

CHAPTER 6: CONCLUSION

6.1 INTRODUCTION

The aim of the study was to determine the central auditory processing and continuous performance patterns of children with ADHD in the medicated and non-medicated state. A specific multi-dimensional test battery consisting of a comprehensive CAPD test battery (as recommended by Bellis and Ferre, 1999), the IVA CPT test and the IVA STAR (narrative report writer for the IVA CPT) (Sandford and Turner, 2001) was used to assess the children. The inter- and intra-group tendencies of central auditory processing and (auditory and visual) continuous performance of three groups of children representing the three different types (combined, hyperactive-impulsive and inattentive) of ADHD were compared. Thereafter, the results of the specific multi-dimensional test battery were analyzed in relation to the different types of ADHD and subprofiles of CAPD as outlined in the Bellis/Ferre Model (Bellis, 1999).

As discussed in Chapter 5, statistical analysis was only possible for research group 1 (combined type of ADHD) and research group 2 (inattentive type of ADHD) as research group 3 (hyperactive-impulsive type of ADHD) consisted of only one participant. The results of the participant in research group 3 have been discussed qualitatively against the background of the results of research groups 1 and 2 in Chapter 5.

6.2 CONCLUSIONS

The results of the study show that:

- The incidence of the hyperactive-impulsive type of ADHD among children appears to be lower than for the combined and inattentive types of ADHD. This finding is consistent with the reports of Millstein et al (1998) and Wilens et al (2002) and is reflected in the fact that only one participant with the hyperactive-impulsive type of ADHD (representing research group 3) was identified to partake in the study.
- Stimulant medication enhanced the performance of the children with the combined and hyperactive-impulsive types of ADHD on measures of CAPD and continuous performance, but did not appear to have a significant effect on the performance of children with the inattentive type of ADHD. This supports the pharmacological management of the combined and hyperactive-impulsive types of ADHD (Barkley, 1998, Chermak et al, 1999), but suggests that the use of stimulant medication in children with the inattentive type of ADHD be carefully considered.
- The attention and impulsivity deficits observed in children with the three different types of ADHD (combined, hyperactive-impulsive and inattentive) appear to be supramodal in nature, i.e. deficits occur in both the auditory and visual modalities, as seen in the continuous performance measures. This finding supports Chermak et al's (1999) model of the supramodal nature of the deficits associated with ADHD.
- Stimulant medication appears to have a greater impact on visual modality than for auditory modality, as seen in the continuous performance measures. Sandford et al (1995) have suggested that different types of medication and treatment may be more effective for one modality than another.

- The analysis of the CAPD test results of the participants in the different research groups in relation to the subprofiles outlined in the Bellis/Ferre Model (Bellis, 1999) suggest that a relatively high number (40%) of participants diagnosed with the combined type of ADHD additionally met the requirements for the Output-organization subprofile. Bellis (2003b) has suggested that the Output-organization subprofile more likely reflects an attention disorder than a CAPD. The results of this study thus support this theory.
- The analysis of the specific multi-dimensional test battery results in relation to the IVA CPT procedural guidelines for diagnosing the different types of ADHD suggests that the IVA CPT has a 80% sensitivity for the combined type of ADHD (when low test validity and low fine motor regulation scores are also ascribed to particularly severe manifestations of inattention and hyperactivity-impulsivity), a 30% sensitivity for the inattentive type of ADHD and a 0% sensitivity for the hyperactive-impulsive type (though it should be remembered that only one participant with this type of ADHD had was included in the study). The American Academy of Pediatrics (2000) has reported that tests of continuous performance have a 70% sensitivity and specificity for ADHD but do not differentiate between the different types of ADHD in their report.

6.3 EVALUATION OF THE RESEARCH METHODOLOGY

A strength of this study is that the participants included in the study were clearly defined. The defining characteristics of the participants in many previous studies on ADHD have been subjective, poorly defined, and disconnected from any theoretical construct or empirical base (Chemak and Musiek, 1997). In this study the defining characteristics of the participants were based on the DSM-IV criteria (American Psychiatric Association, 1994), with the different types of ADHD reflected in the 3 research groups. A double criterion was also set for

allocating each participant to a specific research group: Firstly, the participants were required to have been diagnosed as having ADHD by a medical practitioner, and secondly, the participants, were required to meet the DSM-IV criteria (American Psychiatric Association, 1994) for a specific type of ADHD as reported by both the parents of the child and the teacher. Checklists (Appendices I and II), based on the DSM-IV (American Psychiatric Association, 1994), were completed independently by the teacher and the parents. To summarize, each participant was required have a medical diagnosis of ADHD, and to meet the specific ADHD type criteria by both the teacher and the parents before being allocated to a particular research group.

Another strength of the study was that the teachers administered the medication at the school where the data collection was also done. The researcher was thus able to accurately record the time of administration of the medication, the type of medication as well as the dosage of the medication. The children were also assessed in their school that was a familiar environment and thus a less-threatening test environment.

An additional strength of the study was that the participants were required to have no reported medical history of neurological functioning or other co-occurring disorders such as a hearing disorder, visual disorder, Tourette syndrome, Oppositional defiant disorder, Conduct disorder and Obsessive compulsive disorders. By controlling for and excluding children with these additional disorders, the extraneous variables affecting the study could be better controlled.

The limitations of the study are as follows:

- A limited number of participants were included in the study. Ten participants were allocated to research groups 1 (combined type of ADHD) and 2 (inattentive type of ADHD), and only one participant was allocated to research group 3 (hyperactive-impulsive type of ADHD). The number of

participants allocated to research groups 1 and 2 was limited to ten participants per group due to the lengthy testing required. Furthermore, it was also necessary to test each participant twice, namely in the medicated and the non-medicated state. The reason for including only one participant in research group 3 (hyperactive-impulsive type of ADHD) was that only one of the children at the school used in the study met the participant selection criteria for inclusion in this group. This finding is consistent with reports in the literature (Millstein et al, 1998) of a lower incidence of the hyperactive-impulsive type of ADHD. Wilens et al (2002) estimate that in the ADHD population, 50-75% of children have the combined type of ADHD, 20% of children have the inattentive type of ADHD with less than 15% of children having the hyperactive-impulsive type of ADHD.

- The test materials used in compiling the specific multi-dimensional test battery were not South African based, and had been compiled in the USA, as similar measures are not available in South Africa.

CAPD measures with a low linguistic load were included in the test battery to control for the effects of differences in grammatical structures and vocabulary that could have influenced the test results of the participants. The stimuli used in the Dichotic digits test (digits) and the Frequency pattern test (frequency patterns) require the ability to repeat four single digits and the ability to label tones as “low” or “high”, as discussed in Chapter 4. Words are the stimuli used in the Low pass filtered speech test and the Speech masking level difference test. Although the Low pass filtered speech test and Speech masking level difference tests were compiled for the USA population, an examination of the words included in the tests revealed that these words should also be familiar to children in SA. Some of the words included in the tests do, however, require a fairly

advanced level of vocabulary, for example words such as “seize”, “dodge” and “void”.

The children included in both the pilot and actual study ranged in age from 8 to 12 years and thus had different levels of linguistic ability. The children in the actual study also attend a school for children with learning disability and children with learning disability are reported to have a higher incidence of language impairment (Medwetsky, 2002). It was thus decided to read the list of words to each child and discuss the meaning of the words prior to commencing with the testing. By familiarizing the children with the words the effects of language ability could be reduced in order to obtain a more accurate reflection of each child’s central auditory processing. Prior to commencing with the CAPD testing, the children were familiarized with the test material, as outlined and motivated in Table 4.8. These procedures were also followed in compiling the normative data using 50 mainstream children, as discussed in the pilot study. The results of the participants included in the study could thus be compared with the locally compiled CAPD normative data (collected as part of the pilot study).

The IVA CPT and IVA STAR (Sandford and Turner, 2001) used for assessing auditory and visual continuous performance have also been compiled in the USA. The stimuli consist of the numbers “1” and “2” that are heard and seen by the participant. The participant is required to click the mouse each time s/he hears or sees a “1”. The stimuli used thus place a low demand on both linguistic and visual perception abilities, as opposed to other tests of continuous performance as discussed in Chapter 2. Normative data could not be compiled locally as an automated database is used (n=1700 normal individuals, aged 5-90+) with results being presented as quotient scores that take both age and gender into account.

- The CAPD test battery used in the study is based on the recommendations of Bellis and Ferre (1999). As discussed in Chapter 3, Bellis (2003a) recently provided an update on recommendations for the components of a comprehensive CAPD test battery. The value of this updated comprehensive CAPD test battery, in differentiating between ADHD and CAPD, warrants further investigation but was beyond the scope of this study as the data collection for this study had been completed prior the publication of these recommendations.
- The number of individuals used in the compilation of the CAPD normative data was limited, namely a total of 50 children with 10 children in each of the following age categories: 8 years, 9 years, 10 years, 11 years and 12 years of age. The normative data compiled (Appendix XI) did, however, allow for comparisons to be made with the CAPD test results of the 10 participants in research groups 1 and 2 respectively and the 1 participant in research group 3. Thus, although the number of children included in compiling the normative data was limited, these numbers were adequate for the purposes of the study.
- Based on the recent shift in conceptualizing ADHD as an executive dysfunction (Chermak et al, 1999) the inclusion of a test of executive dysfunction would have been a valuable adjunct to the specific multi-dimensional test battery. The decision not to include a test of executive function was based on the fact that there is currently no agreed on test battery for assessing executive dysfunction in children (Packer, 2002). The inclusion of a test battery of executive function would have increased the length of the test sessions that were already 1 hour and 15 minutes long. The specific multi-dimensional test battery was also administered twice to each participant, i.e. in both the medicated and non-medicated state.

- The testing was done at the school in the teachers' computer room, where the noise levels were monitored using a Rion Sound Level Meter NA-24 set on function A. The room is situated away from the central noise areas of the school, has a dimension of 3x2m² and is fitted with a carpet and curtains. The noise levels were monitored in the room and noise levels were kept below the 40-45dB SPL marker on the sound level meter. The sound level meter had been calibrated according to SABS standards. Ideally, the testing should have been done in a soundproof booth but for the reasons discussed under 4.4.2 this was not possible as the data collection needed to be done at the school. By using a sound level meter and controlling the environmental noise, the researcher was able to assess all the subjects under the same controlled and quiet conditions.

6.4 CLINICAL IMPLICATIONS OF THE STUDY

The results of the study have yielded the following important clinical implications:

- While the pharmacological management of the combined and hyperactive-impulsive types of ADHD appears to be indicated, the use of stimulant medication in children with the inattentive type of ADHD should be carefully considered. Children with the inattentive type of ADHD did not derive any significant benefit from stimulant medication as reflected in the measures of CAPD and continuous performance used in the study.
- The relatively high number (40%) of the participants diagnosed with the combined type of ADHD that also met the requirements of the Output-organization subprofile as outlined in the Bellis/Ferre Model (Bellis, 1999) suggests that the management strategies for these two disorders be reconsidered. Bellis (2003b) has suggested that the Output-organization subprofile more likely reflects an attention disorder than a CAPD. It is thus possible that some children diagnosed with the Output-organization subprofile may benefit from stimulant medication. It is also possible that

some children with the combined type of ADHD may benefit from the management strategies typically used for children with the Output-organization subprofile, for example: a highly structured environment, training in the use of organizational aids, speech therapy focusing on expressive language, and assistive listening technology (Bellis, 1999).

- The linkages between ADHD and CAPD underscore the importance of a thorough and multi-disciplinary approach. Differentiating ADHD and CAPD hinges on the accurate diagnosis of these conditions and thus warrants a multi-disciplinary approach (Chermak et al, 1999).

6.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the results of the study the following recommendations are made for further research:

- An investigation into the executive function of the three different types of ADHD, namely the combined type, the hyperactive-impulsive type and the inattentive type.
- An investigation into the relationships between the combined and hyperactive-impulsive types of ADHD (DSM-IV) and the Output-organization subprofile of Bellis and Ferre (1999) and Bellis (2003a).
- An investigation into the possible links between the Tolerance fading memory category of Katz et al (1992) and the Output-organization subprofile of Bellis and Ferre (1999) and Bellis (2003a).
- An investigation into the value of stimulant medication in the management of the inattentive type of ADHD.
- The development of test measures for CAPD and continuous performance for the South African context.

- An investigation to determine the prevalence of ADHD and the different types of ADHD using clearly defined participant characteristics, i.e. the DSM-IV (American Psychiatric Association, 1994) criteria rather than checklists and rating scales.
- An investigation into the relationship between Hyperkinetic disorder (ICD-10, World Health Organization, 1992) and the Combined type of ADHD (DSM-IV, American Psychiatric Association, 1994).
- An investigation into the continuous performance of children diagnosed with the different CAPD subprofiles outlined in the Bellis/Ferre Model (Bellis, 2003a) to determine whether CAPD is modality specific or supramodal in nature.

6.6 CONCLUDING REMARKS

ADHD is the most commonly occurring neurobehavioral disorder in children (National Institutes of Health Consensus Committee, 1998, Chermak et al, 1999) and yet remains shrouded in controversy. Despite progress made in the assessment, diagnosis and treatment of ADHD in recent years, questions are still raised concerning the existence of the disorder, whether it can be reliably diagnosed and, if treated, what interventions are the most effective. In particular, concern is expressed regarding the perceived over-diagnosis of ADHD pointing to the dramatic increase in prescriptions for stimulant medication among children in recent years (American Academy of Pediatrics, 2000).

At the heart of the controversy lies the lack of congruity in defining ADHD as a disorder. The defining characteristics of children with ADHD in both clinical practice and in many research studies have been subjective, poorly defined, frequently changing and disconnected from any theoretical construct or empirical base (Chermak and Musiek, 1997). This has led to the controversy surrounding the etiology and prevalence of ADHD (and the different types of ADHD), as well

as the value of different assessment methods and treatment options in the management of children with ADHD.

In this study a “specific multi-dimensional test battery” comprising a measure of (auditory and visual) continuous performance and a CAPD test battery was compiled to assess children with the three different types of ADHD (diagnosed using the DSM-IV criteria of the American Psychiatric Association, 1994). It was envisaged that, by investigating the continuous performance and central auditory processing abilities of children with ADHD, new insights could be developed into the theoretical constructs underlying ADHD. The specific multi-dimensional test battery used in the study was administered to the children in the three research groups (each representing one of the three types of ADHD) in both the medicated and non-medicated state.

A strength of the study is that the characteristics of the children included in the study have been clearly defined. The results of the study, discussed in Chapter 5 and summarized in Chapter 6, provide some valuable insights into the theoretical constructs underlying the three different types of ADHD. In Chapter 6 recommendations are also made for further research and the clinical implications of the results are discussed.

Research in the field of ADHD is both challenging and intriguing but, in the process of research, the children living daily with this disorder and their families should not be forgotten. It is hoped that the results of this study and their clinical implications will prove to be valuable in managing children with ADHD in the clinical setting.

“ADHD is real – a real disorder, a real problem, and often a real obstacle. It can be heartbreaking and nerve-wracking”
(Barkley, 2000: 19).