Investigating Organisational Strategies in HIV infection

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ABSTRACT

HIV infection affects numerous cognitive domains, including fine motor coordination, information processing speed, and executive functioning. This study focused on one aspect of executive functioning, organisational strategy (i.e.. the strategy a person employs in order to complete a task efficiently). A group of HIV-positive individuals (*n* = 63*)* and a matched group of HIV-negative individuals (*n* = 63*)* were administered the Rey Complex Figure Test. In addition, there was a subdivision of the HIV-positive group, according to the symptomatic (*n* =15) and asymptomatic (*n* = 48) classification categories. The symptomatic participants exhibited diagnostically-recognised levels of neurocognitive impairment, whereas the asymptomatic did not. Organisational strategy in completing the task was measured by the Rey Complex Figure-Organisational Strategy Score system, which is a quantitative capturing of the quality of the approach taken to the task (P. Anderson, V. Anderson, & Garth, 2001). Results showed no statistically significant between-group difference, with an estimated effect size of 0.09. Further analysis showed, however, that within the HIV-positive group there was a statistically significant difference between symptomatic and asymptomatic individuals. Poor organisational strategies was associated with increased level of impairment. These findings support the social and economic importance of identifying cognitive deficits in HIV-positive individuals in South Africa, especially those that impact on everyday functioning.

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It is an incorrect assumption that all HIV-positive individuals who have not developed full blown AIDS are fully functional. All HIV-positive individuals experience physiological, psychiatric, and neuropsychological deficits. This research will focus on a specific domain, one that falls within the broader category of executive functions: organisational strategy. It will examine whether a deficit in organisational strategy is present in HIV-positive individuals when compared to a sample of HIV-negative individuals.

Most of the research conducted on these neuropsychological deficits has been based on a different strain of the virus from what we have in South Africa. Clade B strain is prevalent in North America and Western Europe (where most published HIV research is conducted), whereas clade C is prevalent in most of the rest of the world, including South Africa (Mattson, Haughey, & Nath, 2005; Nath et al., 2008). The information that we possess about the clinical features of HIV may not be applicable to the other regions due to possible mutations of the virus in the different strains and that may result in different effects on the brain.

HIV in South Africa

HIV affects South Africa economically and socially and only through understanding the disease and its full effects can we expect to devise treatment plans which are manageable and effective. A majority of the world's HIV-positive population is not where the research is conducted, with 70% found in sub-Saharan Africa (Buvé, Bishikwabo-Nsarhaza, & Mutangadura, 2002). Since the outbreak of HIV/AIDS globally, the spread in Africa has been rapid and pervasive. Over 5.54 million people in South Africa are HIV positive, and the illnesses associated with HIV lead to a majority of hospital admissions being AIDS-related conditions (Van der Spuy, 2009). There have been several indications that the demographic strata most affected are young adults, between the ages of 18 and 40, and the previously disadvantaged (Abdool Karim, 2004; Buvé et al., 2002; Van der Spuy, 2009). In fact, HIV in South Africa lopsidedly affects poor, previously disadvantaged individuals (Abdool Karim, 2004).

HIV-Associated Neurocognitive Disorders (HAND)

Neurology of HAND. HIV makes the human body more vulnerable to opportunistic infections, and affects the brain. Specifically, HIV infection affects the central nervous

system by passing through the blood-brain barrier, where it can persist in the system for decades (Anthony & Bell, 2008; Catalan & Burgess, 1996; Ghafouri, Amini, Khalili, & Sawaya, 2006; Kaul & Lipton, 2006). There have been no definitive agreements on the specific brain regions involved in HAND, however, which has led to statements describing HAND as non-region specific (Woods, Moore, Weber, & Igor Grant, 2009). Grant and Heaton (1990) suggest that it is difficult to know the exact brain areas involved because most of the information found is at autopsy, where other opportunistic infections may have affected non-HAND-related brain areas as well. These arguments illustrate the care that is required when attempting to map brain-behaviour correlations in HIV.

There is support for the brain-behaviour mapping argument when taking the basal ganglia as an example. This brain region is strongly associated with fine motor skills, and post-mortem examinations of HIV-positive individuals have shown atrophy in this region, thereby explaining why one of the core deficits of HAND is fine motor dysfunction. Not surprisingly, numerous studies have shown that HIV infection affects cortical and sub-cortical areas, including the frontal cortex, parts of the posterior cortex, the basal ganglia, and the cerebellum (Grant & Heaton, 1990; Kaul & Lipton, 2006; Mapou & Law, 1994; Mattson et al., 2005; Woods et al., 2009).

Reductions in grey and white matter have been found upon autopsy in people with HIV. Cortical atrophy is more generalised in large areas, and demyelation is in smaller patches (Grant & Heaton, 1990). The deterioration in volume of the brain structures involved is progressive, and correlations are repeated with a decrease in cognitive functioning over time (Ghafouri et al., 2006). The most consistent brain-behaviour findings in HAND are associated with white matter loss (Woods et al., 2009). A link can be posited between the loss of white matter, which plays an important role in brain communications, and relative spread of atrophy. Using the basal ganglia as an illustration, the disruption of the connections between the basal ganglia and the frontal cortex has an impact on the individual's fine motor functioning.

Classifications. The HAND classification was devised based on clinical symptoms found during research. The diagnostic criteria focus on neurocognitive deficits, due to the inconsistency found in the presentation of affective and motor symptoms. The HIV Neurobehavioral Research Center (HNRC) found three categories of differing severity, each with specific directions on the degree of neurocognitive impairments required for a person to fall within a category. The categories are HIV-associated asymptomatic neurocognitive impairment (ANI), HIV-1-associated mild neurocognitive disorder (MND), and HIV-1-

associated dementia (HAD) (Antinori et al., 2007). The full diagnostic criteria can be seen Appendix A.

Assessment of HAND is determined by measuring at least five areas of neurocognitive functioning which are known to be affected by HIV infection (Woods et al., 2009). Two main screening tests have been used over the years to screen for neurocognitive impairment in HIV-positive populations: the International HIV Dementia Scale (IHDS: Sacktor et al., 2005) and the Mini-Mental State Exam (MMSE: Folstein, 1983). These tests have few tasks, therefore allowing them to be administered bedside. They are screening tools because they simply aim to give a general idea of whether further investigation is required.

Asymptomatic and symptomatic individuals. Another way to classify HIV-positive individuals is to divide them into AIDS, symptomatic and asymptomatic categories devised by the Center for Disease Control (CDC) in 1993 (as cited in Reger, Welsh, Razani, Martin, & Boone, 2002). Individuals classified with AIDS have an opportunistic infection usually defined in AIDS; whilst symptomatic individuals have serious illness that is not usually defined in AIDS (Reger et al., 2002). Asymptomatic individuals do not have a serious illness. The term illness can be spread to include neurocognitive impairment, in that symptomatic individuals are those that have neurocognitive deficits, whereas asymptomatic individuals are not diagnosed with neurocognitive deficits. These stages show a temporal progression with the disease, with asymptomatic individuals usually being in earlier stages of HIV than symptomatic individuals are.

Most of the HIV research has shown greater neurocognitive impairment in the later stages of HIV, but there is disagreement about whether some impairment is present in the earlier, asymptomatic stages (Baldewicz, 2004; Reger et al., 2002). In studies where impairment was found, there was a wide range of neurocognitive domains in which deficits were present, including speed of information processing, attention and psychomotor skills. However, these deficits had very small effect sizes. There is a suggestion that the sub-cortical areas are the first to be affected in HIV infection, therefore resulting in the presence of greater psychomotor skills in the early stages of the disease, whereas executive function deficits occur later on (Baldewicz, 2004).

Neurocognitive impairment is associated with HIV infection, in that neurocognitive impairment increases with disease progression (Baldewicz, 2004). It is important to identify progressive impairment as it impacts daily functioning and quality of life.

Executive Functions

Executive functions are processes in human cognition that control and integrate other aspects of cognition, and that are used to adapt to a range of environmental changes and demands. They have an influence on cognitive, emotional, and motor functioning, leading some to argue that they should not be viewed as a single entity (Andrewes, 2002).

Executive functions do not have a single function or component; the term encapsulates a variety of abilities such as forming goals with long term consequences in mind, having multiple response alternatives, choosing and initiating goal-directed behaviours, being able to monitor the social appropriateness of one's own behaviours, being able to change behaviours when conditions change, and continuing with an activity in the presence of distractions (Andrewes, 2002; Baddeley, 1998; Bryan & Luszcz, 2000; Duff, Schoenberg, Scott, & Adams, 2005; Snyder, Nussbaum, & Robins, 2006).

Executive functions have been associated with the prefrontal cortex in particular, although there is no simple functional relationship, with some prefrontal cortex damage not resulting in executive function impairment. Neurologic and psychiatric patients with executive dysfunction hint at the importance of executive functions in everyday functioning, as well as in other cognitive domains (Duff et al., 2005).

Importance of organisational strategy. Organisational strategies are those a person employs in order to complete a task; therefore, they fall under the umbrella of executive functions. Organisational strategies are used to organise random stimuli into clusters of information which are meaningful, thereby impacting the approach taken when attempting to solve a problem (Shin, Sun-Young Park, Se-Ran Park, Seol, & Kwon, 2006). We use organisational strategies from a young age, using more abstract, conceptual strategies with development. Advanced conceptual strategies involve looking at a problem as a whole and then breaking it down into sub-goals that are more manageable, whereas more piecemeal approaches involve looking at each aspect individually without considering the bigger picture (P. Anderson, V. Anderson, & Garth, 2001; Delaney, Ericsson, & Knowles, 2004).

However, the use of strategies is not a linear process, and even with the skills available to use a conceptual strategy when faced with a new task, some people may revert to the more piecemeal approaches (P. Anderson et al., 2001; Delaney et al., 2004). Anderson et al. (2001) argue that this trend depends on the task requirements; for example, when building a house the foundations have to be complete before starting on the walls. Some tasks require a step-by-step approach, but even in these approaches, there is a sense of overall organisation towards a specific goal. In the context of HIV-positive individuals in South Africa, identifying declines in organisational strategy is important at levels beyond the individual.

For example, impairments in organisational skills may leave many people of working age unable to perform their jobs at optimal levels.

Using the Rey Complex Figure-Organisational Strategy Score. The Rey Complex Figure (RCF) test was originally devised to assess the perceptual organisation and visual memory abilities (Lezak, 2004). Now the test is used to assess attention, concentration, visuospatial attention, visuomotor functioning, and planning and organising abilities (Strauss, Sherman, & Spreen, 2006). The RCF comprises of a figure (rectangle with multiple elements inside and outside of the main rectangle). The test consists of three tasks, a copy task, 3-minute delay, and 30-minute delay, in which the participant attempts to reconstruct the figure on a piece of paper. The RCF is therefore a complex cognitive task, and it can be used to examine the ability of the test-taker to organise the figure into a meaningful reproduction. The figure drawn reflects how the individual perceives the RCF, especially in the copy condition.

Quantitative scoring systems are the most popular ways to score the RCF used in clinical and research settings (Hamby, Wilkins, & Barry, 1993; Lezak, 2004). However, despite its popularity it is unable to access the qualitative aspects of organisational abilities and other executive functions (Shin et al., 2006). Quantifying the qualitative aspects of behaviours allows for using psychometrically sound measures that tap into the processes behind behaviour rather than just the product (Poreh, 2000).

Researchers have developed various qualitative scoring systems for the RCF, each of them attempting to take note of the process used when drawing the figure (Hamby et al., 1993; Ruffolo, Javorsky, Tremont, Westervelt, & Stern, 2001). Examples of qualitative scoring systems include the Boston Qualitative Scoring System (BQSS: Stern et al., 1994) and the Rey Complex Figure Organisational Strategy Score (RCF-OSS: P. Anderson et al., 2001). Using different colours at timed intervals to indicate the order in which the different elements of the figure were drawn, the patient's strategy is identifiable.

Anderson et al (2001) developed the RCF-OSS for children and pre-adolescents. The RCF-OSS is a 7-point scoring system based on a 5-point scoring system devised by Hamby et al (1993). Anderson et al. found that successful completion of the RCF relied on planning and organisational skills. However, because motor and coordination skills have an undue influence on quantitative accuracy-based scoring systems, these traditional scoring systems are unable to tease out the organisational strategies employed. Even though this test was constructed with a paediatric population in mind, it is applicable to adult populations in that

the conceptual strategies identified are thought to stabilise after adolescence and into early adulthood (P. Anderson et al., 2001; Lezak, 2004).

In constructing the RCF-OSS, Anderson et al. (2001) identified seven levels of the conceptual strategies, based on organisation, commonly utilised when completing the RCF. The most basic level exhibits no attempt to draw the figure so that what is drawn is unrecognisable. The second and third levels feature poor organisation and random organisation, respectively. In these levels, there has been some attempt to draw the figure, with drawings at the third level exhibiting at least one configural element. The fourth level indicates that a piecemeal approach was adopted. This kind of approach differs from all the rest in that the difference elements are drawn individually, in an organised manner, but the whole gestalt is not captured. There is an inability to process all the information in the figure so it is broken up into smaller visual units (Lezak, 2004; Yudofsky, Hales, & Publishing, 2008). It has been suggested that a piecemeal approach may indicate some right-sided deficits. The fifth to seventh levels have the main configural elements drawn early, with the most advanced strategy of excellent organisation having them drawn before any other part of the figure (P. Anderson et al., 2001). Scoring criteria for each level is explained in more detail in Appendix B.

The first attempt to use an RCF qualitative scoring system to differentiate between HIV-positive individuals and HIV-negative individuals was Hamby et al (1993). Their scoring system focused on the strategy employed when copying the figure, as opposed to the accuracy-based scoring of other systems. They were not the first to use a qualitative scoring system, but they did what other qualitative scoring systems failed to do; that is, to achieve some form of construct validity. In their study, they were able to separate asymptomatic and symptomatic individuals; with the symptomatic group using significantly poorer strategies than the asymptomatic group.

Specific Aims and Hypotheses

There is little clinical neuropsychological data in South Africa which can be used to interpret and inform the data collected during research, thus further studies are required in order to see the effects of HIV clade C infection in an appropriate context. No test is culture-free, not even non-verbal tests, and it is important to consider this fact when utilising a test or scoring system constructed using a population from a different culture (Rosselli & Ardila, 2003). For example, accurate reproductions of a geometric picture such as the RCF require certain skills that are valued in the Western culture, but that might not be valued in other

cultures. In order to draw population-relevant conclusions it is best, when operating in developing-world contexts, to compare the scores of the target population against scores of individuals from similar demographic backgrounds, including age, gender and education.

This study aimed to develop understanding of executive functions in HIV infection in South Africa. The focus was on organisational strategy. Investigating organisational strategy in HIV-positive individuals required a comparison with a control group of HIV-negative individuals. I hypothesised that participants in the HIV-positive group would exhibit poorer organisational strategies than those in the HIV-negative group. Furthermore, I hypothesised that within the HIV-positive group there would be poorer organisation in those with more symptomatic presentation.

METHODS

Research Design and Setting

This study was a cross-sectional comparison of two groups: an HIV-positive group and an HIV-negative group. Furthermore, the HIV-positive group was subdivided into a symptomatic and an asymptomatic group according to their level of impairment, based on a global *z*-score which was used as a proxy for HAND diagnosis. Studies have shown that global screening tests, such as the IHDS and the MMSE, are not useful as diagnostic tools because they are not sensitive to the milder forms of HAND. Grant and Heaton (1990) suggest the use of specific neuropsychological tests in order to differentiate between the different types of HAND. I followed this suggestion in the current study.

The global *z*-score was derived from patient scores on a battery of 15 neuropsychological tests that assessed motor functions, learning and memory, attention, executive functions, information processing speed, and language. It was established by comparing each HIV-positive participant's score against the mean of the HIV-negative group on each measure, and then dividing the sum of those *z*-scores by 15 to get an average (global) *z*-score.

Testing took place at the Department of Psychiatry and Mental Health at Groote Schuur Hospital. Testing rooms were free from all outside distractions.

Participants

This study formed part of an ongoing research project whose aims were to establish norms on neuropsychological tests and explore neurocognitive deficits in HIV infection. I was granted permission to access and score the participant data dating back to 2008.

There were 126 participants in the final sample, all of whom were selected randomly from those who had taken part in the broader research project. There were 63 participants in the HIV-positive group and 63 in the HIV-negative group. Participants were recruited from three community clinics in the Western Cape. Within the HIV-positive group, participants with a *z*-score greater than -1.00 were assigned to the asymptomatic group ($n = 48$) and those with less than -1.00 were assigned to the symptomatic group ($n = 15$). The cut-off point was set at 1 standard deviation (SD) because it is at this point that the HAND diagnostic criteria recognise the presence of neurocognitive deficits (Antinori et al., 2007; Woods et al., 2009). Considering this criterion, and with the division between the symptomatic and asymptomatic categories being the presence of serious illness, the standard of 1 SD as a proxy for serious illness, or neurocognitive impairment, becomes applicable. The basic demographic characteristics of the HIV-positive and the HIV-negative groups are displayed in Table 1.

Table 1
Demographic Characteristics of the Current Sample

Variable	HIV-positive	HIV-negative	t/X^2	*p*	ESE
Age					
Mean (SD)	28.89 (3.82)	24.19 (5.30)	5.71	< .001***	1.02[a]
Education					
Mean(SD)	10.21 (1.49)	10.92	-2.83	.005**	-0.5[a]
Sex					
(female : male)	47:16	42:21	0.957	.33	0.09[b]

Note: ESE = estimate of effect size.
[a]Estimate of effect size using Cohen's *d*.
[b]Estimate of effect size using Cramer's V.
* p < .05; ** p < .01, *** p < .001

Exclusion criteria. The two groups had similar sets of exclusion criteria with some differences. There were basic exclusion criteria of uncorrected hearing loss, uncorrected visual impairment, colour-blindness and disability in the upper extremities that would affect motor performance. Participants in both conditions who abused alcohol or other psychoactive substance within the preceding three months and had an uncontrolled medical condition, for example poorly controlled diabetes mellitus and epilepsy, were excluded from the study. Participants with schizophrenia or bipolar disorder were also excluded from the study.

Potential participants in the HIV-positive group with a contra-indication to Magnetic Resonance Imaging (MRI), such as pregnancy, metal within them, or claustrophobia, and those who refused to sign the consent form were not included. In addition, the presence of an identified central nervous system neurological condition (e.g. lymphoma, or untreated neuro-syphilis or crytococcal infection) resulted in exclusion from the study, although if it was

deemed that the neurological condition was fully treated the participant was eligible for inclusion. Furthermore, and those who had a history of head injury that resulted in a loss of consciousness for more than 30 minutes or required overnight admission to a hospital were excluded from the study.

Similarly, in the HIV-negative group a history of head injury that resulted in a loss of consciousness of at least 5 minutes or a hospital admission of more than 24 hours. Brain surgery, Alzheimer's dementia, Parkinson's disease, stroke, and seeing a professional for memory or thinking problems also resulted in exclusion from the study. HIV-negative participants taking antidepressant, anti-anxiety and antipsychotic medications as well as electroconvulsive treatment were not included in the study. Participants with common psychiatric diagnoses (e.g. Huntington's chorea, encephalitis, and multiple sclerosis) were also excluded from the study.

Measures

Rey Complex Figure. The RCF copy condition has high internal reliability, as well as inter- and intra-rater reliability. There is a modest correlation between the RCF and other measures of visual-constructional abilities, such as the relevant subtests of the Wechsler Intelligence Test, showing divergent validity (Strauss et al., 2006). Like other neuropsychological tests, there are no RCF norms for South Africa, although the test is commonly used in South African clinical neuropsychological practice and in South African-based research studies (Skuy, Schutte, Fridjhon, & O'Carroll, 2001).

Procedure

The RCF was a part of a neuropsychological battery. The copy task had a 5 minute time limit during which administrator gave the participants a different coloured pencil every 30 seconds until the participant felt they had completed the drawing, thereby allowing for an identification of the order in which the components of the complex figure were drawn.

Upon arrival for testing, participants completed an informed consent form in their preferred language (English, Xhosa, or Afrikaans). There was a provision of monetary compensation to participants for their transport costs from the hospital back to their homes, even to those excluded at the first step. The amount varied between excluded and included participants. Testing took place over one session in a quiet, isolated room. The session lasted approximately 5 hours, depending on the speed which the participant performed the tasks. Participants could indicate at any time if they wanted to take a break, and the administrator offered breaks as well. To avoid any language effects on test results, the participants were

able to choose at the beginning of the session what language they preferred to be tested in (Afrikaans, English, or Xhosa), and that language was used throughout the session.

Retrospective scoring was performed on the data. A detailed description of the elements drawn with each colour pencil was recorded, in order to tease out the order in which the elements were drawn, and at which point.

Statistical Analysis

An initial investigation of the descriptive statistics allowed for consideration of the different group characteristics on the RCF-OSS, and the underlying assumptions of parametric statistical tests were examined. The statistical analyses were all performed using SPSS version 18, and alpha was set at .05 for all statistically significant decisions. Due to this study falling within a larger research project that was attempting to establish norms for the target population, the control group for this study was the HIV-negative group. The administration of the RCF has three conditions, but for the purposes of the study, I will not use the data collected from the recall drawings.

An independent samples *t*-test was run for the between-group analysis (between HIV-positive and HIV-negative groups), whilst a Mann-Whitney *U* test was used for the within-group analysis (between the asymptomatic and the symptomatic groups) due to the unequal sample sizes. Furthermore, an independent samples *t*-test was run on the RCF-Copy, comparing the HIV-positive and HIV-negative groups. This test, as well as a correlational analysis between the RCF-Copy and the RCF-OSS, was run for validity purposes. For the correlational analysis, the HIV-positive and HIV-negative scores were collapsed into one condition.

A hierarchical regression was run on the data to explore the amount of total variance each demographic difference explained, with the RCF-OSS as an outcome. The predictor variables were entered into the model individually, with age entered first followed by education and then sex. This was because age had the most certain effect on RCF performance in previous literature, although the differences between adults are usually found when using adults older than 60 years for comparison (Ettenhofer, Hambrick, & Abeles, 2006; Strauss et al., 2006; Troyer & Wishart, 1997). The influence of education and sex are debatable, but education was entered first into the model due to its relative impact with age on performance in some cases (Strauss et al., 2006).

RESULTS

The RCF-OSS was piloted for inter-rater reliability, with a small sample (n = 20) randomly selected and evaluated by two raters (my co-supervisor and I). High inter-rater reliability was found (r = .89, r^2 = .80).

Between-Groups Analysis: HIV-positive versus HIV-negative

This analysis compared the organisational strategy performance of the HIV-positive group and the HIV-negative group on the RCF-OSS using an independent samples t-test. Furthermore, an independent samples *t*-test was run using performance on the RCF copy task as judged by the conventional scoring system as the outcome variable. Finally, I ran a correlational analysis of the RCF-Copy and the RCF-OSS scores. The correlational analysis was used to show that RCF-OSS is measuring similar RCF performance aspects to the quantitative scoring task, but still tapping into something that the RCF-Copy score does not. Table 2 displays the results of between-group *t*-test analyses.

Table 2
Between-Group t-Test Analyses

Measure	HIV-positive		HIV-negative		*t*	*p*	ESE[a]
	Mean	SD	Mean	SD			
RCF-OSS	5.08	1.15	5.19	1.23	-0.52	.60	-0.09
RCF-Copy	28.34	7.70	32.53	4.28	-3.77	< .001***	-0.67

Note: ESE = Estimate of effect size, which was Cohen's *d*.
*** p < .001

The table shows that there were no statistically significant between-group differences on the performance on the RCF-OSS. These results suggest that participants in the HIV-positive group and those in the HIV-negative group used similar organisational strategies when completing the RCF-Copy task. However, there is a statistically significant difference on the quantitative measure of the RCF-Copy, indicating that participants in the HIV-positive group reproduced the RCF significantly less accurately than participants in the HIV-negative group did. The very small effect size on the RCF-OSS indicates that the lack of between-group significance is not likely to change with a slightly bigger sample size. The RCF-Copy analysis was associated with a large effect size, suggesting that the difference was not inflated due to the larger range of scores available in the small sample size.

The correlational analysis performed on the data showed a statistically significant moderate correlation between RCF-OSS scores (M = 5.14, SD = 1.19) and RCF-Copy scores

($M = 40.44$, $SD = 6.554$), $r = .43$, $p < .001$. The positive relationship suggests that higher RCF-Copy scores are likely to associate with higher RCF-OSS scores, although the small effect size ($r^2 = .19$) and modest size of the correlation suggest that the scores will not necessarily follow this pattern in most cases.

Further investigation of the RCF-OSS and the possibility of demographic data loading onto RCF-OSS performance and impacting the results lent itself to a hierarchical regression. The resulting model collapsed the HIV-positive and HIV-negative groups into a single outcome of RCF-OSS because of the groups not being statistically equivalent on the measures of age and education. The HIV-positive group was significantly older and had less education than the HIV-negative group (Table 1). For the analysis, each variable was entered into the model separately, beginning with HIV status and then followed by age, education and sex. The resulting model is presented in Table 3.

Table 3.
Hierarchical Regressional Analysis: Demographic Data and RCF-OSS Scores.

Model	β	t	p
Step 1			
Constant		14.79	< .001***
HIV Status	.05	0.52	.60
Step 2			
Constant		7.76	< .001***
HIV Status	-.04	-0.44	.66
Age	-.20	-1.99	.05*
Step 3			
Constant		5.21	< .001***
HIV Status	-.05	-0.54	.59
Age	-.19	-1.91	.06
Education	.06	0.60	.54
Step 4			
Constant		4.74	< .001***
HIV Status	-.07	-0.68	.50
Age	-.20	-1.98	.05*
Education	.07	0.74	.46
Sex	.10	1.05	.30

R^2 in Step 1 = .002
R^2 change in Step 2 = .031
R^2 change in Step 3 = .003
R^2 change in Step 4 = .009

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

This analysis indicates that age added a statistically significant contribution to the explanation of the variance, 3.1%. This result might point to age having an effect on the

organisational strategy used by people. The other demographic variables, gender and education, each contributed less than 1% to the variance, thereby suggesting that they have no marked impact on RCF-OSS scores.

Between-Group Analysis: Symptomatic versus Asymptomatic

The global *z*-score data had unequal sample sizes, thus requiring a non-parametric test to be run. A Mann-Whitney *U* test was performed on the data, comparing the performance of the asymptomatic and symptomatic groups on the RCF-OSS. Table 4 displays the demographic data.

Table 4
Demographic details of HIV-positive group

Variable	Symptomatic (n = 15)	Asymptomatic (n = 48)	t/X^2	p	ESE
Age					
Mean (SD)	31.33 (3.09)	28.13 (3.73)	-3.02	.004**	0.89[a]
Education					
Mean(SD)	9.47 (1.51)	10.44 (1.43)	2.27	.03*	-0.67[a]
Sex					
(*female:male)*	9:6	38:10	2.216	.14	0.19[b]

Note: ESE = estimate of effect size.
[a]Estimate of effect size using Cohen's *d.*
[b]Estimate of effect size using Cramer's V.
* p < .05; ** p < .01, *** p < .001

The results showed that the symptomatic group (M = 4.5, SD = 0.85) performed statistically significantly more poorly than the asymptomatic group (M = 5.25, SD = 1.18), p < .001. The symptomatic group employed poorer organisational strategies than the asymptomatic group when copying the RCF. There was a large effect size of d = 0.67.

DISCUSSION

The results of this study do not support the first hypothesis, that there would be a significant difference between the HIV-positive and the HIV-negative group in terms of organisational strategy. The second hypothesis, that there would be a significant difference in organisational strategy between the asymptomatic and the symptomatic groups of the HIV-positive participants, was strongly supported by the data. The latter data suggest that organisational strategies are poorer with higher levels of neurocognitive impairment, and by extension with greater severity of HAND status.

Organisational Strategies in HIV

The lack of a significant difference between the HIV-positive and the HIV-negative groups poses a number of questions, the first being of the sampling. The participants' data were randomly selected from a database in which 23.5% of participants were diagnosed with HAND (Joska, Fincham, Stein, Paul, & Seedat, 2010). Neurocognitive deficits usually appear in the later stages of disease progression, and considering the selection process, it may have been possible that most of the participants included in the HIV-positive group were in the early stages of HIV-infection (Carey et al., 2004). Given that the HIV-positive group consisted of only 15 participants whose score fell more than 1SD below the mean of the control or norm group, it is possible that the RCF-Copy results indicate subtle deficits (Nath et al., 2008).

Differentiating asymptomatic individuals who show subtle signs of cognitive deficits from HIV-negative controls is sometimes near impossible (Igor Grant & Robert K. Heaton, 1990). In the asymptomatic stage, there may be neurocognitive impairment in some domains, but it has not reached the levels warranting a HAND diagnosis (Mapou & Law, 1994). It is important to consider the existence of a group of individuals within the HIV-positive population that do not meet the criteria for a HAND diagnosis, but still have some degree of neurocognitive impairment. An illustration of this point is the individuals with global *z*-scores that fell between 0 and -1.00. These individuals do not fall under any definitions of HIV-related neurocognitive deficits, but the RCF-Copy results show that they perform significantly more poorly on some tasks, suggesting some level of impairment. Asymptomatic individuals making up the majority in the HIV-positive group may suppress any differences between the minority of symptomatic individuals and the HIV-negative group.

The analysis within the HIV-positive group reflects this point, in that there was a statistically significant difference in performance between the asymptomatic and symptomatic participants. The term asymptomatic is a misnomer because there was a degree of neurocognitive impairment; however, it did not fall within the diagnostic parameters set up by the HNRC for HAND. It is important to acknowledge the presence of neurocognitive impairment at all stages of HIV-infection, especially when those deficits are subtle.

The cognitive deficits associated with HIV can cause a significant interruption in important aspects of daily living, and thus early detection is very important. For example, the subtle finger contraction difficulties often present in HIV can be exacerbated when they have more demand for processing placed upon them, such as when operating complex machinery

at work. There can also be an impact on the more mundane everyday activities such as deficits in free recall which can be troublesome when grocery shopping without a list, and remembering to adhere to medication regiments (Gongvatana et al., 2007; Gorman, Foley, Ettenhofer, Hinkin, & Gorp, 2009; Morgan et al., 2009).

This study replicated the findings of Hamby et al. (1993) regarding organisational strategies being employed by symptomatic and asymptomatic individuals. Executive functions are normally affected in the later stages of most neurocognitive disorders, and the stages of neurocognitive disorders are associated with the increasing degrees of impairment found in individuals (Bryan & Luszcz, 2000; Woods et al., 2009). In this study, the same can be posited for HIV-infection, where the clinical population was able to be discriminated from the non-clinical.[1]

The second question relates to the RCF-OSS scoring system itself and whether it was measuring what it purported to be. The RCF-OSS was devised for a paediatric population and that may have influenced the data (P. Anderson et al., 2001; Lezak, 2004). People use more conceptual strategies from their late teens, suggesting that perhaps the RCF-OSS is not able to differentiate between differences in strategy among adults. However, when people are faced with novel tasks, the requirements of the task determine what kinds of strategies are utilised, so less complex tasks can be completed efficiently with a piece-meal approach(P. Anderson et al., 2001). This then suggests that the RCF-OSS can be applicable to adults as well (Lezak, 2004).

The correlational analysis between the RCF-OSS and the RCF-Copy also addresses the issue of the validity of the RCF-OSS. A moderate but significant correlation was found between the two scoring systems, suggesting that the two measures tap into some of the same abilities. However, because it is not a perfect correlation it suggests that the RCF-OSS is measuring something that the RCF-Copy was not. The convergent validity assumed from this result indicates that the RCF-OSS is measuring a distinct neurocognitive ability over and above what the RCF-Copy quantitative score measures.

The analysis of the RCF-Copy quantitative score as an outcome and HIV status as a predictor produced significant results indicating that HIV-negative individuals perform better

[1] I use the term clinical to refer to individuals who exhibit diagnostically-recognised deficits associated with a disorder.

on this measure than HIV-positive individuals. This piece of data seems to suggest that there is a level of cognitive impairment in the HIV-positive group, even though the between-group analysis on the RCF-OSS did not indicate the presence of deficits. The question then arises of why is it that the RCF-OSS was not able to detect deficits when the RCF-Copy did.

Executive functions may influence other domains of functioning, but they can remain relatively intact while there is a deficit in the affected domain (Snyder et al., 2006). This means that poor performance on a task that relies on executive functions for successful completion may be because of impairment in other neurocognitive abilities. This result highlights the possibility of deficits in visual perception and construction in the HIV-positive group, even with intact organisational abilities. This is plausible when taking into account that for a level-7 score on the RCF-OSS the rectangle and the midlines must be drawn first. Following this, all the outside and internal elements that are present need to be aligned with the midlines; so a drawing without all 18 elements could score poorly on the RCF-Copy, but highly on the RCF-OSS if the configural elements are present, therefore a conceptual strategy will not always lead to an accurate copy of the RCF. Support for the presence of other neurocognitive deficits is evidenced by the global *z*-scores which showed deviations from the norm.

Further analysis showed age as a contributing factor to RCF performance, with younger participants performing better than older ones. This pattern of data is supported in the literature (Ettenhofer et al., 2006; Strauss et al., 2006; Troyer & Wishart, 1997). Performance on the RCF tends to drop as part of normal age-related cognitive impairment, but this is commonly in older adults (i.e. those over the age of 60) and not in those in their mid-20s to early-30s (Bryan & Luszcz, 2000). The neurocognitive impairment suggested in HIV-infection could have played a part in the early onset of deficits that would naturally occur in the aging population. The results of this study indicate that the age-related difference may be more due to the presence of neurocognitive impairment than age, with age only adding 3.1% to the explanation of the variance between the groups' organisation strategies.

In contrast, there have been arguments that the age effect in the organisational quality of the RCF is the other way round: older adults use more effective organisational strategies more than young people do when they complete the RCF (Hartman & Potter, 1998). This finding should act as a caveat when interpreting age-related effects on organisational strategies. Further examination of Hartman and Potter's argument shows that they used a different scoring system: the Boston Qualitative Scoring System (BQSS). Proponents of this system recognise the sensitivity of this system to identifying mild neurocognitive

impairments, but the BQSS may not be as psychometrically sound as the RCF-OSS. The BQSS is a widely used method of qualitative scoring and has been found to be sensitive to differentiating clinical and non-clinical populations, but its divergent validity with non-executive tasks has not been fully explored (Boone, 2000; Hartman & Potter, 1998).The BQSS has low inter-rater reliability in some of its scores (Boone, 2000; Liberman, Stewart, Seines, & Gordon, 1994). The psychometric properties of the BQSS could be due to the multi-faceted nature of the scoring system, designed to access many domains, such as perseveration, organisation, planning and fragmenting, also making it more time consuming to administer than the RCF-OSS.

Despite Hartman and Potter (1998) findings acting as a caveat when interpreting the findings of the current study, it should be noted again that the age-related effects could be due to the neurocognitive impairment associated with HIV infection as opposed to a simple age-impairment relationship. It is not only the age-impairment relationship that should not be viewed as simple. Organisational strategy deficits vary according to the pathology of the individual in terms of the kinds of errors made. For example, people with frontal lesions can leave out important elements or include additional items (P. Anderson et al., 2001). Understanding the types of errors made when planning behaviour can aid in developing rehabilitation regimes, and possibly lessen the impact of the milder cognitive impairments on everyday functioning.

There has not been much research conducted on the neuropsychological deficits associated with HIV in South Africa (Joska et al., 2010; Joska et al., 2010). This type of research is useful for public health policy choices as well as clinical purposes. When considering public health policy, a more in depth understanding of HIV can lead to more effective treatment programs and interventions. Clinically, because most of the people affected by the disease have a low socioeconomic status, any deficits that impair their ability to work and earn money for their household will affect the family as well as the individual. Accurate identification of deficits can also aid in rehabilitation and deficit management.

A study in India where clade C is prevalent, showed some similarities in the presentation of symptoms between clade C and clade B infection, thereby perhaps giving less weight to the different-clade argument (Das Gupta et al., 2007). However, this study relied upon an Indian population, using Indian population norms, which may or may not be applicable to the South African population. The published norms for testing cannot apply in all populations due to demographic differences between populations, such as culture, education and age to name a few examples (Singh et al., 2010). Neuropsychological

assessment is vital for diagnosis and rehabilitation, and it is crucial to apply the appropriate norms relevant to the person being tested. Age relative to education is an important factor in test performance, thus making it near impossible to compare populations with different characteristics (Skuy et al., 2001).

Limitations and Directions for Future Research

Due to the nature of the larger research project within which this one was nested, I had to score the data retrospectively, which is a more difficult task than if I had scored the reproductions as they were being drawn by participants (P. Anderson et al., 2001). In the cases where the multiple lines drawn with one colour were the configural elements, it was easy to make a decision regarding what score to assign. However, when the diagonals and the midlines were drawn in the same colour, a benefit-of-the-doubt judgement had to be made. Although some of the scoring was based on subjective judgement, the inter-rater reliability shows that these judgements did not bias the results unduly. It would be interesting for future research to replicate the study with live scoring (i.e. a stroke-by-stroke recording of participants drawing the figure).

The results of this study cannot be generalised too widely due firstly to the relatively small sample size and secondly to the nature of what was investigated. True population norms require samples of more than 1000 participants, which are very costly and need many years in order to compile all of the data (Singh et al., 2010). This study only had 126 participants, and 63 of them were in the control group. This means that the results of this study may not be applicable to all HIV-positive individuals with neurocognitive impairment. A recommendation for future research would be to accumulate enough data to establish true population norms using the RCF-OSS, thereby allowing for replications of this study to be generalised broadly.

Secondly, care needs to be taken when generalising these results due to the lack of ecological validity associated with executive function tasks (Norris & Tate, 2000). There is doubt as to whether the results obtained in an artificial laboratory setting can translate to the real world, especially with executive functions, which play a role in everyday functioning. Traditional executive functioning tasks are impure in the sense that they do not test for any single function. There is a large amount of overlap in task requirements in some tasks due to the difficulty in separating executive and non-executive components of the tasks (Bryan & Luszcz, 2000; Duff et al., 2005; Miyake et al., 2000). This study has tried to elucidate organisational strategies from other neurocognitive deficits associated with HIV infection

using the RCF, but no definitive statements could be made regarding their exact nature. Future research could attempt to investigate organisational strategies in more natural settings, such as while doing everyday tasks.

Summary and Conclusions

This study aimed to investigate organisational strategies in HIV-infection in South Africa. Asymptomatic individuals employed better strategies than symptomatic individuals, which suggested that organisational strategy deficits begin to show when there is greater neurocognitive impairment.

The RCF showed itself to be a sensitive tool to non-organisational strategy deficits when using the traditional quantitative RCF-Copy scoring system, and comparing it with that of the RCF-OSS. The lack of differences between the groups on RCF-OSS performance contrasted with the presence of a difference on quantitative RCF-Copy performance paints an interesting picture. There are indications that non-organisational deficits are present in the HIV-positive group. The different scoring systems were compared to investigate further, and a moderate relationship between them suggested that although the two scoring systems measure some of the same aspects, they also tap into different abilities.

Executive dysfunction has been associated with greater levels of neurocognitive impairment, which was illustrated in the symptomatic group when compared with the asymptomatic group. These findings have implications for South Africa, looking at future public health policies, as well as with regards to rehabilitation programs. Due to the demographic nature of HIV prevalence in South Africa, the majority are living in poverty; the impact of deficits in organisational strategies takes on economical and social undertones. Impairment in everyday functioning, caused by an inability to complete tasks efficiently, has far reaching effects, and the identification and understanding of said impairment can go a long way towards setting up coping strategies.