Average	8	Average	8	Average	3	Low Average	6	Low Average	5	Borderline
7	Low Average	9	Average	14	Superior	10	High Average	11	Average	5	Borderline	8	Average	5	Borderline
15	Superior	13	High Average	15	Superior	12	High Average	9	Average	5	Borderline	6	Low Average	7	Low Average
12	High Average	12	High Average	8	Average	6	Low Average	10	Average	5	Borderline	4	Borderline	3	Extremely Low
7	Low Average	6	Low average	8	Average	7	Low Average	9	Average	1	Extremely Low	3	Extremely Low	3	Extremely Low
15	Superior	12	High Average	13	High Average	12	High Average	13	High Average	8	Average	10	Average	9	Average
10	Average	12	High Average	10	Average	8	Average	8	Average	3	Low Average	6	Low Average	5	Borderline
9	Average	8	Average	11	Average	11	Average	10	Average	9	Average	8	Average	2	Extremely Low
10	Average	8	Average	12	High Average	11	Average	10	Average	6	Low Average	8	Average	4	Borderline
7	Low Average	8	Average	12	High Average	10	Average	11	Average	8	Average	9	Average	5	Borderline
8	Average	7	Low average	11	Average	8	Average	11	Average	5	Borderline	12	High Average	8	Average
10	Average	10	Average	9	Average	10	Average	7	Low Average	3	Extremely Low	5	Borderline	2	Extremely Low
11	Average	14	Superior	7	Low Average	7	Low Average	10	Average	7	Low Average	10	Average	5	Borderline
13	High Average	14	Superior	9	Average	15	Superior	14	Superior	9	Average	9	Average	10	Average
10	Average	10	Average	9	Average	10	Average	7	Low Average	3	Extremely Low	5	Borderline	2	Extremely Low
11	Average	11	Average	6	Low Average	8	Average	7	Low Average	9	Average	5	Borderline	3	Extremely Low
11	Average	12	High Average	13	High Average	11	Average	15	Superior	9	Average	9	Average	11	Average
10	Average	10	Average	10	Average	10	Average	11	Average	5	Borderline	10	Average	4	Borderline
13	High Average	10	Average	9	Average	11	Average	11	Average	9	Average	9	Average	7	Low Average
12	High Average	13	High Average	9	Average	10	Average	9	Average	7	Low Average	14	Superior	8	Average
6	Low Average	7	Low average	13	High Average	13	High Average	10	Average	7	Low Average	8	Average	7	Low Average
8	Average	8	Average	10	Average	11	Average	10	Average	6	Low Average	8	Average	4	Borderline
11	Average	5	Borderline	8	Average	11	Average	7	Low Average	6	Low Average	9	Average	1	Extremely Low
14	Superior	13	High Average	10	Average	13	High Average	11	Average	8	Average	10	Average	2	Extremely Low
9	Average	9	Average	5	Borderline	10	Average	7	Low Average	4	Borderline	4	Borderline	2	Extremely Low
11	Average	5	Borderline	10	Average	10	Average	11	Average	8	Average	6	Low Average	1	Extremely Low
10	Average	11	Average	13	High Average	15	Superior	10	Average	4	Borderline	6	Low Average	3	Extremely Low
13	High Average	13	High Average	7	Low Average	9	Average	7	Low Average	5	Borderline	6	Low Average	1	Extremely Low
11	Average	13	High Average	9	Average	8	Average	14	Superior	6	Low Average	9	Average	8	Average
10	Average	11	Average	13	High Average	15	Superior	10	Average	4	Borderline	6	Low Average	3	Extremely Low
12	High Average	13	High Average	7	Low Average	10	Average	11	Average	2	Extremely Low	4	Borderline	3	Extremely Low
8	Average	7	Low Average	15	Superior	17	Very Superior	13	High Average	8	Average	12	High Average	9	Average
12	High Average	13	High Average	7	Low Average	10	Average	11	Average	2	Extremely Low	4	Borderline	3	Extremely Low

WASI BD		WASI Sims		WASI MR		WASI VIQ		WASI PIQ		WASI FSIQ		INN Completion time		INI Completion time	
7	Low Average	5	Borderline	7	Low Average	72	Borderline	85	Low Average	75	Borderline	7	Low Average	5	Borderline
7	Low Average	6	Low Average	9	Average	74	Borderline	89	Low Average	79	Borderline	14	Superior	13	Superior
7	Low Average	9	Average	6	Low Average	86	Low Average	83	Low Average	83	Low Average	7	Low Average	12	High Average
7	Low Average	6	Low Average	6	Low Average	76	Borderline	83	Low Average	77	Borderline	9	Average	11	Average
8	Average	3	Extremely Low	10	Average	70	Borderline	93	Average	78	Borderline	8	Average	8	Average
9	Average	8	Average	8	Average	85	Low Average	92	Average	86	Low Average	8	Average	12	High Average
7	Low Average	3	Extremely Low	4	Borderline	64	Extremely Low	79	Bordeline	121	Extremely Low	8	Average	6	Low Average
6	Low Average	7	Low Average	5	Borderline	78	Borderline	75	Bordeline	75	Borderline	7	Low Average	10	Average
5	Borderline	4	Borderline	5	Borderline	74	Borderline	74	Bordeline	72	Borderline	6	Low Average	10	Average
10	Average	9	Average	12	High Average	86	Low Average	106	Average	95	Average	5	Borderline	8	Average
6	Low Average	3	Extremely Low	4	Borderline	77	Borderline	75	Bordeline	74	Borderline	4	Borderline	6	Low Average
6	Low Average	1	Extremely Low	5	Borderline	63	Extremely Low	79	Bordeline	69	Extremely Low	6	Low Average	7	Low Average
7	Low Average	7	Low Average	5	Borderline	76	Borderline	78	Bordeline	75	Borderline	6	Low Average	9	Average
9	Average	11	Average	15	Superior	99	Average	110	Average	106	Average	6	Low Average	7	Low Average
5	Borderline	4	Borderline	5	Borderline	74	Borderline	74	Bordeline	72	Borderline	6	Low Average	10	Average
7	Low Average	2	Extremely Low	4	Borderline	61	Extremely Low	76	Bordeline	66	Extremely Low	7	Low Average	10	Average
5	Borderline	4	Borderline	6	Low Average	73	Borderline	71	Bordeline	73	Borderline	9	Average	6	Average
10	Average	9	Average	8	Average	86	Low Average	93	Average	88	Low Average	9	Average	5	Borderline
8	Average	8	Average	6	Low Average	89	Low Average	86	Low Average	86	Low Average	10	Average	12	High Average
5	Borderline	1	Extremely Low	3	Extremely Low	58	Extremely Low	72	Bordeline	63	Extremely Low	7	Low Average	6	Low Average
7	Low Average	8	Average	8	Average	83	Low Average	86	Low Average	83	Low Average	10	Average	9	Average
13	High Average	13	High Average	15	Superior	106	Average	124	High Average	115	High average	13	High Average	11	Average
5	Borderline	1	Extremely Low	3	Extremely Low	58	Extremely Low	72	Bordeline	63	Extremely Low	7	Low Average	6	Low Average
4	Borderline	7	Low Average	2	Extremely Low	77	Borderline	66	Extremeley Low	70	Borderline	6	Low Average	6	Low Average
12	High Average	12	High Average	9	Average	106	Average	100	Average	104	Average	10	Average	11	Average
7	Low Average	7	Low Average	7	Low Average	79	Borderline	84	Low Average	79	Borderline	9	Average	6	Low Average
7	Low Average	3	Extremely Low	9	Average	83	Low Average	89	Low Average	85	Low Average	13	High Average	8	Average
13	High Average	11	Average	9	Average	98	Average	105	Average	101	Average	18	Very Superior	14	Superior
10	Average	8	Average	11	Average	87	Low Average	101	Average	93	Average	11	Average	13	High Average
7	Low Average	6	Low Average	1	Extremely Low	76	Borderline	70	Bordeline	71	Borderline	9	Average	8	Average
6	Low Average	3	Extremely Low	8	Average	46	Extremely Low	85	Low Average	71	Borderline	7	Low Average	11	Average
6	Low Average	5	Borderline	3	Extremely Low	71	Borderline	72	Bordeline	69	Extremely Low	7	Low Average	6	Low Average
5	Borderline	6	Low Average	1	Extremely Low	72	Borderline	66	Extremeley Low	66	Extremely Low	7	Low Average	6	Low Average
5	Borderline	2	Extremely Low	5	Borderline	58	Extremely Low	76	Bordeline	65	Extremely Low	7	Low Average	7	Low Average
8	Average	4	Borderline	7	Low Average	71	Borderline	88	Low average	77	Borderline	6	Low Average	5	Borderline
7	Low Average	7	Low Average	9	Average	72	Borderline	90	Average	78	Borderline	10	Average	7	Low Average
6	Low Average	8	Average	7	Low Average	86	Low Average	92	Average	178	Low Average	10	Average	10	Average
8	Average	4	Borderline	7	Low Average	71	Borderline	88	Low average	77	Borderline	6	Low Average	5	Borderline
8	Average	7	Low Average	7	Low Average	77	Low Average	88	Average	80	Average	7	Low Average	8	Average
11	Average	9	Average	11	Average	95	Average	108	Average	104	Average	11	Average	16	Superior
8	Average	7	Low Average	7	Low Average	77	Low Average	88	Average	80	Average	7	Low Average	8	Average

INS Completion time		IN Total erros		Towes total achievement score		Towers time per ratio		Towers Move accuracy ratio		Towers rule violations per item ratio	
		6	Low Average								
		11	Average								
				9	Average	14	Superior	6	Low Average	11	Average
9	Average	8	Average	13	High Average	13	High Average	8	Average	6	Low Average
				12	High Average	11	Average	8	Average	9	Average
9	Average	6	Low Average	11	Average	12	High Average	6	Low Average	11	Average
				11	Average	11	Average	9	Average	11	Average
11	Average	2	Extremely Low	13	High Average	14	Superior	6	Low Average	11	Average
				13	High Average	7	Low Average	11	Average	10	Average
				12	High Average	10	Average	9	Average	10	Average
10	Average	3	Extremely Low	11	Average	12	High Average	2	Extremely Low	11	Average
7	Low Average	6	Low Average	11	Average	12	Average	2	Extremely Low	12	Average
				11	Average	11	Average	9	Average	11	Average
6	Low Average	3	Extremely Low	10	Average	13	High Average	1	Extremely Low	11	Average
8	Average	6	Low Average	11	Average	11	Average	4	Borderline	9	Average
6	Low Average	8	Average	10	Average	11	Average	7	Low Average	10	Average
11	Average	8	Average	11	Average	14	Superior	11	Average	11	Average
5	Borderline	1	Extremely Low	7	Low Average	11	Average	7	Low Average	9	Average
17	Very Superior	2	Extremely Low	9	Average	14	Superior	7	Low Average	11	Average
11	Average	17	Very Superior	12	High Average	12	High Average	9	Average	11	Average
5	Borderline	1	Extremely Low	7	Low Average	11	Average	7	Low Average	9	Average
4	Borderline	1	Extremely Low	7	Low Average	8	Average	7	Low Average	1	Extremely Low
12	High Average	8	Average	11	Average	13	High Average	5	Borderline	11	Average
11	Average	5	Borderline	6	Low Average	11	Average	2	Extremely Low	10	Average
11	Average	7	Low Average	11	Average	12	High Average	7	Low Average	10	Average
14	Superior	10	Average	10	Average	13	High Average	6	Low Average	11	Average
12	High Average	11	Average	10	Average	12	High Average	3	Extremely Low	10	Average
9	Average	2	Extremely Low	7	Low Average	11	Average	8	Average	11	Average
11	Average	6	Low Average	8	Average	13	High Average	8	Average	11	Average
4	Borderline	6	Low Average	7	Low Average	11	Average	7	Low Average	11	Average
				11	Average	12	High Average	9	Average	11	Average
7	Low Average	9	Average	8	Average	10	Average	7	Low Average	10	Average
2	Extremely Low	2	Extremely Low	11	Average	10	Average	11	Average	9	Average
10	Average	5	Borderline	9	Average	12	High Average	9	Average	11	Average
9	Average	10	Average	10	Average	10	Average	9	Average	19	Average
2	Extremely Low	2	Extremely Low	11	Average	10	Average	11	Average	9	Average
8	Average	6	Low average	10	Average	6	Low Average	9	Average	10	Average
13	High Average	12	High Average	10	Average	12	High Average	7	Low Average	8	Average
8	Average	6	Low average	10	Average	6	Low Average	9	Average	10	Average