

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION AND RATIONALE

Attention Deficit Hyperactivity Disorder (ADHD), the most commonly occurring neurobehavioral disorder in children (Chermak, Hall III and Musiek, 1999) has received increasing attention in the past decade. Professional and public interest has increased along with debate in the media concerning the diagnostic process and treatment strategies used for children with ADHD (Gibbs, 1998). Particular concern has been expressed regarding the perceived over-diagnosis of ADHD pointing to the dramatic increase in prescriptions for stimulant medication among children in recent years (Safer, Zito and Fine, 1996, American Academy of Pediatrics, 2000). In addition, the significant variations in the type and amount of stimulants prescribed, as well as wide variations in the diagnostic methods and criteria currently employed, are questioned (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 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 controversy concerning the etiology and prevalence of ADHD (and the different types of ADHD), and also the value of different assessment methods and treatment options in the management of children with ADHD.

The two primary diagnostic criteria classification systems used in diagnosing ADHD are the Diagnostic and Statistical Manual of Mental Disorders – Fourth edition (DSM-IV) (American Psychiatric Association, 1994) that is used in North America and Australia and the International Classification of Diseases – Tenth

edition (ICD-10) (World Health Organization, 1992) that is used in Europe and the United Kingdom. The term ADHD used in North America refers to children with a consistent pattern of inattention and/or hyperactivity with an onset early in childhood (Chermak et al, 1999, American Academy of Pediatrics, 2000). The DSM-IV criteria (American Psychiatric Association, 1994) used in diagnosing ADHD, differentiate between three different types of ADHD, namely the combined type, the inattentive type and the hyperactive-impulsive type. In contrast, the term Hyperkinetic Disorder (based on the ICD-10 criteria of the World Health Organization (1992) used in Europe and the United Kingdom) is characterized by the early onset of both overactive and inattentive behaviors (McConnell, 1997). The Combined type of ADHD (DSM-IV criteria) thus shows some similarity to Hyperkinetic Disorder (ICD-10 criteria). This may explain the lower prevalence (1-2%) of Hyperkinetic Disorder in comparison with ADHD in children (reported prevalence rates vary from 3-9%) and may explain the perceived over-diagnosis of overactive and inattentive behavior in children and consequently the perceived over-prescription of stimulant medication in North America (McConnell, 1997).

Adding to the above controversy is the fact that, despite efforts to standardize the defining characteristics specified in the DSM-IV, these characteristics remain subjective and may be interpreted differently by different observers (American Academy of Pediatrics, 2000). Additionally, there is an increasing trend to use a wide variety of diverse teacher questionnaires and rating scales in diagnosing ADHD in children (American Academy of Pediatrics, 2000). These questionnaires and rating scales include both commercially available materials and clinic-based materials. Although questionnaires and rating scales may be useful for acquiring additional information, the American Academy of Pediatrics (2000) does not endorse the sole use of these measures in the diagnosis of ADHD in children.

The diagnosis of ADHD in children is further complicated by the variety of other psychological and developmental disorders that frequently co-exist with ADHD. As many as one third of children with ADHD, have a co-existing disorder such as conduct defiant disorder, depression, anxiety disorder, speech and language impairment, learning disability and/or central auditory processing disorder (American Academy of Pediatrics, 2000).

Differentiating between ADHD and Central Auditory Processing Disorders (CAPD) is a particular challenge for professionals as both groups are heterogeneous in nature and yet present with many similar characteristics (Keller, 1998, Chermak et al, 1999). Children diagnosed with ADHD are frequently reported to present with difficulties on tasks that challenge the central auditory nervous system (Chermak et al, 1999, Copeland, 2002). It has been proposed that CAPD and ADHD may even reflect a singular disorder (Gason, Johnson and Burd, 1986, Keller, 1998). The observed co-morbidity of CAPD and ADHD most likely reflects a shortcoming in the theoretical constructs of these disorders, as well as the diagnostic criteria and procedures used in differentiating ADHD and CAPD.

In the literature there are three opposing theoretical schools of thought regarding the conceptualization of ADHD and CAPD. In the first school of thought, CAPD is considered to be a specific disorder of the auditory modality, while ADHD is suspected to be supramodal in nature. Included in this school of thought is the model of McFarland and Cacace (1995) who view auditory modality specificity as a criterion for diagnosing CAPD, and recommend using similar tasks in multiple (auditory and visual) sensory modalities to differentiate between auditory specific and supramodal disorders. In the second school of thought, CAPD is viewed as an auditory specific deficit but the possible existence of co-existing multimodality symptoms based on a shared neurophysiological site of dysfunction is acknowledged. In contrast, ADHD is ascribed to executive dysfunction and thought to be supramodal in nature. In this school of thought there are three

models, namely the model of Chermak et al (1999), the Bellis/Ferre Model (Bellis, 2003a) and the model of Barkley (1998). Finally, in the third school of thought, CAPD is not viewed as an auditory modality specific disorder but rather as a multimodal disorder. Included in this school of thought is the Buffalo Model of Katz, Smith and Kurpita (1992).

Although the above three opposing theoretical schools of thought provide some interesting hypotheses and insights into ADHD and CAPD in children, research is required in order to validate that the deficits associated with the three different types of ADHD are supramodal in nature, as suggested by McFarland and Cacace (1995), Chermak et al (1999) and Bellis (2003a). McFarland and Cacace (1995) recommend using similar tasks in multiple (auditory and visual) sensory modalities to differentiate between auditory specific and supramodal disorders. There are a number of commercially available tests of continuous performance that assess either the visual or the auditory modality such as The Auditory Continuous Performance Test and The Visual Continuous Performance Test compiled by Morris, O'Neil, Crawford and Mockler (Riccio, Reynolds and Lowe, 2001). The Integrated Visual and Auditory Continuous Performance Test (IVA CPT) (Sandford and Turner, 2001) has an advantage over other commercially available tests as it combines both auditory and visual stimuli into a single measure (Kane and Whiston, 2001). Further research using a measure such as the IVA CPT (which combines both auditory and visual stimuli) could provide valuable insights into the nature of the deficits associated with ADHD.

Research is also necessary to determine the value of tests of CAPD in differentiating between ADHD and CAPD in children. Bellis and Ferre (1999) and Bellis (2003a) have suggested that tests of CAPD may be useful in differentiating between ADHD and CAPD and suggest that children with ADHD can be expected to perform normally or poorly across all measures of CAPD, with no clear error patterns that can be linked to the CAPD subprofiles. Bellis and Ferre (1999), however, do not differentiate between the different types of ADHD.

Further research examining the central auditory processing of the three different types of ADHD, namely the combined type, the inattentive type and the hyperactive-impulsive type, is warranted and may provide a new understanding of the relationship/s between ADHD and CAPD and the theoretical constructs underlying these disorders.

By compiling a “specific multi-dimensional test battery”, comprising of a measure of (auditory and visual) continuous performance and a CAPD test battery to assess children diagnosed with the three different types of ADHD, it is possible that new insights may develop into the theoretical constructs underlying ADHD. The term “specific multi- dimensional test battery”, as used here, encompasses two concepts, namely “specific” and “multi-dimensional”. The concept “specific” refers to specific measures of both central auditory processing and continuous performance. The term “multi-dimensional” refers to the complexity and diversity of the factors being considered, namely both central auditory processing, and auditory and visual continuous performance.

An important consideration in administering the above, specific multi-dimensional test battery, is the decision of whether tests of CAPD and continuous performance should be administered to children with ADHD in the medicated or non-medicated state. Chermak et al (1999) suggest that the purpose of the testing should guide the decision of whether the testing takes place in the medicated or non-medicated state. For example, by administering tests of CAPD in the medicated state to children with ADHD, aspects such as attention can be controlled, thus providing a more accurate representation of the child’s central auditory processing abilities. If, on the other hand, the purpose of the testing is to determine the child’s attention and vigilance (continuous performance), then, testing the child in the non-medicated state would be more appropriate. If, however, the purpose of the testing is to determine the effect of medication on the child’s functioning, then testing in the medicated state, or at least a comparison of the child’s functioning in both the medicated and non-medicated

state, is recommended. By assessing children in both the medicated and non-medicated state, information can be gleaned about the central auditory processing abilities of children diagnosed with the three different types of ADHD, the nature of the deficits associated with ADHD (i.e. supramodal or modality-specific), as well as the effect of medication on the children's functioning.

The above controversy surrounding the diagnosis of ADHD is also reflected in the management of ADHD in children. The American Academy of Pediatrics (2001) recommends the use of stimulant medication and/or behavioral therapy (modifying the environment to alter or change behavior) in the treatment of children with ADHD. Stimulant medication is thought to exert a therapeutic effect by enhancing executive function by facilitating dopamine transmission in the prefrontal cortex (Volkow, Wang, Fowler, Logan, Gerasimov, Maynard, Ding, Gatley, Gifford, and Franceschi, 2001). Unlike most other medications, stimulant dosages are not weight dependent and dosing schedules should be carefully determined and monitored in each child (American Academy of Pediatrics, 2001). Chermak et al (1999) have suggested that the recent conceptualization of the combined and hyperactive-impulsive types of ADHD as an executive dysfunction supports the pharmacological management of these disorders. In contrast, Chermak et al (1999) view the inattentive type of ADHD as a processing disorder and have suggested that stimulant medication may not necessarily be the most effective form of treatment in this group of children. Further research is required to determine the value of stimulant medication in treating the different types of ADHD.

Against this background the rationale underlying the study is to determine the central auditory processing and the (auditory and visual) continuous performance of children diagnosed with the three different types of ADHD in the medicated and non-medicated state. It is hoped that the results of the study will provide new insights into the theoretical construct underlying ADHD, assist in the

validation of ADHD as a disorder, and provide guidelines for the management of ADHD in children.

1.2 DEFINITION OF TERMINOLOGY

In order to facilitate understanding of the fundamental issues of the study and avoid misunderstanding, it is necessary to define the terminology used in the study. The terms that will be defined in this section are “Attention Deficit Hyperactivity Disorder” (ADHD), “Central Auditory Processing Disorder” (CAPD), “Continuous performance”, and a “Specific multi-dimensional test battery”.

1.2.1 Attention Deficit Hyperactivity Disorder (ADHD)

The two primary diagnostic classification systems used in diagnosing ADHD are the DSM-IV criteria (American Psychiatric Association, 1994) used in North America and Australia and the ICD-10 (World Health Organization, 1992) used in Europe and the United Kingdom. The term ADHD used in North America refers to children with a consistent pattern of inattention and/or hyperactivity with an onset early in childhood (Chermak et al, 1999, American Academy of Pediatrics, 2000). The DSM-IV criteria used in diagnosing ADHD differentiate between three different types of ADHD, namely the combined type, the inattentive type and the hyperactive-impulsive type. In contrast, the term Hyperkinetic Disorder (based on the ICD-10 criteria used in Europe and the United Kingdom) is characterized by the early onset of both overactive *and* inattentive behaviors (McConnell, 1997). The Combined type of ADHD (DSM-IV criteria) thus shows some similarity to Hyperkinetic Disorder (ICD-10 criteria).

ADHD consists of a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development; manifests in at least two settings; interferes with developmentally appropriate social, academic, or occupational functions; and presents before age 7 years (American Psychiatric

Association, 1994). Patterns of inattention, hyperactivity and impulsivity are used to differentiate between the three different types of ADHD (American Psychiatric Association, 1994). The predominantly inattentive type presents primarily with symptoms of inattention. The predominantly hyperactive-impulsive is considered a behavioral regulation disorder and the combined type is characterized by both hyperactivity-impulsivity and inattention. The criteria for the diagnosis of the three different types of ADHD, as stipulated by the American Psychiatric Association (1994), are presented in Table 1.1. The DSM-IV criteria for the diagnosis of the different types of ADHD require the presence of six or more symptoms of inattention and/or hyperactivity-impulsivity persisting for 6 or more months. The combined type of ADHD meets criteria A and B, as outlined in Table 1.1, the predominantly inattentive type meets criterion A, but not B, and the predominantly hyperactive-impulsive type meets criterion B, but not A.

Although the broader diagnostic criteria of the DSM-IV (American Psychiatric Association, 1994) will primarily be used in the study, the results will also be considered against the background of the ICD-10 criteria (World Health Organization, 1992).

1.2.2 Central Auditory Processing Disorder (CAPD)

Consensus on a definition of CAPD has plagued audiologists and other interested professionals for decades, with much disagreement among factions and disciplines (Bellis, 1999, Bellis, 2003a).

Definitions of CAPD have, according to Bellis (1999), ranged from the very general (i.e., "What we do with what we hear", Katz, 1992) to the very specific (i.e., an auditory modality-specific deficit in bottom-up processing of acoustic features of speech, McFarland and Cacace, 1995).

**Table 1.1: DSM-IV Criteria for diagnosis of the different types of ADHD
(American Psychiatric Association, 1994)**

<p>A. Inattention</p> <ol style="list-style-type: none">1. Poor attention to details or careless mistakes2. Difficulty sustaining attention in tasks3. Does not seem to listen when spoken to4. Does not follow through on instructions and tasks5. Difficulty organizing tasks6. Difficulty with sustained mental effort7. Loses things necessary for tasks8. Often distracted by extraneous stimuli9. Often forgetful in daily activities <p>B. Hyperactivity-Impulsivity</p> <p>Hyperactivity</p> <ol style="list-style-type: none">1. Fidgets or squirms2. Leaves seat in classroom3. Runs or climbs excessively4. Difficulty in engaging in quiet activity5. "On the go" or acts as if "driven by a motor"6. Talks excessively <p>Impulsivity</p> <ol style="list-style-type: none">7. Blurts out answers8. Difficulty waiting turn9. Interrupts or intrudes on others
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The ASHA Task Force on Central Auditory Processing Consensus Development (1996: 41) recognized this dilemma and convened a task force who collaborated and defined CAPD as "an observed deficiency in one or more of the following processes:

- Sound localization and lateralization
- Auditory discrimination
- Auditory pattern recognition
- Temporal aspects of audition, including
 - temporal resolution
 - temporal masking
 - temporal integration
 - temporal ordering

- Auditory performance decrements with competing acoustic signals
- Auditory performance decrements with degraded acoustic signals”.

Chermak et al (1999) further refined the above definition by adding the central auditory processes responsible for generating the auditory evoked potentials. Chermak et al (1999: 290) define CAPD as "a deficit in one or more of the central auditory processes responsible for generating the auditory evoked potentials and the behaviors of sound localization and lateralization, auditory discrimination, auditory pattern recognition, temporal processing (for example, temporal resolution, temporal masking, temporal integration, and temporal ordering), auditory performance with competing acoustic signals, and auditory performance with degraded acoustic signals".

Although the above definitions succeed in isolating audition into some of its constituent behaviors, both definitions fail to uncover underlying mechanisms responsible for these behaviors. These definitions also fail to acknowledge the possible interdependency and/or linkages between these behaviors and difficulties in listening, language, learning and communication (Bellis, 1999, Bellis, 2003a). Finally, Jerger (1998) criticizes the definitions, as they do not provide a sufficient conceptual framework for understanding CAPD as a phenomenon.

Based on the above discussion, the definitions of CAPD proposed by the ASHA Task Force on Central Auditory Processing Consensus Development (1996) and Chermak et al (1999) as well as the criticisms of Jerger (1998) and Bellis (1999, 2003a), the following integrated definition of CAPD will be used in the study:

CAPD refers to a breakdown in the auditory modality, and more specifically of the central auditory processes, attributable to central nervous system pathology and/or the functioning of these pathways, usually in the absence

of a peripheral hearing impairment, which may co-exist with high level complex behaviors such as listening, language and learning based on the interconnectedness of the central nervous system.

The above central auditory processes refer to those processes which are responsible for generating auditory evoked potentials as well as the behaviors responsible for sound localization and lateralization, auditory discrimination, auditory pattern recognition, temporal processing, and auditory performance with degraded acoustic signal and in the presence of competing acoustic signals.

Although it is recognized that CAPD may occur in individuals with a peripheral hearing impairment, the participants included in this study were required to have intact peripheral hearing. The motivation for this decision (which is discussed in greater depth in Chapter 4) is to insure a more homogeneous participant population, representative of children typically presenting with CAPD in the clinical situation.

Finally, the term Central Auditory Processing Disorder (CAPD) rather than Auditory Processing Disorder (APD) will be used in this study despite the recommendations made by Jerger and Musiek (2000) at the Consensus Conference on the Diagnosis of Auditory Processing Disorders in School-Aged Children held in Dallas in April 2000. Jerger and Musiek (2000: 3) suggested that the term APD might be more “in keeping with the goals of maintaining operational definitions, avoiding the imputation of anatomical loci, and emphasizing the interactions of disorders at both peripheral and central sites”. While the term APD may emphasize the interactions between the peripheral and central sites, it

hazes the differentiation between CAPD and auditory neuropathy (a functional disorder of the inner hair cells of the cochlear and/or the auditory nerve) that may exhibit some symptoms similar to CAPD, but which remains a separate disorder. In the past CAPD has been seen as a disorder of the brainstem, cerebrum (auditory cortex), corpus callosum and efferent auditory pathways, with the term “central” referring to the auditory pathways superior to the auditory nerve. The inclusion of the term “central” thus helps to differentiate between auditory neuropathy and CAPD and emphasizes that CAPD is a central disorder, i.e. central to the peripheral auditory system.

Concern over the appropriateness of removing the term “central” has also been expressed, as it holds the potential danger of broadening the scope of the disorder to such a degree that it holds little or no clinical value (Bellis, 2003a). It remains to be seen whether audiologists will generally accept the use of the term APD as opposed to CAPD (Medwetsky, 2002, Bellis, 2003a).

1.2.3 Continuous Performance

Continuous performance is a collective term that will be used to refer to measures of attention and vigilance. Continuous performance can and will be measured for both the auditory and visual modalities. The Integrated Visual and Auditory Continuous Performance Test (IVA CPT) of Sandford and Turner (2001) combines both auditory and visual stimuli in a counterbalanced design, together with attention and vigilance. The IVA CPT (Sandford and Turner, 2001) will be discussed in greater depth in Chapter 4.

1.2.4 Specific multi-dimensional test battery

In this study a “specific multi-dimensional test battery” comprising of a measure of (auditory and visual) continuous performance and a CAPD test battery was compiled to assess children diagnosed with the three different types of ADHD. The term “specific multi-dimensional test battery”, as used here, encompasses

two concepts, namely “specific” and “multi-dimensional”. The concept “specific” refers to specific measures of both central auditory processing and continuous performance that were included. The term “multi-dimensional” refers to the complexity and diversity of the factors being considered, namely both central auditory processing, and (auditory and visual) continuous performance of the children in the medicated and non-medicated state.

1.3 DIVISION OF CHAPTERS

The division of the chapters in this study is presented in Table 1.2.

1.4 SUMMARY OF CHAPTER 1

The orientation to and rationale underlying the study are presented in Chapter 1. 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 managing ADHD in children are discussed. In particular, the value of a specific multi-dimensional test battery comprising of a continuous performance test, as well as a CAPD test battery in investigating the theoretical constructs underlying ADHD, is presented. This is followed by a definition and discussion of the terminology used in the study as well as an overview of the division and content of the chapters in the dissertation.

Table 1.2: Division of Chapters

Division of chapters	Outline of content
Chapter 1: Introduction	Chapter 1 provides an introduction to the study and presents the orientation to and rationale for the study. In order to facilitate understanding of the fundamental issues of the study and to avoid misunderstanding, the terminology used in the study is defined. The terms that are defined are "Attention Deficit Hyperactivity Disorder" (ADHD), "Central Auditory Processing Disorder" (CAPD), "Continuous performance", and "Specific multi-dimensional test battery". An outline of the chapters of the study is also provided.
Chapter 2: ADHD in children: Controversies and directions for further research	Chapter 2 presents a critical review of the etiology of ADHD, the different diagnostic criteria and ensuing controversy, additional diagnostic tools, the prevalence rates of ADHD and the ADHD types, co-existing disorders and differentiating ADHD from CAPD, recent developments in the conceptualization of ADHD, the treatment of ADHD and finally, directions for further research.
Chapter 3: The value of tests of continuous performance and CAPD in differentiating between ADHD and CAPD in children	Chapter 3 highlights the challenges facing professionals in differentiating between ADHD and CAPD in children. The three opposing schools of thought regarding the conceptualization of ADHD and CAPD are presented and, against this background, the value of a specific multi-dimensional test battery (comprising of a measure of continuous performance and a CAPD test battery) is discussed.
Chapter 4: Research methodology	Chapter 4 presents the research methodology of the study, and entails a description and discussion of the aims, research design, participant selection criteria and procedures, as well as a description of the participants, apparatus and material and, finally, the data analysis procedures used in the study.
Chapter 5: Results and discussion	In Chapter 5 the results of the study are presented and discussed according to the formulated sub-aims. This entails a comparison of the inter- and intra-group tendencies of central auditory processing and continuous performance of the three research groups in the medicated and not medicated state. The results of the specific multi-dimensional test battery are also analyzed in relation to the different types of ADHD and subprofiles of CAPD. The results of the study are discussed against the background of the literature.
Chapter 6: Conclusion	The conclusions of the study are presented in Chapter 6. This is followed by a critical evaluation of the study as well as a summary of the clinical implications of the study. Finally, recommendations are made for further research.