

Early Signs of Success in the Cognitive Rehabilitation of Children Living with HIV/AIDS in Rural South Africa

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Abstract—Antiretroviral treatment is found to be lacking in its ability to aid improvements in HIV-associated neurocognitive deficits. Despite the fact that a significant portion of South Africa’s population is affected by HIV-infection, no known studies on the potential benefits of cognitive rehabilitation therapy exist for this context. This study used a quasi-experimental research design and sought to provide preliminary findings on the application of a cognitive intervention program (Attention Process Training (APT) to improve attention function in a sample of children living with HIV/AIDS. Three vertically infected HIV-positive children were assigned to eight APT intervention training sessions addressing selective attention. Selective attention measures were taken before and after intervention training, using two subtests of the Test for Everyday Attention in Children (TEA-Ch). Although repeated non-parametric analyses showed non-significant findings for the pre and post scores after the APT intervention ($Z=1.15, p = 0.25$ and $Z = 0.0, p = 1.00$) slight improvement in attention scores was noted. Future recommendations include the need for a control group, a larger sample size, and running the intervention over a longer period of time.

Keywords— HIV, cognitive rehabilitation, TEA-Ch, APT, selective attention.¹

I. Introduction

One of the major difficulties in understanding and adequately treating the HI-virus is the varied ways in which an individuals’ immunological system is affected by the virus. HIV

related problems can range from biological to neurocognitive problems [1]. Research suggests that a considerable number of HIV positive children are affected by neurocognitive disabilities as a result of the virus. Studies also suggest that CNS symptoms present more frequently in HIV positive children living in resource-constrained areas [7]. In children, HIV seems to compromise the brain mostly in two cognitive domains; expressive language and attention [2]. For the purposes of this research, the researcher focused on the latter cognitive function (attention) as this cognitive domain is considered by most to be a primary and germane cognitive domain for further cognitive process to occur [3].

A. Attention

The anatomy of attention is not completely understood, however, some principles regarding the organization of attention have been conceptualized. By definition, according to Malia and Brannagan [3] attention is regarded as the primary modality of cognition and all other “secondary” levels of cognition such as working memory, and information processing are dependent on this system [3] Different distinct attention categories such as focused attention, sustained attention and selective attention have been proposed. This research focused on selective attention, defined as the ability to focus selectively on specific target information whilst disregarding other competing and distracting information [10]. The research specifically sought to study selective attention in a sample of children with HIV/AIDS who are on HAART medication.

II. Review of Literature

HAART and Cognitive Rehabilitation Therapy

While there is no cure for HIV/AIDS, Highly Active Antiretroviral Therapy (HAART) has been used to counteract HIV infection by slowing viral replication, and decreasing the number of contaminated cells flowing into the CNS and

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reducing the progression of neurocognitive dysfunction [4]. However, the literature is replete with studies that indicate that HAART does not improve HIV-related neurocognitive decline [5] [6]. While some studies have suggested that HAART can improve cognition if administered early enough, others maintain that such findings have been inconsistent [1]. Given the fact that HIV-associated neurocognitive difficulties persist regardless of the administration of HAART, adequate treatments procedures that supplement HAART need to be pursued [2]; [3].

A. **Cognitive Rehabilitation Therapy**

Cognitive Rehabilitation Therapy (CRT) is defined as the addressing of, and developing of cognitive skills which have been compromised as a result of neurological trauma [3]. CRT falls into either the category of a restorative or compensatory approach. The restorative approach assumes an improvement in cognitive functions due to more effective neural organization that result from repeated practicing of specific cognitive skills. The compensatory approach assumes improved cognitive functioning as a result of strategies that support damaged cognitive processes [8].

In the only study on pediatric HIV/AIDS cognitive rehabilitation, Boivin and colleagues [5] developed the first African study to explore the benefits of Computerized Cognitive Rehabilitation Therapy (CCRT) in children living with HIV. The sample was made up of vertically-infected HIV positive children with neurocognitive difficulties.

The above participants took part in 10 training sessions over the course of 5 weeks, during which the program addressed attention, visual motor skills, memory and logic. It has since being suggested that more research of this nature is needed in primary school children living with HIV so as to improve their attention skills which may have been compromised as a result of the virus. No such studies exist in the South African context. Our study sought to fill the gap in the South African HIV/AIDS literature and improve attention functioning in children HIV/AIDS.

The second study to be published on cognitive rehabilitation in the HIV population was a study titled ‘SmartBrain in HIV Seropositive and Seronegative adults’ by Becker et al. [11]. This study investigated the efficacy of a neuro-rehabilitation program in 60 adults, of which 30 individuals were HIV-positive adults and 30 participants made up the seronegative comparison group. Participants allocated to the intervention group accessed the SmartBrain program from home-based computer sessions over a period of 24 weeks.

Results for this study indicate that participants who frequently participated in the cognitive rehabilitation exercises experienced the most improvement in cognitive functioning. While the outcome of this research was inconclusive, the results suggest that the program may be more effective in cases of better adherence if used as indicated [11].

III. Methodology

A. **Design**

The aim of the research was to investigate whether HIV vertically infected children show improved selective attention skills following sustained CTR using the APT. The research was a quasi-experimental design consisting of pre- and post-intervention measures. For this project, the intervention (APT) was the independent variable, while the dependent variable was the measured changes in pre-intervention and post-intervention attention scores.

B. **Participants**

6 HIV vertically infected children were identified for the study and only three parents gave consent. All children were selected using convenience sampling technique. Two of the three participants were on antiretroviral therapy drugs (ARVs) at the time of the study. Participants were male and ranged from 10 to 12 years of age ($M = 11$; $SD = 1$). All participants were recruited from a

local primary school in the Eastern Cape, South Africa.

C. Materials

The *Test of Everyday Attention for Children (TEA-Ch)* [9], a well-documented psychometric measure of attention was used to measure selective attention. The *Sky Search* task required children to recognize matching space-ships amongst non-matching space-ships on an A3 size piece of paper, and to indicate matching pairs by circling these with a permanent marker pen. The task had to be completed in the shortest amount of time possible. The second half of this subtest required participants to complete a motor control task, which entailed the circling of matching space-ships with no non-matching space-ships to distract from this task.

For both the *Sky Search* and its motor control, a calculation was made for the time taken per correct target indicated. A Sky Search Attention Score was then calculated by subtracting the motor control result from the *Sky Search* as per the *TEA-Ch* manual (Please see Figure 1 below for example of a participant’s Sky Search Task).

In the *Map Mission* subtest, participants were presented with an A3 sized, full color roadmap and were asked to find as many targets (petrol pumps or knife and fork signs) within one minute. This subtest was timed and correctly identified targets were counted and noted.

The *Attention Process Training (APT)* was utilized as the intervention model to improve selective attention. The *APT* is both a computer program and a manual program designed for use in different contexts [10]. To the knowledge of the researcher, this is the first time that the *APT* has been applied as a rehabilitation tool for an HIV pediatric population.

D. Procedure

Participants were seen individually after school on secure and quiet school premises. Participant pre-test scores on Version A of the *Sky Search* and *Map Mission* were derived. When the pre-testing phase was complete, children were then seen individually and trained for a period of three sessions per week for five weeks on the *APT*. In total eight intervention sessions were conducted with each participant. The *APT* intervention included three tasks varying with different levels of difficulty as per the *APT* manual. The difficulty level of these tasks was adjusted depending on how well or how badly participants managed on each task [10]. Following the 5 week long intervention, post-testing using version B of the *Sky Search* and *Map Mission* subtests was conducted.

IV. Results

Table 1 shows the raw, nonstandardised pre- and post-test means on the selective attention subtest for both *TEA-Ch* subtests (*Sky Search* : $M = 21.68$; $M = 8.62$; *Map Mission*: $M = 29.67$; $M = 25.33$). Figure 2 shows the Box Plot of the data.

Table 1

	Pre-Test	Post Test		
	M (SD)	M (SD)	Z	Sig
Sky Search	21.68 (14.82)	8.62 (3.79)	1.15	.25
Map Mission	29.67 (13.61)	25.33 (11.02)	0.00	1.00

Note. An Alpha level of 0.05 for all statistical tests was used.

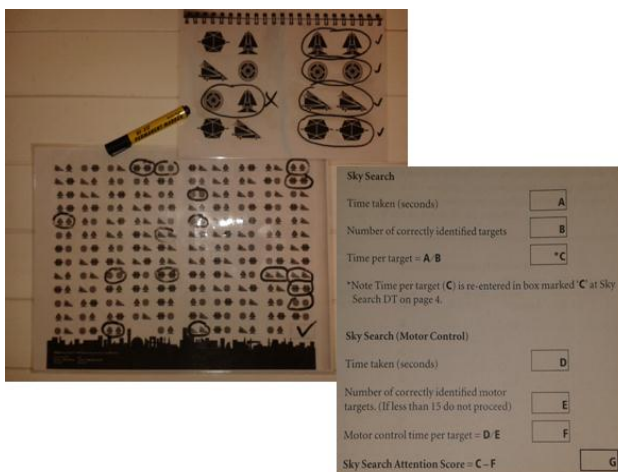


Figure 1. Example of a participant’s Sky Search Task.

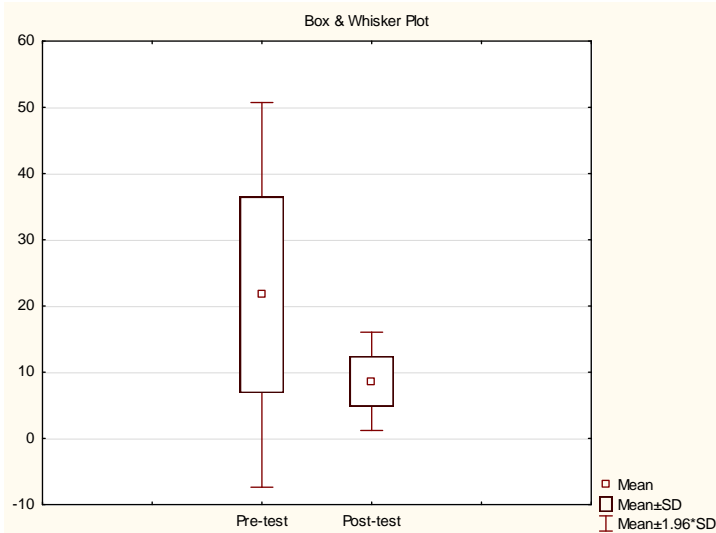


Figure 2. Box Plot of Sky Search Attention Scores (Pre- and Post-Test)

Using the means scores on the *Sky Search* to compare pre- and post-intervention measures ($M = 25.33$; $M = 8.62$) scores on selective attention appear to have improved following the intervention as lower scores on the subtests indicate better outcomes. In addition, post-test standard deviations ($SD = 3.79$; $SD = 11.02$) appear to be promising, due to the fact that scores are less widely distributed and have lower values compared to pre-test measures ($SD = 14.82$; $SD = 13.61$).

Furthermore, the fact that the mean and standard deviation scores do not overlap, implies that these two sets of data are quite different and that a change has occurred between the two measures. It could be assumed that this change was due to the *APT* intervention. The *Sign Test* indicated that there were no significant differences between the pre- and post-test scores for selective attention following the *APT* intervention ($Z = 1.15$, $p = 0.25$ and $Z = 0.00$, $p = 1.00$). In spite of this lack of significance, slight modifications were witnessed as observed in the mean and standard deviations of the *Sky Search* Attention scores.

V. Discussion

Clinical and Theoretical Significance of Study

The techniques used in this study employed CRT as a restorative approach to improve selective attention by practicing exercises and tasks that would strengthen this specific skill [4]. Slight modifications on attention scores post the intervention were observed although these changes did not approach significance partly due to the small sample size employed. Nevertheless, this study provides a good baseline study from which to design future research to explore the benefits of CRT on vertically-infected HIV-positive children.

Additional research is needed to support or qualify the findings of derived in this research. As such, to validate the clinical and theoretical significance of this study would include addressing the various limitations that were observed during the study such as a) sample size, and b) employing longer duration intervention exercises so as to make selective attention processes become automatic. Further observations made during the *APT* intervention included children displaying difficulties in other attention modalities such as sustained and alternating attention problems, future research can also focus on these attention systems and the benefit of CRT as it related to these modalities in children with HIV.

ARV Adherence

Whether ARVs had been taken consistently since diagnosis was beyond the spectrum of this study. However, it was interesting to observe how participants on ARVs differed from participants who were not on any medication. In this study, one participant was not on any medication at the time of the research, and although no significant conclusions can be drawn from these observations, they would appear to support the literature stating that non-adherence to ARVs is linked to greater cognitive deficits [4]; [12]. Our data showed that the participant who was not on any medication experienced negligible or no change between pre- and post-intervention measures, whereas pre- and post-test data comparisons for the other two participants seemed to indicate small improvements.

As such, it could be argued that in line with other possibilities, non-adherence to ARVs might

have contributed to the non-significant findings in this study similar to those observed by Becker and colleagues [12]. The findings of this research, although not significant, point to a clear benefit of using cognitive rehabilitation therapy and in line with ARV's to better improve the attention skills of many children living with HIV. To expand on the current findings, future research should seek to standardize the *APT* intervention program and adapt relevant exercises so as to create context-appropriate intervention practice tasks for children in a context such as South Africa.

Our current research on HIV cognitive rehabilitation at Rhodes University is aiming to create relevant practice exercises to aid attention relevant to the South African context. Our current research is also trying to minimize practice effects on *TEA-Ch* tasks by creating new attention measurement in line with the development of Psychology in South Africa and Africa at large. Our current research is also exploring the efficacy of CRT in more complex research designs models to further evaluate the efficacy of CRT in HIV/AIDS pediatric populations. HIV/AIDS continues to be a great challenge to the African continent and the current line of research can only but advance science by exploring new avenues such as CRT to aid cognitive function in children living with HIV/AIDS.

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