FINE MOTOR SKILLS IN AFRIKAANS SPEAKING PRIMARY SCHOOL CHILDREN WITH ATTENTION DEFICIT/HYPERACTIVITY DISORDER

by

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DECLARATION

I, Estelle Mc Alpine, declare that the dissertation hereby submitted to the University of the North as partial fulfilment for the degree of Master of Arts in Clinical Psychology, has not previously been submitted by me for a degree at any other university, that it is my own work in design and execution, and that all the material contained therein has been duly acknowledged.

Signature .....

Date:.....

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ABSTRACT

The purpose of this study was to investigate whether poor motor skills are associated with ADHD. Afrikaans speaking primary school children were screened for ADHD with the Disruptive Behaviour Disorder scale (DBD). They were matched for gender and age with a normal group without ADHD symptoms. The children (31 ADHD and 31 Controls) were assessed for fine motor skills on three instruments: the Grooved pegboard, Maze co-ordination and Finger tapping tests.

To some degree all three tests of fine motor skills revealed poorer performances in the ADHD group than in the normal group. The finger-tapping test showed the least discrimination between the groups. The girls performed significantly poorer on all tests. There were statistically significant effects of hand dominance.

Results show that tests for fine motor skills discriminate between children with ADHD and normal comparisons. These results appear to support the hypothesis that poor motor skills are associated with ADHD.

Chapter 1

INTRODUCTION

1.1 Background

Attention Deficit Hyperactivity disorder (ADHD) is a heterogeneous disorder, with early onset and potentially poor prognosis. The three main symptoms are inattention, overactivity and impulsiveness (Barkley, 1998). The combination of inattentive, overactive and impulsive behaviour is recognised as a disorder when these behaviours are severe, developmentally inappropriate and impair functioning at home and school (Swanson, Sergeant, Taylor, Sonuga-Barke, Jensen and Cantwell, 1998). The behavioural problems arise before the age of seven and are developmentally persistent.

ADHD is the most common childhood psychiatric disorder in Europe and the United States, affecting 3 – 10 % of primary school children (Meyer, Eilertsen, Sundet, Tshifularo, & Sagvolden, 2004). According to the DSM IV the prevalence of ADHD is 3 – 5 % of school-age children. These rates vary, according to the population sampled, the diagnostic criteria and diagnostic instruments used.

There are no exact figures for South Africa, but Meyer (1998) found prevalence rates of 7.1 % in the North Sotho speaking primary school

population. Male to female ratios are approximately 3: 1 in population-based studies and vary from 9: 1 to 6: 1 in clinic-referred samples (Meyer, 1998).

Data from cross- sectional, retrospective and follow-up studies indicate that children with ADHD are at risk for developing other psychiatric disorders in childhood, adolescence and adulthood (Vogel & Holford, 1999). ADHD is associated with proneness to repeated accidents, depressive and anxiety disorders, and learning disabilities and school failure. The disorder is also associated with a later increased incidence of substance abuse if not diagnosed and treated at an early stage (Biederman, Wilens, Mick, Spencer, & Faraone, 1999).

The precise aetiology of ADHD is not known, but genetic research (including twin/adoption and family studies and molecular genetic studies) indicate that ADHD has a genetic component (Kuntsi & Stevenson, 2001), while several studies point to neuro-anatomical and neuro-chemical contributions to ADHD (Sagvolden & Sergeant, 1998). The majority of biochemical theories, concerning the aetiology of ADHD, are based on the catecholamine hypothesis, that emphasises the primary role of the neurotransmitters dopamine and norepinephrine (Swanson, Castellanos, Murias, LaHoste & Kennedy, 1998).

In a recently published article, ADHD is explained as caused by dysfunctioning dopamine systems that influence learning, behavioural planning and motor co-ordination (Johansen, Aase, Meyer, & Sagvolden,

2002). This neuropsychological theory of ADHD indicates that motor problems are associated with ADHD, in addition to the main symptoms of inattention, impulsiveness and overactivity.

1.2 Aim of the study

The aim of this study is to test whether motor problems are associated with ADHD as suggested by Sagvolden and co-workers (Johansen et al., 2002; Sagvolden and Sergeant, 1998).

1.3 Delineation of the study

Chapter 2 will focus on the nature of ADHD, symptoms, diagnostic criteria, co-morbid disorders and associated impairments, prevalence and gender differences, treatment, prognosis and outcomes. Chapter 3 will focus on the neurobiology of ADHD and describe a neuropsychological model of the disorder. Chapter 4 will discuss the various components of an assessment of ADHD.

Chapter 5 will discuss the problem and formulate the hypotheses of the study, while chapter 6 will describe the methodology that was employed. Chapter 7 will report on the results of the study, while Chapter 8 will discuss the results, implications and limitations of the study and will make recommendations for future research.

Chapter 2

BACKGROUND OF ATTENTION DEFICIT/HYPERACTIVITY DISORDER

2.1 Introduction

ADHD is the most recent diagnostic label for children presenting with attention problems, impulsiveness and overactivity (Barkley, 1998). This condition is based on the presence of 18 otherwise normal disruptive behaviours of childhood, that are defined as psychiatric symptoms only if they occur "to a degree that is maladaptive and inconsistent with developmental level" (Swanson, Schuck, Mann, Carlson et al, In Press).

Diagnostic labels for inattentive, impulsive children have changed over the last century, yet the actual nature of the disorder has changed little, if at all, from descriptions a century ago (Barkley, 2003; Still, 1902).

Sagvolden and Sergeant (1998), describe ADHD as a seemingly heterogeneous group of behaviour disorders affecting between 1,3 – 5% of primary school children. It usually manifests before the age of seven years and is more common in boys. ADHD is a major risk factor for later delinquency, substance abuse and personality disorders and half of children diagnosed with ADHD have psychiatric disorders as adults (Taylor, 1998).

Therefore, it is clear that increased understanding of this disorder, leading to better and earlier interventions, is important (American Psychiatric Association, 2000).

2.2 Symptoms and Diagnosis

2.2.1 Primary Symptoms

The three main symptoms of ADHD are impulsiveness, inattention and overactivity. Sagvolden (1999a) argues that all three symptoms may not be primary, but may be secondary to an underlying deficit in reinforcement processes. This model is supported by several authors (Johansen et al., 2002; Sagvolden, Aase, Zeiner, & Berger, 1998a; Sagvolden & Sergeant, 1998; Sagvolden, 1999b).

Quay (1997) argues that ADHD represents a deficit in the brain's behavioural inhibition system. Several researchers (Barkley, 1998; Oosterlaan & Sergeant, 1998; Rubia, Oosterlaan, Sergeant, Brandeis, & van Leeuwen, 1998) support this disinhibition model. Other results, however, contradict this hypothesis (Brandeis, van Leeuwen, Rubia, Vitacco, Steger, Pascual-Marqui et al., 1998; Sagvolden et al., 1998a; Sonuga-Barke, Williams, Hall, & Saxton, 1996; Sonuga-Barke, Saxton, & Hall, 1998). Sonuga-Barke and colleagues have shown that inhibition problems only occur in certain situations and that these are more likely to reflect sensitivity to delay rather than an underlying inhibitory deficit (Sonuga-Barke, 1995; Sonuga-Barke et al., 1996). (See discussion of different views in chapter 3).

2.2.1.1 Impulsiveness

Impulsiveness is defined as acting without reflecting and failure to plan ahead (Johansen et al., 2002; Taylor, 1998).

Impulsiveness manifests as impatience, difficulty in delaying responses, blurting out answers before questions are completed, difficulty awaiting turn and frequently interrupting and intruding on others. These individuals typically make comments out of turn, fail to listen to directions, initiate conversations at inappropriate times, interrupt others excessively, grab objects from others, touch things they are not supposed to and clown around. Impulsiveness may lead to accidents (e .g. knocking over objects, banging into people or grabbing a hot pan), or to engagement in dangerous activities without considering possible consequences (American Psychiatric Association, 2000).

Barkley (1998) describes impulsiveness as a deficiency in inhibiting behaviour in response to situational demands. Those forms of impulsiveness often associated with undercontrol of behaviour, inability to delay a response or defer gratification, and inability to inhibit dominant responses, are the ones most frequently identified in children with ADHD.

Clinically these children:

-Respond quickly to situations without waiting for instructions to be completed and therefore careless errors often result.

-Fail to consider potentially negative or destructive consequences and engage in frequent and unnecessary risk taking.

-Find situations and games that involve sharing/co-operation/ restraint very problematic.

-Verbally say things indiscreetly without regard for feelings, blurt out answers prematurely and interrupt the conversations of others (Barkley, 2003).

Sagvolden (1999a) states that impulsiveness is reflected in an inability to withhold inappropriate responses, such as premature responding, over-rapid responsiveness, excessive attraction to immediate reward, acting without reflecting, recklessness and impetuous behaviour. He also maintains that analysing these behaviour components has shown that altered reinforcement processes can explain impulsiveness. Faced with situations or tasks, in which they have to delay seeking gratification and work towards a long-term goal, they often opt for the immediate and smaller reward that requires less work or effort and takes the least amount of time.

The layman's impression of these children is that they have poor self-control, are irresponsible, immature, lazy and rude (Green & Chee, 1997).

2.2.1.2 Inattention

Attention is a multidimensional construct and can refer to alertness, arousal, selectivity, sustained attention, distractibility and span of apprehension (Barkley, 1998).

Children with ADHD display difficulties with attention, relative to normal children of the same age and gender. The dimension impaired in ADHD reflects an inability to sustain attention or persist at tasks, remember and follow through on rules and instructions, and to resist distractions while doing so (Barkley, 2003).

Inattention may manifest as failure to give close attention to details or making careless mistakes. These children look as if they are not listening or hearing what is said. They tend to shift from one uncompleted task to the next and often don't follow through on requests or instructions, failing to complete schoolwork and chores. They typically avoid activities that demand self-application and mental effort, or that require close concentration, for example homework. Their work habits are disorganised and the materials needed for the task are often lost or damaged. They are easily distracted by outside stimuli and are often forgetful. In social situations, inattention may be expressed as frequent shifts in conversation and not listening to others (American Psychiatric Association, 2000).

Parents and teachers frequently complain that these children do not seem to listen as well as they should for their age, cannot concentrate, are easily distracted, fail to finish assignments, are forgetful and change activities more often than others (DuPaul, Ervin, Hook, & McGoey, 1998).

This is supported by research, with observations that these children: exhibit more "off-task" behaviour and less work production, look away more often from assigned tasks, show less persistence at tedious tasks, are slow and less likely to return to an activity once interrupted and are less capable of shifting attention across tasks flexibly (Borger & van der Meere, 2000; Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001).

2.2.1.3 Hyperactivity

Hyperactivity refers to excessive and developmentally inappropriate levels of activity, both motor and vocal.

Hyperactivity may manifest as restlessness, fidgeting, squirming in one's seat, by not remaining seated when expected to do so, excessive running and climbing in inappropriate situations, difficulty playing quietly, by appearing constantly on the go and talking excessively (American Psychiatric Association, 2000).

These children are described as: getting out of their seats in the classroom, moving around, restlessly moving their arms and legs, playing with objects unrelated to the tasks, talking excessively and out of turn and making excessive noises during quiet activities (Green & Chee, 1997).

Sagvolden and Sergeant (1998) state that hyperactivity may be seen in some situations and absent in others. It may also be absent from novel situations. Thus it may be the failure to regulate the activity level to the setting or task demands that is most problematic in ADHD. It is definitely not just a greater than normal activity level.

2.2.2 Diagnosis

The DSM IV diagnostic criteria for ADHD are some of the most rigorous and most empirically derived criteria available in the history of clinical diagnosis for this disorder.

These criteria were derived from a committee of some of the leading experts in the field, a literature review of ADHD, an informal survey of empirically derived rating scales assessing the behavioural dimensions related to ADHD, by the committee and from statistical analysis of the results of a field trial of the items using 380 children from 10 different sites in North America (Barkley, 2003).

2.2.2.1 DSM IV criteria

According to the DSM IV manual the following criteria must be met in order to diagnose ADHD:

Table 2.1 DSM IV criteria (APA, 1994)

A. Either (1) or (2)

(1) Six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention

Often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities.

Often has difficulty sustaining attention in tasks or play activities.

Often does not seem to listen when spoken to directly.

Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions)

Often has difficulty organising tasks and activities.

Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework).

Often loses things necessary for tasks or activities (e.g. toys, school assignments, pencils, books, or tools.)

Is often easily distracted by extraneous stimuli.

Is often forgetful in daily activities.

(2) Six (or more) of the following symptoms of hyperactivity-impulsiveness have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity

Often fidgets with hands or feet or squirms in seat.

Often leaves seat in classroom or in other situations in which remaining seated is expected

Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feeling of restlessness)

Often has difficulty playing or engaging in leisure activities quietly.

Is often 'on the go "or often acts as if "driven by a motor "

Often talks excessively'

Impulsiveness

Often blurts out answers before questions have been completed.

Often has difficulty awaiting turn

Often interrupts or intrudes on others (e.g., butts into conversations or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before 7 years of age.

C. Some impairment from the symptoms is present in 2 or more settings (e.g., at school (or work) or at home.)

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a pervasive developmental disorder, schizophrenia, or other psychotic disorder and are not better accounted for by another disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, or personality disorder.)

Code based on type:

314.01 Attention-Deficit/Hyperactivity Disorder, Combined Type: if both criteria A1 and A2 are met for the past 6 months

314.00 Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type: if criterion A1 is met but criterion A2 is not met for the past 6 months

314.01 Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive, Impulsive Type: if criterion A2 is met but criterion A1 is not met for the past 6 months

2.2.2.2 ADHD subtypes

Although most individuals have symptoms of both inattention and Hyperactivity-Impulsiveness, there are some individuals in whom one or the other pattern is predominant. Therefore, for a current diagnosis the appropriate subtype should be indicated based on the predominant symptom pattern for the past six months.

ADHD, Combined type should be used if six or more symptoms of inattention and six or more symptoms of Hyperactivity-Impulsiveness have persisted for at least six months.

ADHD, Predominantly Inattentive type should be used if six or more symptoms of inattention (but fewer than six symptoms of Hyperactivity-Impulsiveness) have persisted for at least six months.

ADHD, Predominantly Hyperactive-Impulsive type should be used if six or more symptoms of Hyperactivity-Impulsiveness (but fewer than six symptoms of inattention) have persisted for at least six months (American Psychiatric Association, 2000).

Dykman and Ackerman (1993) concluded in a review, that youngsters with ADHD characterised by predominantly Hyperactive-Impulsive

behaviour, exhibited more problems related to impulse control and aggressive-defiant behaviour (externalising behaviour disorder traits). In contrast, youngsters with ADHD of the Inattentive type expressed greater overanxious, dysthymic, depressive and interpersonal withdrawal symptoms (internalising behaviour disorder characteristics).

2.2.3 Co-morbid disorders and associated impairments

2.2.3.1 Co-morbid disorders

Individuals diagnosed with ADHD are often found to have a number of other disorders. In community-derived samples, up to 44% of ADHD children had at least one other disorder and 43% had at least two or more additional disorders. In clinically diagnosed ADHD children it was found that 87% had at least one other disorder, and 67% at least two or more (Kadesjo & Gillberg, 2001). Jensen and colleagues (2001) found that only 32% of a sample of children with the combined type of ADHD had "ADHD alone".

The major co-morbid conditions of ADHD include: Oppositional Defiant Disorder (ODD), Conduct Disorder (CD), Learning disorders, Anxiety disorders, Mood disorders and Tic disorders (Tourette's disorder) (Sandberg, 2002).

ODD and CD are the most common co-morbid conditions associated with ADHD. Studies of clinic referred ADHD children found that 54-67% will meet criteria for ODD, while 20-50% of these children may have CD (Barkley, 1998; Lahey, McBurnett, & Loeber, 2000). ADHD, ODD and CD

are grouped together under the label Disruptive Behaviour disorders, in the DSM IV.

The overlap of anxiety disorders with ADHD was found to range from 10-40% in clinic-referred children, averaging about 25% (Barkley, 2003). Jensen and colleagues found that anxiety was as common as ODD in their sample of children with Combined subtype ADHD (Jensen et al, 2001).

Evidence of the co-occurrence of mood disorders (major depression and dysthymia) with ADHD is now fairly substantial. Most studies place the association between 20 and 30% (Faraone , Biederman, Wozniak, Mundy, Mennin & O'Donnell, 1997; Jensen, Martin, & Cantwell, 1997; Spencer, Wilens, Biederman, Wozniak, & Harding-Crawford, 2000).

Co-morbid rates for learning disorders vary from 19-26%. This number may increase to 80% depending on criteria used to define learning disability (Barkley, 2003).

2.2.3.2 Associated developmental impairments

Apart from increased risk for various psychiatric disorders, children and adolescents with ADHD are also more likely to experience a substantial variety of developmental, social and health risks (Barkley, 2003). Research has shown that the following impairments are likely to be associated with ADHD: Impaired academic achievement, decreased working memory, impaired planning ability, speech impairments (10-54%), delayed motor co-ordination (up to 52%), sluggish gross motor movements, poor self-regulation of

emotion, greater problems with frustration tolerance and interpersonal and social problems (Barkley, 1998).

ADHD is also associated with medical and health risks such as greater proneness to accidental injury (up to 57% according to Shelton, Barkley, Crosswaite, Moorhouse, Fletcher, Barrett et al. (1998)), possible delay in growth during childhood (Spencer, Biederman, Harding, O'Donnell, Faraone & Wilens, 1996), difficulties surrounding sleep (Ball, Tiernan, Janusz, & Furr, 1997; Gruber, Sadeh, & Raviv, 2000); and greater risks for vehicle accidents (Barkley, Murphy, Dupaul, & Bush, 2002).

2.3 Prevalence and Gender differences

2.3.1 Prevalence

According to Barkley (1998), true prevalence can not be accurately determined, because it can't be strictly defined and precisely measured. It is expert consensus, however that the prevalence of ADHD is approximately three to five percent of the childhood population. This number depends on how ADHD is defined and measured, the population studied and the degree of agreement between parents and teachers

The individual symptoms of ADHD are found in a large percentage of normal children, however, the requirement is that the number and degree of these behavioural characteristics must be developmentally inappropriate for the child's age and gender, before it is considered a clinical disorder (American Psychiatric Association, 2000).

The following is a summary of some research results in terms of prevalence:

Table 2.2 Research results: Prevalence of ADHD

Study	N	Country	Age	M:F	Prev.
Rohde et al (1999)	1013	Brazil	Adol.	11:1	5.8%
Meyer (1998)	2438	SA(N Sotho)	6-12	2.3:1	7.1%
Taylor et al (1998)	U	UK	Prim.	4:1	4-19%
Wolraich et al (1996)	8258	USA	Prim.	U	7.3%
Gadow et al (1997)	1441	USA	Prim.	U	7.7% In. 2% H/I 2.9% Co.

U – Unknown Prim. – Primary school age

Barkley (2003) states that lower prevalence rates result from using complete DSM IV criteria and parent reports (2-6% in Breton, Bergeron, Valla, Berthiaume, Gaudet, Lambert, et al., (1999)), and higher rates if just a cut-off on teacher ratings is used (up to 23% in DuPaul, Power, Anastopoulos, & Reid (1998)) and (15% in Nolan, Gadow, & Sprafkin (2001)).

2.3.2 Ethnic, Cultural and National differences

Studies using DSM IV criteria have found the disorder across numerous countries (Barkley, 2003) and across different ethnic and cultural groups (Luk, Leung, & Ho, 2002). Recent prevalence rates found in different countries are summarised as follows:

Table 2.3 Prevalence rates in different countries

Study	Criteria	N	Ethnicity	Age	Prev.
(Kroes et al, 2001)	Parent ratings	2290	Dutch	6-8	3-8%
(Liu et al, 2000)	Teacher ratings	2936	Chinese	6-11	5.3%
		1694	Chinese	12-16	3.9%
(Rohde et al, 1999)	Teacher ratings	1013	Brazilian	12-14	5.8%
(Pineda et al, 1999)	DSMIV/P.r.	504	Colombian	4-7	20% M
					12% F
(Bu-Haroon et al, 1999)	Teacher ratings	1110	Arabian	Prim.	14.9%
(Gadow et al, 2000)	Parent ratings	600	Ukrainian	10-12	19.8%
(Meyer, 1998)	Teacher ratings	2438	Northern Sotho	6-12	7.1%
					9.6% M
					4.4% F

Research among the different language groups of the Limpopo province of South Africa found prevalence rates similar to Western rates for both genders in all language groups (Meyer, 1998; Meyer et al., 2004).

Cultural differences in the interpretations given to the symptoms of ADHD by teachers and parents and in expectations for child behaviour exist and may have contributed to the higher rates of the disorder found in some of these countries compared to the North American rates (Barkley, 2003). Meyer et al (2004) concluded that, although it seems that various cultures may have different perceptions and interpretations of behaviour, they discriminate between different kinds of behaviour patterns in a similar way as implied in the Western diagnostic systems of ADHD.

2.3.3 Socio-economic differences

Few studies have examined the relationship of ADHD to socio-economic status (SES), and those that have, are not especially consistent (Barkley, 2003). Trites, Dugas, Lynch and Ferguson (1979), and Szatmari (1992) both found that rates of ADHD tended to increase with lower SES. However, in another study Szatmari, Offord and Boyle (1989) found that low SES was no longer associated with rates of ADHD when other co-morbid conditions (for example, Conduct Disorder) were controlled for.

What is clear for now is that ADHD occurs across all socio-economic levels (Barkley, 2003).

2.3.4 Gender differences

The proportion of males versus females manifesting the disorder varies considerably across studies, from 2:1 to 10:1, with an average of 6:1, in clinically referred samples. This may be due to the fact that ADHD boys tend to display more disruptive behaviour than ADHD girls, which results in boys being more frequently referred than girls (Heptinstall & Taylor, 2002).

Gaub and Carlson (1997) did a meta-analysis of past research of gender differences in ADHD and reached the following conclusions:

Clear behavioural gender differences were revealed in several domains, with ADHD girls showing lower levels of hyperactivity, fewer Conduct Disorder diagnoses, lower rates of externalising behaviour but greater intellectual impairment.

Among clinic-referred samples, girls and boys with ADHD showed similar levels of impairment on internalising behaviour, peer aggression and peer dislike. Inattention was the exception, as a trend for greater severity among girls was found.

Gender differences did not emerge for several domains, including level of impulsivity, academic performance, social functioning, fine motor skills and parental education.

A study by Sharp, Walter, Marsh, Ritchie, Hamburger and Castellanos (1999) compared a sample of girls with previously studied boys. They found

that girls with DSM IV combined type were strikingly similar to the boys. On the other hand, when there were differences, they were mostly in the direction of greater severity for the girls.

2.4 The diagnostic process

This will be discussed in Chapter 4

2.5 Treatment of ADHD

Treatment strategies for ADHD should be designed to address the behavioural, cognitive, family and social problems characteristic of ADHD (Coffey, 1997). Multimodal treatment is recommended (Meyer & Aase, 2003; Taylor et al., 1998) and should involve both pharmacological and psychosocial interventions (Swanson, Sergeant, Taylor, Sonuga-Barke, Jensen & Cantwell, 1998a; Taylor et al., 1998).

2.5.1 Pharmacological intervention

Various controlled trials with thousands of patients, and views expressed in thousands of clinical and empirical reports have established consensus about the use of stimulant medication in the treatment of ADHD. This includes the fact that they reduce the symptoms of ADHD, where 80% of patients have clinically meaningful benefits, and that, despite some common side effects, these medications are safe. They were also found not to be addictive when used in the correct doses and to be effective in treating adults with ADHD (Elia, Ambrosini, & Rapoport, 1999; Gillberg et al., 1997;

Greenhill, Halperin, & Abikoff, 1999; Solanto, 1998; Swanson, Wigal, Udrea, Lerner, Agler, Flynn, et al., 1998b; Wilens & Biederman, 1992).

Psychostimulants (D-amphetamine (Dexedrine®); Methylphenidate (Ritalin®) and D-L-amphetamine (Adderall®)) have been shown to significantly improve the core symptoms of ADHD (inattention, impulsiveness and hyperactivity) (Elia et al., 1999; Greenhill et al., 1999; Solanto, 1998). These improvements were more pronounced in hyperactive-impulsive behaviour than in inattention (Swanson, Pfiffner, Wigal, & McBurnett, 1993).

Ritalin® (methylphenidate) is the medication of choice. This medication influences the actions of both norepinephrine (noradrenaline) and dopamine in the synapse and, specifically, alters the activity of the nigro-striatal and meso-cortico-limbic dopaminergic systems, as well as noradrenergic projections from the locus coeruleus to the cortex (Solanto, 1998). It is effective for four hours and is usually given two to three times per day (Solanto, 1998; Swanson, Castellanos, Murias, LaHoste and Kennedy, 1998).

Solanto (1998) states that robust data is available regarding the safety and efficacy of Methylphenidate (Ritalin) in the short-term treatment of ADHD children aged 5 to 14 years. In spite of these findings there is still controversy, especially among the general public in terms of the use of these medications.

2.5.2 Psychosocial interventions

There appears to be agreement that a psychosocial intervention for ADHD should include a behaviour therapy program, involving parent and teacher training, as well as behaviour modification techniques (Barkley, 1998; Coffey, 1997; Meyer & Aase, 2003; Pelham., Wheeler, & Chronis, 1998; Taylor, 1998).

Behaviour therapy programs for ADHD children aim to teach parents and teachers behaviour management skills based on sound behavioural learning principles. These include: educating parents and teachers about the disorder; consulting with the parents and school in terms of appropriate placement and management; helping the parents and teacher identify specific problem situations, and finding behaviour management techniques for them. The most widely used of these techniques are: paying positive attention to appropriate behaviour and compliance; communicating commands and setting rules more effectively; and using appropriate negative consequences for problem behaviours (Barkley & Murphy, 1998; Meyer & Aase, 2003; Taylor et al., 1998).

Pelham and colleagues reported that two psychosocial interventions have been proven to meet the criteria for a well-established treatment of ADHD: behavioural parent training, and behavioural intervention in the classroom setting (Pelham et al., 1998). Both of these interventions are based on the general principles of behavioural modification (reinforcement,

punishment, extinction and stimulus control) and have been in use for over 30 years.

Swanson et al. (1998a) reported that these interventions have limited short-term effects on some ADHD symptoms like hyperactivity, but large effects on associated features like opposition, defiance and aggression.

2.5.3 Long-term effects of treatment

Extensive research has documented the short-term effectiveness of both stimulant medication (Swanson et al., 1998b) and psychosocial treatments (behavioural parent training and behavioural token systems in the classroom) (Pelham et al., 1998). Little controlled research has been conducted to evaluate the long-term effectiveness of these two treatment modalities (National Institutes of Health, 2000).

This issue was addressed in the MTA study that evaluated the long-term effects of pharmacological and psychosocial interventions in children with ADHD. The main finding of this study was that carefully crafted medication management was superiour to behavioural treatment and to routine community care that included medication. Combined treatment did not yield significantly greater benefits than medication management for core ADHD symptoms, but may have provided modest advantages for non-ADHD symptoms and positive functioning outcomes (MTA-Cooperative Group, 1999).

2.6 Prognosis and outcomes of ADHD

A number of longitudinal studies following children and adolescents with disruptive behaviour disorders (ADHD, ODD and CD) found that they had higher rates of antisocial personality disorder, substance abuse, poor educational and occupational status, more frequent job changes as compared with controls, lower self-esteem and poorer social skills (Barkley, Fischer, Smallish, & Fletcher, 2002; Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993).

Follow-up studies in the USA confirmed a poor prognosis (Swanson et al., 1998a). A 10 year follow-up of 7 year old boys in London found that hyperactive behaviour was a strong risk factor for later psychiatric diagnosis, antisocial behaviour, and social and peer problems, even after allowing for a coexisting conduct disorder (Taylor, Chadwick, Heptinstall, & Danckaerts, 1996).

Biederman, Mick, and Faraone (2000) reported that the symptoms of hyperactivity and impulsiveness tend to decline at a higher rate and at an earlier age, than those of inattention.

Based on these findings, that ADHD symptoms continue into adolescence and adulthood, and that it is a risk factor for later psychiatric disorders and social dysfunction, it is clear that a better understanding of the disorder, leading to improved and timely interventions, is essential (Sagvolden et al., 1998a).

Chapter 3

THE NEUROBIOLOGY OF ADHD

3.1 Genetics

Strong support for the neurobiological basis for ADHD is provided by many studies showing that the disorder runs in families. Twin, adoption and family studies provide convincing evidence for a genetic component in ADHD (Samudra & Cantwell, 1999). Recent molecular investigations into specific genes also support this position (Zametkin & Liotta, 1998).

3.1.1 Adoption studies

A study of three groups of children (adopted children with ADHD, children with ADHD living with their biological parents, and a control group) showed a pattern of elevated prevalence among just the biological parents of ADHD children (6% vs. 18% vs. 3% respectively) (Sprich, Biederman, Crawford, Mundy, & Faraone, 2000).

Van den Oord, Boomsma and Verhulst (1994) identified a strong genetic component for the attention problem dimension of the CBC (Children's Behaviour Checklist). This scale has a strong association with the diagnosis of ADHD (Achenbach & Ruffle, 2000).

3.1.2 Twin studies

A study by Goodman and Stevenson (1989) found a 51% concordance rate for hyperactivity in 39 pairs of monozygotic twins, compared with 33% in dizygotic twins. The same study showed heritability of 64% for hyperactivity and inattention. Other large-scale twin studies are consistent with these findings (Edelbrock, Rende, Plomin, & Thompson, 1995; Gillis, Gilger, Pennington, & DeFries, 1992; Kuntsi et al., 2001; Stevenson, 1992; Gjone, Stevenson, & Sundet, 1996).

Recent studies found a degree of heritability, ranging from 0,75 to 0,97 (Burt, Krueger, McGue, & Iacono, 2001; Coolidge, Thede, & Young, 2000; Thapar, Holmes, Poulton, & Harrington, 1999). These studies show an average heritability of at least 0,80 for ADHD. These studies also consistently found little, if any effect of shared (rearing) environment on the traits of ADHD.

3.1.3 Family studies

For years, researchers have noted higher prevalence of psychopathology in the parents and other relatives of children with ADHD. Higher rates of ADHD, conduct problems, substance abuse and depression have been repeatedly observed in these studies (Barkley, DuPaul, & McMurray, 1990; Biederman, Munir, Knee, Habelow, M'Armentano, Autor et al., 1992; Pauls, Leckman, & Cohen, 1993)

Research by Biederman and colleagues found that if a parent has ADHD the risk in the offspring is 57% (Biederman, Faraone, Mick, Spencer, Wilens, Kiely et al., 1995).

Thus, ADHD clusters among biological relatives of children or adults with the disorder, strongly implies an hereditary basis to this condition (Barkley, 1998).

3.1.4 Molecular genetic research

The next step in genetic research is to search for variations of specific genes that are functionally associated with ADHD. Stimulant medication has pronounced effects on the catecholamine systems, norepinephrine (NE) and dopamine (DA). Therefore genes that govern the NE and DA systems were a logical place to start (Pliszka, 2003). Most genetic research however, has concerned the dopaminergic genes (Pliszka, 2003; Swanson, Flodman, Kennedy, Spence, Moyzis, Schuck et al., 2000b).

Two candidate dopaminergic genes have been investigated: the **dopamine transporter gene (DAT1)** and the **dopamine receptor D4 gene (DRD4).**

The DAT1 gene was associated with ADHD in several studies (Cook, Stein, Krasowski, Cox, Olkon, Kieffer et al., 1995; Gill, Daly, Heron, Hawi, & Fitzgerald, 1997). However, others have not been able to replicate this association (Holmes, Payton, Barrett, Hever, Fitzpatrick, Trumper et al., 2000; Swanson et al., 2000b).

The DRD4 (repeater gene) was most reliably found in samples of children with ADHD (Faraone, Biederman, Weiffenbach, Keith, Chu, Weaver et al., 1999; Swanson, Oosterlaan, Murias, Schuck, Flodman, Spence et al., 2000a; Swanson et al., 2000b; Thapar, Holmes, Poulton & Harrington, 1999). Specifically, it was the 7-repeat form of this gene that was found to be over-represented in children with ADHD (LaHoste, Swanson, Wigal, Glabe, Wigal et al., 1996). This gene was previously associated with the personal trait of high-novelty-seeking behaviour and the gene's impact on postsynaptic sensitivity is primarily found in frontal and prefrontal cortical regions, believed to be associated with executive functions and attention (Barkley, 1998).

Swanson et al. (2000b) give a summary of several studies investigating dopamine genes and indicate that all three published studies of the DAT1 gene reported an association with ADHD, while four of the five studies reported an association of the DRD4 gene with ADHD.

Both of these dopamine genes were reported to be associated with ADHD in different samples, but the association was not strong. This indicates that ADHD has multiple causes and other factors must be specified to understand the aetiologies of ADHD (Sunohara, Roberts, Malone, Schacher, Tannock, Basile et al., 2000; Swanson et al., 2000a; Swanson et al., 2000b).

Five dopamine receptor subtypes, coded by five different genes, have been identified and grouped into 2 families: D1-type, consisting of subtypes D1 and D5; and the D2-type, consisting of subtypes D2, D3 and D4 **(Figure 3.3)**. The D1 and D2 receptor subtypes are present in high concentrations in the accumbens and caudate/putamen complex, the D3 and D4 receptors are sparse compared to the other receptors, but are localised in the meso-cortico-limbic pathway, while the D5 receptors are limited to the hippocampus, hypothalamus and cortex (Solanto, 1998).

According to Sagvolden (1999), ADHD seems to have genetic components associated with genes coding for receptors in the dopamine D2 family and membrane dopamine transporter (DAT) proteins. It is however unlikely that one gene will account for the whole ADHD syndrome.

It is possible that dopamine genes may contribute to a dopamine deficit. This in turn may produce under activity in dopamine pathways, both the ***meso-cortico-limbic pathway*** (rich in D4 dopamine receptors in the frontal lobes) and the ***nigro-striatal pathway*** (rich in D2 dopamine receptors) (Swanson, Castellanos, Murias, LaHoste, & Kennedy, 1998).

3.1.5 Other factors producing dopamine dysfunction

Johansen et al. (2002) argue that dopamine dysfunction plays a pivotal role in the neurobiology of ADHD. Therefore, ADHD-like symptoms may be produced not only by genetic factors, but also by any other agent that alters dopaminergic functioning. This includes some environmental pollutants

(Holene, Nafstad, Skaare, Bernhoft, Engen & Sagvolden, 1995; Sagvolden, 2000) and chronic intake of dopamine agonists like cocaine and amphetamines (Solanto, 1998; Swartz & Breen, 1993).

3.2 Brain imaging

Brain imaging consists of several techniques that are used to try and view the neurochemical and neuroanatomical differences in people with ADHD. These techniques can be broken down into two types: structural or functional.

Computerised Tomography (CT) and Magnetic Resonance Imaging (MRI) provide structural images, while Single Photon Emission Tomography (SPECT) and Positron Emission Tomography (PET) produce functional images. Functional magnetic resonance imaging (fMRI) combines both structural and functional techniques, by measuring blood flow (Zametkin & Liotta, 1998).

3.2.1 Structural studies (CT, MRI)

Results from earlier studies, using CT scans, showed no significant differences between ADHD and normal children (Nasrallah, Loney, Olson, McCally Whitters, Kramer & Jacoby, 1986; Shaywitz, Shaywitz, Byrne, Cohen, & Rothman, 1983).

The MRI scan has higher resolution and gives a better analysis of brain structure; these scans have begun to suggest differences in some brain regions

in those with ADHD. Findings from several independent studies have identified two brain regions (frontal lobes and basal ganglia) that are smaller in ADHD groups, compared to control groups (Aylward, Reiss, Singer, Brown & Denckla, 1996; Castellanos et al., 1996). Volumetric measurements of the caudate nucleus indicate a smaller right caudate nucleus in ADHD boys (Filipek, Semrud-Clikeman, Steingard, Renshaw, Kennedy & Biederman, 1997).

Castellanos et al. (1996) and Castellanos et al. (2001) confirmed that the right anterior frontal caudate and globus pallidus regions were smaller in an ADHD group than in a control group. It was also found that the volumes of the cerebellar hemispheres were significantly smaller in ADHD boys. Another study confirmed this finding (Mostofsky, Reiss, Lockhart, & Denckla, 1998).

3.2.2 Functional studies (PET, SPECT)

Although it has been claimed that SPECT imaging is clinically useful, to date quantitative clinical research studies have not appeared to support these claims. SPECT scans also involve significant doses of ionising radiation, which raises ethical issues in terms of their use in research (Zametkin & Liotta, 1998).

PET research has started to provide some insights into the field of ADHD. PET scans analyse brain glucose metabolism. A study by Zametkin, Liebenauer, Fitzgerald, King, Minkunas and Herscovitch (1993), found significant reductions in the brain metabolism of adolescents with ADHD

(Zametkin & Liotta, 1998). Many of these studies found a decrease in brain metabolism of the basal ganglia (Matochik, Nordahl, Gross, Semple, King, Cohen et al., 1993; Zametkin, 1990; Zametkin et al., 1993). These findings are of importance, given the hypothesis implicating the corticostriatal circuits in ADHD.

The fMRI scan has only recently been used to study ADHD. A study by Rubia, Overmeyer, Taylor, Brammer, Williams, Simmons et al. (1999) reported differences in frontal striatal circuitry. This study also scanned subjects while they were performing a stop task and a "delay" task. Hyperactive subjects showed less brain activity (predominantly in the right frontal cortex) during both tasks, and in the right inferior prefrontal cortex and left caudate nucleus during the stop task.

These findings are consistent with earlier PET studies. There is a need for more research in this area (Zametkin & Liotta., 1998).

3.3 Neurochemistry

As mentioned before, most theories emphasise the role of the neurotransmitters dopamine and norepinephrine, in the deficits underlying ADHD.

Castellanos (1997) extended a unitary dopamine theory by proposing that different abnormalities might exist in 2 dopamine regions: underactivity in a cortical region (i.e. anterior cingulate) resulting in cognitive deficits; and overactivity in a subcortical region (i.e. caudate nucleus) resulting in motor excesses.

Arnsten, Steere and Hunt (1996) modified the noradrenergic theory of ADHD in a similar way. They proposed that different abnormalities may exist in 2 noradrenergic regions: underactivity in a cortical region (dorsolateral prefrontal) resulting in primary memory deficits; and overactivity in a subcortical region (Locus coeruleus), resulting in overarousal.

Solanto (1998) suggested the possibility of relative overactivity both in the dopaminergic and the noradrenergic systems.

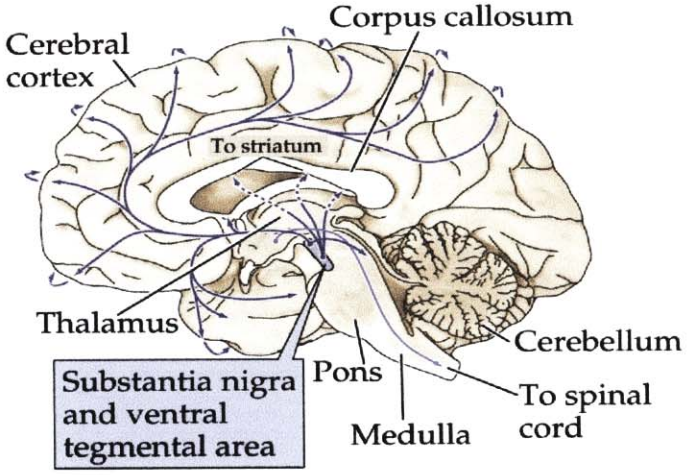
Sagvolden and co-workers suggest that ADHD symptoms are caused by reduced dopaminergic functions (Johansen et al., 2002; Sagvolden, 1999a; Sagvolden & Sergeant, 1998b).

The dopaminergic system consists of two major branches:

The **nigro–striatal branch**: originating in the substantia nigra and projecting mainly to the neostriatum (caudate / putamen complex).

The **meso–cortico-limbic-branch:** originating in the ventral tegmental area and projecting to the prefrontal cortex and nucleus accumbens (Sagvolden & Sergeant, 1998b). **(See figure 3.1)**

Figure 3.1 - Dopamine Pathways (Purves et al, 2001)



3.4 Theoretical viewpoints of deficits underlying ADHD

Various attempts have been made to describe ADHD in terms of fundamental neuropsychological or behavioural characteristics. Among the most influential of these is Barkley's (1998) theory of behavioural disinhibition.

3.4.1 Barkley's theory of behavioural disinhibition

Barkley (1998) argues that poor behavioural inhibition is the core deficit of ADHD. This impairs the development of executive functions necessary for self-regulation of behaviour, cognition and emotion, leading to deficits in 4 types of executive functions. These are: working memory; self-regulation of arousal, affect and motivation; internalisation of speech to

mediate behaviour via internalised rules and active problem solving; and reconstitution (the ability to analyse and synthesise information in order to solve social and cognitive problems) (Solanto-Gardner, Arnsten & Castellanos, 2001).

3.4.2 Sergeant's cognitive energetic theory

Sergeant and colleagues (1999) argue that disinhibition is inadequate to account for ADHD deficits and have suggested additional deficits of cognitive self-regulation in terms of availability and/or allocation of cognitive resources (Solanto-Gardner et al., 2001). They characterise the core deficit of ADHD as a state (activation) deficit, rather than a process deficit, that selectively affects output stages rather than input stages of information processing, and do not support the hypothesis of behavioural inhibition (Swanson et al, 1998).

3.4.3 Swanson's neuroanatomical network theory of attention

Swanson and colleagues (1998) characterised the core deficit of ADHD as a combination of alerting and executive control deficits. According to this framework, state and behavioural inhibition deficits would be considered as attentional deficits (Swanson, Posner, Cantwell et al, 1998c).

3.4.4 Sonuga-Barke's dual pathway model

Sonuga-Barke (2002), in conjunction with the National Institute for Mental health (NIMH), compared the two main opposing views of the deficits underlying ADHD. This study suggests that the poor inhibitory control and delay aversion put forth by these two viewpoints are independent,

co-existing characteristics of ADHD (combined type). These findings were used to propose a dual pathway model of ADHD, that recognises two distinct subtypes of the disorder. One subtype is the result of dysregulation of thought and actions resulting from poor inhibition control associated with the meso-cortical branch of the dopamine system projecting to the cortical centres (e.g. prefrontal cortex). The other subtype is a motivational style characterised by altered delay of reward gradient linked to the meso-limbic dopamine branch associated with the reward circuits (e.g. nucleus accumbens).

This model predicts that **DTAP** (dysregulation of thought and action pathway) ADHD will be context independent, associated with relatively severe and generalised cognitive dysregulation, be categorical in nature and be less strongly associated with genetic factors. The **MSP** (motivational style pathway) ADHD will be context (environment) dependant, have a more limited pattern of cognitive impairments associated with the provision, protection and utilisation of time, be a continuously distributed trait and be closely associated with genetic factors.

Therefore this model describes ADHD as a developmental outcome of two distinct psychological/developmental processes.

3.4.5 A central nervous system theory of ADHD

3.4.5.1 Neurochemical factors

Sagvolden and co-workers suggest that ADHD symptoms are caused by a dysfunctioning dopamine system, that impairs signal transmission (Johansen et al., 2002; Sagvolden, 1999).

A dysfunctioning meso-cortico-limbic dopamine branch will produce altered reinforcement and extinction processes, that on a behavioural level give rise to deficient sustained attention, hyperactivity, behavioural variability, motor and cognitive impulsiveness.

A dysfunctioning nigro-striatal dopamine branch will manifest as poor motor control, longer reaction times, poor response timing, poor handwriting etc. (See more detailed discussion in 3.5)

It is argued that the key features of ADHD (deficient sustained attention, overactivity and impulsiveness) may all be due to altered reinforcement mechanisms and a shorter delay of reinforcement gradient (Sagvolden, Aase, Zeiner & Berger, 1998a).

3.4.5.2 Delay of reinforcement gradient (delay gradient)

This can be explained as follows: A stimulus is a positive reinforcer if its presentation increases the probability that the responses that produced it will occur again. The reinforcement contingencies are the conditions under which a response produces a reinforcer (reward) (Sagvolden, 1999a)

Reinforcers act on responses that already took place by increasing the probability of future responding.

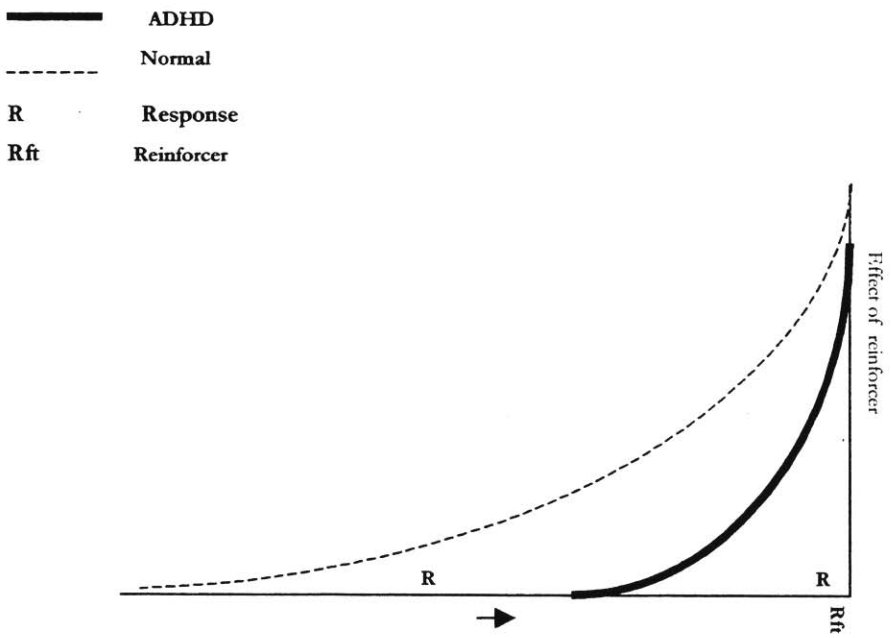
Children with ADHD prefer immediate reinforcers and cannot wait for delayed ones. Their problems seem to occur in situations with low stimulation or low reinforcement density. The reinforcement effect is largest when the reinforcer is delivered immediately after the occurrence of a response and wanes as a function of the delay of the delivery of the reinforcer.

This relation between the effect of the reinforcer and the time interval between response and reinforcer is known as the "delay-of-reinforcement gradient" (Johansen et al., 2002).

The theory postulated by Sagvolden and co-workers states that children with ADHD have a steeper or shorter delay gradient based on a genetically based hypofunctioning dopamine system (Johansen et al., 2002;Sagvolden, 1999a; Sagvolden, 1999b).

Fig. 3.2 Delay-of-reinforcement gradient (Johansen et al., 2002)

The effect of a reinforcer is more potent when the delay between the response and the reinforcer is shorter than when the delay is long. The delay gradient may be steeper and shorter in children with ADHD (Figure 3.2)



3.4.5.3 Neuroanatomical factors

The three different neuroanatomical systems with reduced dopamine are:

- The neostriatum
- The accumbens
- The frontal cortex

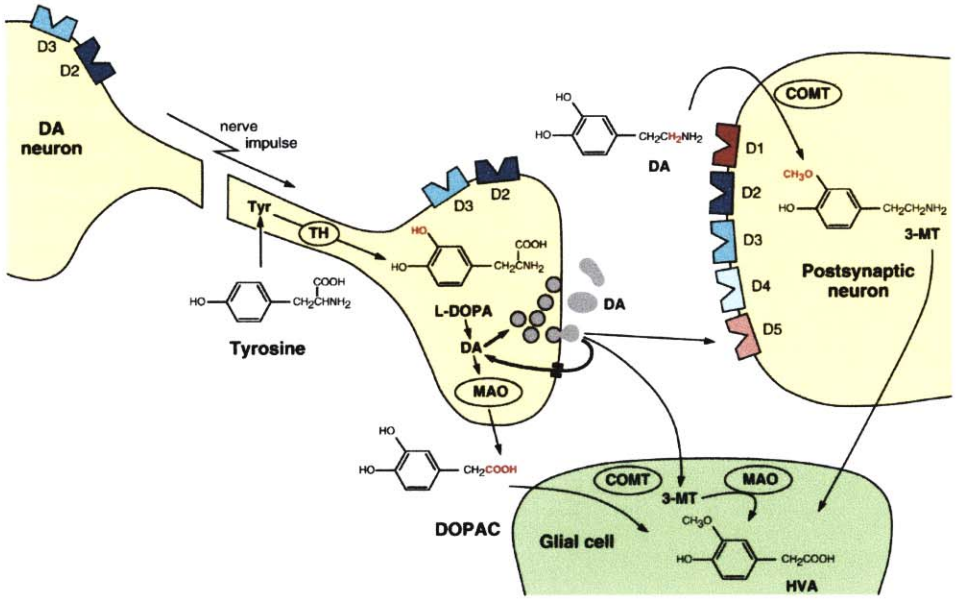
The accumbens is usually implicated in reinforcement, therefore, Sagvolden et al. (1998b) state that the altered delay of reinforcement gradient, overactivity, attention problems and impulsiveness seen in ADHD are associated with the dopamine deficiency seen in the accumbens.

The frontal cortex receives a major dopamine input from the ventral tegmental area. There are well-documented changes in the structure and function of the right frontal cortex in ADHD and impaired executive functions associated with frontal dysfunction (Oades, 1998; Solanto, 1998). Sagvolden et al. (1998b) reported, however that the present research did not unequivocally support this.

The Neostriatum, or caudate/putamen complex

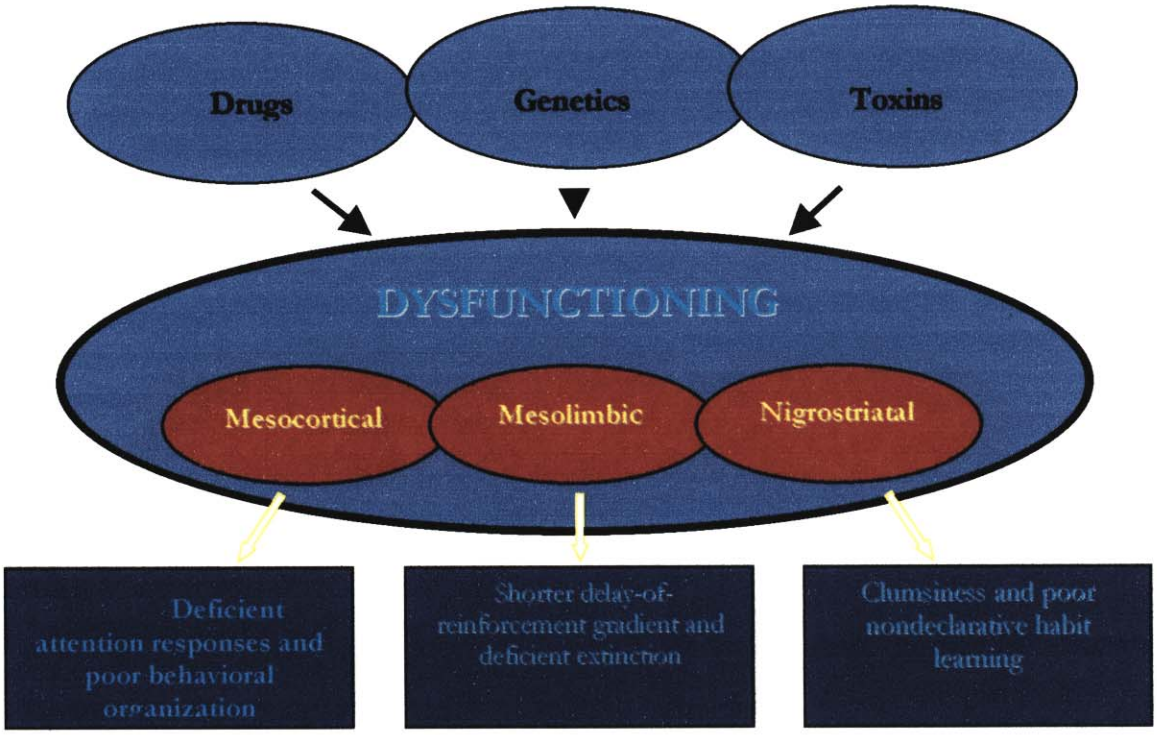
The neostriatum receives the most dense dopamine input of all central-nervous structures. There are anatomical and functional changes in the ADHD neostriatum. Sagvolden (1999a), suggests that symptoms previously explained as response disinhibition problems due to frontal lobe dysfunction, may be due to impaired motor functions associated with dopamine hypo-functioning of the neostriatum.

Fig. 3.3 A dopamine synapse (Modified after Waters, 1995)



The theory by Sagvolden and co-workers can be summarised as follows. **(Figure 3.4)**

Fig. 3.4 A Neurobiological model of ADHD (Johansen et al, 2002)



3.5 Motor functioning in children with ADHD

Motor problems, often characterised as clumsiness or poor motor co-ordination, have been associated with ADHD in addition to the main symptom groups of inattention, impulsiveness and overactivity (Blondis, 1999) (See 3.5.1 Gillberg's DAMP theory).

Children with ADHD may show several motor problems, including longer and more variable reaction times (Brandeis et al., 1998; Oosterlaan & Sergeant, 1998; Rubia et al., 1998), increased variability in speed and less accurate response re-engagement (Oosterlaan & Sergeant, 1998), and impaired orienting responses with very long reaction times (Douglas, 1999).

A dysfunctioning nigro-striatal dopamine branch would be expected, according to the theory by Sagvolden and co-workers (Johansen et al, 2002; Sagvolden & Sergeant, 1998), to cause several 'extrapyramidal' symptoms (neurological 'soft signs') associated with ADHD in the form of impaired timing and force regulation of muscle groups. This may manifest as poor motor control (clumsiness), longer reaction times, poor response timing, abnormal control of eye saccades, poor handwriting and poor correlation of the activity of different body parts (Kadesjo & Gillberg, 1999).

Thus, findings that were previously attributed to response inhibition due to frontal- lobe dysfunction may rather be due to impaired motor control associated with dopamine dysfunction of the neostriatum (Douglas, 1999; Johansen et al., 2002; Sagvolden, 1999a; Sagvolden et al., 1998b). The current view is that mainly manual motor skills seem to be affected in children with ADHD (Pereira, Landgren, Gillberg, & Forssberg, 2001a). A recent study suggests that it is specifically subtle fine motor skills that are problematic in ADHD (Steger, Imhof, Coutts, Gundelfinger, Steinhausen & Brandeis, 2001). This was confirmed by Meyer, Aase and Sagvolden (In press).

3.5.1 Deficits of attention, motor control and perception (DAMP)

Although this concept has been criticised and is not widely used, it does deserve mention. The concept of DAMP (deficits in attention, motor control and perception) has been in use in Scandinavia for 20 years. DAMP is diagnosed on the basis of concomitant ADHD and DCD (developmental co-ordination disorder) (Gillberg, 2003). DCD refers to a common motor problem, previously called " clumsy child syndrome", that may be manifested by marked delays in achieving motor milestones, dropping things, "clumsiness", poor performance in sports or poor handwriting (APA, 1994).

Chapter 4

ASSESSMENT METHODS OF ADHD

4.1 General introduction

There are various expert consensuses, which largely agree what steps should be included in an evaluation of ADHD. The American Academy of Pediatrics published guidelines stating that an assessment should contain information from multiple sources including, interviews with parents and child, reports from teachers, rating scales completed by both parent and teacher and behavioural observations. (American Academy of Pediatrics, 2000).

According to Barkley (1998) the three most important components to a comprehensive assessment of ADHD are the clinical interview, the medical examination and behaviour rating scales. Clinicians should also attempt to supplement findings from these, with objective measures like psychological tests of attention or direct observation of behaviour.

Taylor et al. (1998) agree that an assessment should comprise a clinical interview with the parents, and separately with the child; obtaining school information; testing intelligence, achievement, attention and impulsiveness as

indicated; making behavioural observations during the clinical examination and a physical examination.

An important part of the assessment process is to rule out any other condition that could account for the problems observed and to investigate any coexisting or co-morbid conditions (Meyer & Aase, 2003).

4.2 The components of an assessment of ADHD

This includes the clinical interview with the parent, child and teacher, behaviour rating scales, medical examination and psychological testing.

4.2.1 The clinical interview

The clinical interview can consist of open-ended questions, focused questions about specific behaviours, and standardised interviews, questionnaires and rating scales (American Academy of Pediatrics, 2000)

Standardised interviews

The most current standardised interview for the assessment of child and adolescent psychopathology is the Diagnostic Interview Schedule for Children, which has a parent version (DISC-P) and a child version (DISC-C) (Schaffer & Greenhill, 1979). Although this interview is cumbersome and time consuming, it is keyed directly to the DSM IV and permits the clinician to make an accurate diagnosis of ADHD, ODD or CD (Meyer & Aase, 2003).

4.2.1.1 The parent interview

Although the parent interview is criticised for its unreliability and subjectivity, it is an indispensable part of the evaluation process, as the parents can provide important information about the child's difficulties (Barkley, 1998). The interview with the parents is used to gather information about the following:

Major parental concerns

General descriptions of concerns by parents must be followed with specific questions about the nature of the symptoms (keeping DSM IV criteria in mind), age of onset, chronicity and situational variation of these behaviours (Barkley, 1998; Barkley & Murphy, 1998). The focus here is on a systematic evaluation of symptoms and how they developed (Meyer & Aase, 2003; Taylor et al., 1998).

Developmental history

The developmental history of the child is very important and should include any previous professional reports. Information should include:

Pregnancy and birth history, including the mother's health, nutrition and drug use during pregnancy; details about the birth and any complications, as well as birth-weight and neonatal health (Taylor et al., 1998).

Early developmental history, that includes motor and language milestones, temperament, attachment and sleep or feeding problems.

Medical history, including health status since birth, history of hospitalisation, medications, and problems like tics or epilepsy.

Family functioning, that includes family history and current functioning in terms of parenting styles and relationships, expressed warmth or hostility, family problems (emotional, financial etc.), presence of symptoms in other family members, and any traumatic events (Barkley, 1998; Taylor et al., 1998).

Psychosocial functioning, including peer relationships, friendships and recreational activities (Barkley, 1998; Barkley & Murphy, 1998).

During the interview, the presence of any related problems or co-morbid conditions should be explored.

4.2.1.2 The child interview

The child interview is an opportunity to interact with the referred child. Although it is useful to note the child's behaviour, compliance, attention span, activity level and impulse control, clinicians must guard against drawing any diagnostic conclusions when the children are not problematic during the interview. The novelty of the interview situation may suppress symptoms temporarily, which can lead to false negative diagnosis (Swanson et al., 1998a).

4.2.1.3 The teacher interview

It is important to obtain information from the teacher about behaviour and behaviour problems in the classroom, developmental and social

functioning and situational variation in behaviour. This can occur by telephone and may help to further clarify the nature of the child's problems. Many ADHD children have problems with academic performance and classroom behaviour, and this information is important. This can also include standardised questionnaires and rating scales (Rutter, Taylor, & Hersov, 1994; Taylor et al., 1998)

4.2.2 Behaviour rating scales

An important part of the evaluation is the child behaviour rating scales for parents and teachers. These offer a means of gathering information from informants who may have spent months or years with the child. Rating scales can be given before the interview to focus the interview on those areas of abnormality highlighted in the responses to scale items. In addition, rating scales can be used during the process of treatment, to monitor progress over time or the effects of different doses of medication (Barkley, 1998).

Although rating scales provide important information about clinical history, and the presence or absence of symptoms, they are commonly compromised by rater-specific effects and should be confirmed by the interview and interpreted with caution (Swanson et al., 1998a).

A variety of behaviour rating scales exists. These scales can be "broad band" or "narrow-band" scales.

4.2.2.1 Broad-band scales

These scales cover the major dimensions of child psychopathology, like depression, anxiety, withdrawal, aggression and inattentive and hyperactive behaviour. Such scales include the **Behavioural Assessment system for children (BASC)** (Reynolds & Kamphaus, 1994), the **Child Behaviour Checklist (CBCL)** (Achenbach & Ruffle, 2000) and the **Personality inventory for children** (Lachar, 1982).

The American Academy of Pediatrics (2000) reported that these broad, non-specific rating scales generally have an odds ratio of <2.0 (equivalent to sensitivity and specificity <86%) in studies differentiating referred from non-referred children, and are therefore not recommended in the diagnosis of ADHD.

4.2.2.2 Narrow-band scales

These scales focus specifically on the symptoms of Disruptive Behaviour Disorders (DBD), like ADHD. They are brief, inexpensive and easily administered, and can be completed by teachers or parents, but preferably both (Meyer & Aase, 2003).

Rating scales are commonly used both in assessment and treatment monitoring of Disruptive Behaviour Disorders (Swanson et al., 1998a). These scales include: the Disruptive behaviour disorders rating scale (DBD) (Pelham, Gnagy, Greenslade, & Milich, 1992; Pillow, Pelham, Jr., Hoza, Molina, & Stultz, 1998) that obtains ratings of the DSM IV symptoms of

ADHD, ODD (Oppositional Defiant Disorder) and CD (Conduct Disorder); the Conners rating scales (Conners Parent Rating Scale-CPRS and Conners Teacher Rating Scale- CTRS) (Conners, Sitarenios, Parker, & Epstein, 1998b; Conners, Sitarenios, Parker, & Epstein, 1998a); and the Barkley Home and School situations questionnaire (Barkley & Murphy, 1998).

These narrow, ADHD-specific rating scales appear to accurately distinguish between children with and without the diagnosis of ADHD (American Academy of Pediatrics, 2000).

The DBD rating scale has been translated into the six languages spoken in the Limpopo Province of South Africa and norms that are used in the screening for ADHD have been established (Meyer et al., 2004). This is an important step in making the use of these scales appropriate, valid and reliable for different language and cultural groups in South Africa.

4.2.3 The medical examination

The medical examination is important as a way to exclude medical conditions as a cause of the behaviour problems. This should include a general examination of physical health, evidence of congenital disorder (e.g. foetal alcohol syndrome, neurofibromatosis), an assessment of vision and hearing, any evidence of neurodevelopmental immaturity in gross and fine motor functions, and motor and vocal tics (Taylor et al., 1998).

4.2.4 Psychological tests

Although psychological tests are useful, in that they can provide additional information and aid in exploring co-morbid conditions, the diagnosis of ADHD must be based on information from various sources and not just on the results of tests (American Academy of Pediatrics, 2000; Swanson et al., 1998a).

According to Barkley (1998) psychological testing can help the clinician address the three fundamental questions underlying the evaluation of ADHD:

1. Is the diagnosis justified?

2. If the diagnosis is not justified, are there alternative explanations that better account for the symptoms?

3. If the diagnosis is justified, are there co-morbid conditions that should be identified and treated?

4.2.4.1 A review of tests

Many clinicians, especially psychologists administer a variety of psychological and neuropsychological tests. The tests incorporated into ADHD-related evaluations tend to fall into four categories:

- Cognitive/achievement tests
- General neuropsychological batteries

- Individual neuropsychological tests
- Projective / personality tests.

4.2.4.1.1 Cognitive / achievement tests

Tests of IQ and achievement are useful, and should always be considered if problems are reported in terms of classroom adjustment or progress (Taylor et al., 1998). These tests are often considered central to differential diagnosis, and can play a key role in the identification of, for example, learning disorders. They have however, not been shown to be of value in detecting ADHD characteristics. In other words no subtest or configuration of subtests is sufficiently sensitive or specific to the disorder (Barkley, 1998).

4.2.4.1.2 General neuropsychological batteries

ADHD evaluations may include the administration of formal neuropsychological test batteries, like the Halstead-Reitan (Reitan, 1964) and Luria-Nebraska (Golden, Purisch, & Hammeke, 1985) batteries. These consist of various subtests that assess a broad range of neuropsychological functions (Lezak, 1995).

The evidence of a strong neurobiological basis for ADHD symptoms justifies their inclusion. The rationale is: if neurobiological factors, like frontal lobe dysfunction, heavily contribute to ADHD, then neuropsychological testing should be useful in testing for the presence and strength of those factors (Barkley, 1998).

Based on a review of literature, there appears to be no basis for suggesting routine administration of these batteries in an ADHD evaluation. No subtest or combination of subtests within these batteries demonstrated predictive value (Schaughency, Lahey, Hynd, Stone, Piacineini & Frick., 1989).

A recent study by Solanto and colleagues did however identify two measures or tasks that exhibited excellent discriminant validity when used in combination. The Stop Signal task (based on a paradigm of primary deficits in inhibitory control), correlated with classroom observations; while the Choice Delay task (that conceptualises ADHD as a choice to avoid delay), correlated with teacher ratings of impulsive/hyperactive behaviour, observations of gross motor activity and ADHD composite scores on the Conners and SNAP-IV checklists (Solanto, Abikoff & Sonuga-Barke et al., 2001).

4.2.4.1.3 Individual neuropsychological measures

Although it is hard to justify administration of neuropsychological batteries in the assessment of ADHD, certain individual tests may have a role in the evaluation process. A neuropsychological evaluation may rule out a diagnosis of ADHD, as other neurological conditions may be identified, that better describe the observed symptoms. It should be kept in mind however that there are no neuropsychological tests that reliably identify ADHD in an individual, nor that normal results on a test rules out the possibility of ADHD (Meyer & Aase, 2003).

Tests that have shown to significantly differentiate between children with ADHD and normal comparisons on a group basis includes the Stroop interference test, Continuous performance test (CPT), F-A-S (a verbal fluency test) and the KABC-Hand Movement test (Grodzinsky & Barkley, 1999). These are discussed together with some of the other tests that have been explored in terms of the assessment of ADHD:

- *Wisconsin Card Sorting Test (WCST)* (Grant & Berg, 1948; Heaton & Pendleton, 1981)

This is one of the most commonly used measures of adult frontal lobe dysfunction, but Chelune and Baer (1986) reported norms for children. Impaired performances have been reported for ADHD children for this test (Chelune, Ferguson, Koon, & Dickey, 1986). However, others failed to replicate these findings (Grodzinsky & Barkley, 1999).

Grodzinsky and Barkley (1999) found that this test accurately predicted the presence of ADHD in 50-71% of true cases, while accurately predicting the absence of the disorder in 49%-56%. False-negative rates were 61%-89% and overall accuracy of classification range from 49%-58%. These findings don't encourage the use of this test as a singular means of diagnosing ADHD.

- *Stroop Word-Colour Association Test* (Stroop, 1935)

This is a timed test measuring the ability to suppress or inhibit automatic responses (Barkley, 1998). Almost all studies using this test have found groups of ADHD children to perform more poorly than control groups. Grodzinsky and Barkley (1999) found that this test accurately

predicted presence of the disorder in 88% of diagnosed cases. A recent study by Badenhorst (2003) among Afrikaans speaking children in the Limpopo Province of South Africa showed that the Stroop Test differentiated between children with ADHD and normal controls.

- *Hand movements Scale* (Kaufman & Kaufman, 1983)

This is a well-standardised and normed test for children based on traditional measures of frontal lobe function in adults (Barkley, 1998). Studies have shown that this test differentiates groups of ADHD children from groups of normal children (Grodzinsky & Diamond, 1992).

Rey-Osterrieth Complex Figure (Osterrieth (translated by J Corwin and FW Bylsma), 1993) and (Rey (translated by J Corwin and FW Bylsma), 1993).

This is a paper and pencil task requiring planning and visual-spatial-constructional abilities and is sensitive to deficits from frontal lobe injuries (Lezak, 1995). Although several studies of this test showed ADHD children to perform more poorly on average than normal children, the false negative rate was a very high 96% (Grodzinsky & Barkley, 1999).

- *Trail-making test (Parts A & B)* (Reitan & Wolfson, 1985)

This test was originally part of the Army Individual Test Battery (1944) and has enjoyed wide use as an easily administered test of visual conceptual and visuomotor tracking (Lezak, 1995). Few studies found this test to be useful for differentiating groups of

ADHD children from control groups (Barkley, Grodzinsky, & DuPaul, 1992).

- *Continuous performance tests* (Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956)

This is a vigilance test that is believed to assess sustained attention and impulse control. Although some studies did not support the use of these tests in the diagnosis of ADHD (Faraone, 1996; Green, Wong, & Atkins, 1999), wide-ranging literature has shown it to be the most reliable of psychological tests for discriminating ADHD groups from normal children (Grodzinsky & Barkley, 1999; Mariani & Barkley, 1997).

The Continuous performance task has several versions, including: Conners (1995) Continuous performance test; Gordon diagnostic system (Gordon, 1979; Gordon & Mettelman, 1988); Test of variables of attention (TOVA) (Greenberg & Kindschi, 1996); and the Intermediate visual and auditory CPT (IVA) (Sanford, Fine, & Godman, 1995).

Controlled oral word association test or F-A-S verbal fluency test (Benton & Hamsher, 1989)

A study by Grodzinsky and Barkley (1999) reported that nearly 90% of children with abnormal scores on this test were correctly classified as ADHD. These results indicate that this test may be a useful part of an assessment of ADHD.

Porteus Mazes (Porteus, 1959)

This is a pencil-and-paper maze task requiring planning and organisational skills (executive functions) as well as fine motor dexterity (Lezak, 1995). Although Grodzinsky and Barkley (1999) reported that an abnormal score on this test might indicate a diagnosis of ADHD in more than 80% of the cases, they also found that this test had low sensitivity (27%), such that 73% of the children in the ADHD group had normal scores. Therefore, interpretation of the results of this test should be made with caution.

Motor tests

Tests of fine manual motor skills that have been used to study ADHD include the Grooved pegboard (Matthews & Kløve, 1964), the Maze co-ordination test, and the Finger tapping test (Halstead, 1947; Reitan & Wolfson 1993; Meyer, Aase & Sagvolden, In press). These tests are described in detail in Chapter 6.

4.2.4.1.4 Projective/Personality Measures

No published studies show predictive validity of projective tests (such as drawings, inkblots or story-telling techniques) for the identification of ADHD (Barkley, 1998).

Chapter 5

PROBLEM FORMULATION AND HYPOTHESES

5.1 The Problem: Are poor motor skills associated with ADHD?

5.1.1 Problem Statement:

The main focus of this study is on motor functioning in children with ADHD. Motor problems, often characterised as clumsiness or poor motor co-ordination have been associated with ADHD, in addition to the main symptom groups of inattention, impulsiveness and over activity (Meyer, Aase & Sagvolden, In press).

This study will focus on specifically manual motor skills, as these have been reported to be affected in children with ADHD (Pereira, Landgren, Gillberg, & Forssberg, 2001a).

Impaired motor functions are associated with various factors, including immaturity and alcohol use. Sagvolden and co-workers suggest that impaired motor functions can also be associated with a dysfunction of the neostriatum, which receives major dopamine input from the substantia nigra. There are both anatomical and functional changes in the ADHD neostriatum (Sagvolden et al., 1998b).

A dysfunctioning nigro-striatal dopamine branch would be expected, according to the theory by Sagvolden and co-workers (Johansen et al, 2002; Sagvolden and Sergeant, 1998), to cause several "extra pyramidal" symptoms or neurological soft signs, associated with ADHD in the form of impaired timing and force regulation of muscle groups:

- poor motor control or clumsiness
- longer reaction times
- poor response timing
- abnormal control of eye saccades
- poor correlation of the activity of different body parts

Thus, findings previously attributed to response disinhibition due to frontal lobe dysfunction may rather be due to impaired motor control associated with dopamine dysfunction of the neo-striatum (Johansen et al., 2002).

5.1.2 Aim of the study:

The main aim of the research is to test whether poor motor skills are associated with ADHD, (Johansen et al., 2002; Meyer et al., (In press); Sagvolden, 1999a) among Afrikaans speaking primary school children screened for the symptoms of ADHD. This theory predicts that poor motor skills in ADHD are to a large extent caused by a dysfunctioning nigro-striatal dopamine system.

5.2 Hypotheses

Research hypothesis 1:

Children with ADHD will perform poorer on tests of fine motor skills than children who do not have ADHD. There will be differences between the gender groups.

Null hypothesis 1:

Children with ADHD will not perform poorer on tests of fine motor skills than children who do not have ADHD. There will be no differences between the gender groups.

Specific null hypotheses derived for research hypothesis 1:

1.1 Children with ADHD will not perform poorer than a control group on the Grooved pegboard test.

1.2 Children with ADHD will not perform poorer than a control group on the Maze co-ordination test.

1.3 Children with ADHD will not perform poorer than a control group on the Finger tapping test.

1.4 There will be no differences between the scores of the gender groups on the Grooved pegboard test.

1.5 There will be no differences between the scores of the gender groups on the Maze co-ordination test.

1.6 There will be no differences between the scores of the gender groups on the Finger tapping test.

Research hypothesis 2:

There will be differences between the scores of children with the different ADHD subtypes (combined, hyperactive-impulsive, inattentive) and children without ADHD on tests of fine motor skills.

Null hypothesis 2:

There will be no differences between the scores of children with the ADHD subtypes (combined, hyperactive-impulsive and inattentive) and children without ADHD on tests of fine motor skills.

Specific null hypotheses derived from research hypothesis 2:

2.1 There will be no difference between the scores of children with the combined subtype of ADHD and normal children on the Grooved pegboard test.

2.2 There will be no difference between the scores of children with the hyperactive-impulsive subtype of ADHD and normal children on the Grooved pegboard test.

2.3. There will be no difference between the scores of children with the inattentive subtype of ADHD and normal children on the Grooved pegboard test.

2.4. There will be no difference between the scores of children with the combined subtype of ADHD and normal children on the Maze co-ordination test.

2.5. There will be no difference between the scores of children with the hyperactive-impulsive subtype of ADHD and normal children on the Maze co-ordination test.

2.6. There will be no difference between the scores of children with the inattentive subtype of ADHD and normal children on the Maze co-ordination test.

2.7. There will be no difference between the scores of children with the combined subtype of ADHD and normal children on the Finger tapping test.

2.8. There will be no difference between the scores of children with the hyperactive-impulsive subtype of ADHD and normal children on the Finger tapping test.

2.9. There will be no difference between the scores of children with the inattentive subtype of ADHD and normal children on the Finger tapping test.

Chapter 6

METHODOLOGY

6.1 Research design

This is a quantitative study and the quasi-experimental research design was used, as the subjects could not be randomly assigned to the conditions of the independent variable because they already exhibit the variable.

6.2 Sample

A total sample of 62 children (46 boys and 16 girls) was used in this study. Afrikaans speaking children in the Limpopo Province of South Africa were chosen from the school-based population.

Sixty-two children (31 ADHD and 31 Controls without ADHD symptoms) were chosen by screening the primary school population (grade 2 to 6) of two schools in the Limpopo province using the Disruptive Behaviour Disorder Scale (DBD). The control group was matched with the experimental group for age and gender.

This study is part of a larger study for which permission was obtained from the Department of Education. Permission was then obtained from the participating school principals (Appendix A-Afrikaans letter; Appendix B-English translation). Participation was voluntary and informed consent was obtained from the child's parents or guardian, in the form of an explanatory letter (Appendix C- Afrikaans letter; Appendix E- English translation) with an attached permission slip (Appendix D & F).

Table 6.1 gives an overview of the demographic characteristics of the sample when compared according to gender.

TABLE 6.1: Descriptive statistics for age - gender groups

Clinical groups	N	AGE Means
ADHD boys	23	127.3 □ 20.3
ADHD girls	8	119.3 □ 24.9
Control boys	23	127.0 □ 17.6
Control girls	8	120.1 □ 13.9
All groups	62	125.2 □ 19.1

The differences in age between the ADHD- and Control groups were not statistically significant.

Table 6.2 gives an overview of the demographic characteristics of the sample when organised according to subtype.

TABLE 6.2: Descriptive statistics for age - ADHD Subtypes

ADHD Subtypes	N	AGE Means
Combined	9	116.4 □ 23.9
Hyperactive/impulsive	13	127.5 □ 18.7
Inattentive	9	131.0 □ 22.5
Normal control	31	125.2 □ 16.8

The differences in age were not statistically significant for subtypes.

6.3 Screening

Screening was done using the Disruptive Behaviour Disorder (DBD) rating scale (Pelham, Jr. et al., 1992; Pillow et al., 1998).

The DBD rating scale consists of 45 items, eighteen of which measure ADHD. The behaviour is rated on a four-point scale

- not at all (0)
- just a little (1)
- pretty much (2)
- very much (3)

The DBD rating scale was standardised for the populations of the Limpopo Province in a study by Meyer et al (2004). Translators from the Language Bureau of the University of the North translated the DBD from US

English (Appendix G) into Northern Sotho, Xitsonga, Tshivenda, Setswana and Afrikaans; an independent translator back-translated these into English.

Discrepancies were identified and corrected. The final versions were given to clinical psychologists talking the language fluently to check the terminology.

The data from this study showed that the DBD is a valid screening instrument for use in South Africa (Meyer et al 2004), and that there is no need for separate norms for different language and cultural groups. The two recognised DBD scoring methods (symptom counts according to DSM criteria or cut- off scores based on additive scales) can both be applied.

The Afrikaans version of the DBD scale (Appendix H) was given to both teachers and parents in two primary schools, to complete for all children from Grade 2 to Grade 6. Approximately 2% of DBD's were not returned, or were returned with a refusal to participate.

Children were divided into normal and clinical groups based on teacher ratings of the DBD rating scale. Cut off points for *clinical* (95th percentile or above) and normal (85th percentile and below) groups were based on the results from the prevalence study by Meyer et al. (2004) in which more than 6000 children in the Limpopo Province were rated on the DBD.

According to the forms, scores on Hyperactive and Impulsive (H/I) related items less than fifteen and Inattentive (Inatt) items less than seventeen

were regarded as *normal*. Scores higher than eighteen on the H/I items, and / or higher than twenty-one on the inattentive items were classified as clinical. The children meeting the criteria for inclusion into the clinical group were selected for further testing. They were matched for gender and age with normal children.

Table 6.3 illustrates the results of the DBD screening procedure, according to gender groups.

TABLE 6.3: Descriptive statistics for DBD scores - gender groups

ADHD Groups	N	Inatt Means	H/I Means	Tot ADHD Means
ADHD boys	23	19.4 □ 3.5	18.4 □ 5.3	37.7 □ 5.9
ADHD girls	8	20.6 □ 2.4	18.6 □ 3.7	39.3 □ 4.7
Control boys	23	3.3 □ 4.8	4.1 □ 5.2	7.4 □ 9.4
Control girls	8	3.3 □ 2.8	4.0 □ 5.1	7.5 □ 7.9
All Groups	62	11.5 □ 9.1	11.2 □ 8.8	22.8 □ 17.2

The differences in scores on the DBD rating scale between the ADHD and Control groups were statistically significant.

Table 6.4 illustrates the results of the DBD screening procedure, according to ADHD subtypes

Table 6.4 Descriptive statistics for DBD scores – ADHD subtypes.

ADHD Groups	N	Inatt Means	H/I Means	Tot. ADHD Means
Comb.	9	22.4 □ 1.3	21.8 □ 3.6	44.2 □ 4.7
H/I	13	16.6 □ 2.4	20.2 □ 3.5	36.8 □ 4.7
Inatt.	9	21.9 □ 0.9	13.3 □ 3.7	35.2 □ 3.6
Normal	31	3.1 □ 3.8	3.8 □ 4.3	7.0 □ 7.4
All groups	62	11.5 □ 9.1	11.2 □ 8.8	22.8 □ 17.2

The differences in scores on the DBD rating scale between the ADHD subtypes and a normal control group were statistically significant.

6.4 Instruments

The tests of fine motor skills that were used were the:

- **Grooved Pegboard Test**
- **Maze Co-ordination Test**
- **Finger Tapping Test**

These are all simple, inexpensive and easy-to-administer tests

6.4.1 Grooved Pegboard (Lafayette Instrument Company, # 4202)

This apparatus consists of a metal board (10 x 10cm) that contains a 5 x 5 set of holes each with a groove oriented randomly in different directions. Twenty-five round metal pegs with a ridge running lengthways have to be rotated into the correct position for insertion into the holes. The child is instructed to insert the pegs as fast as possible, completing one row before starting on the next. The test is performed once with each hand, always starting with the dominant hand. Time to completion (in s) is the final score for each hand

The following instruction is given in the child's own language (Afrikaans):

> *"You are now going to put each of these pegs into the holes of this board (show). You can only use one hand. Pick up one peg at a time. Notice that the pegs are not round, neither are the holes in the board. In order to insert it you will have to rotate the peg so that it fits exactly (show two pegs, let the child try the next three, then remove all five pegs). When I tell you to start, you shall start over here (point to the upper left hole of the child is using his right hand and to the upper right hole if the child is using his left hand). Fill this upper row, continue on the next, and so on until all the pegs are inserted. Try to be quick. Use only your (dominant/ non-dominant) hand "*

6.4.2 The Maze co-ordination test (Lafayette Instrument Company #2706A)

This apparatus consists of a simple maze without blind alleys. The maze is placed at ~60 degree angle with the table. The child is required to go through the maze with an electric stylus, trying not to touch the sides. The stylus is connected to an electronic clock and a counter, which record the number of contacts the stylus is making with the sides (counter) and the cumulative time these contacts last (timer). The aim is to move the stylus through the maze, without touching the sides. There is no speed requirement. The test is performed twice with each hand. The total sum touched and cumulative times of contact of two trials with the same-side hand are the final scores.

The following instruction is given in the child's own language (Afrikaans):

> *In this test take this stylus and move it through the maze all the way to here (point). Try to avoid touching the sides (show). Do this with about this speed (Show by moving stylus through about ¼ of the maze). You do not have to rush, if you move too quickly you will make more errors. Try to be accurate. Start with your (dominant) hand. Do not rest your hand or arm against anything".*

6.4.3 The Finger tapping test (Marquardt, type 0925.0201)

This apparatus consists of a micro-switch operated by a key consisting of a metal arm and round disk (20mm in diameter). The key is placed at the short end of a 223mmx151mmx38mm (h) plastic box where the operating hand is rested. The length of the metal from the micro-switch to the centre of the disc is 60mm. The switch needs ~65 g dead weight to close. An electronic counter records the number of micro-switch closing (taps).

The child has to press the switch ~15mm to activate the counter. It is important that the hand is rested in a constant position in contact with the surface of the plastic box to ensure that only the index finger is moving. A stopwatch is used to time each 10-s trial. The child may rest at any time between trials, but is told to take a break at least after every third trial. For each hand, the test is terminated after ten trials, or when five consecutive trials do not vary by more than five taps. The means of the five trials with the highest number of taps are computed for each hand and used as the final scores.

The following instruction is given in the child's own language (Afrikaans):

"Can you please, show me how fast you can press this button with your (dominant) index finger? (If the child is small, touch the index finger. Demonstrate what the child has to do). Rest your arm in a comfortable position and try for yourself. You have to press the button all the way down and release it, or the counter will not work properly). Keep your wrists and arm still and remember to press as fast as you can. I will tell you when to start and when to stop."

6.5 Procedure

The children were always tested by an experimenter fluent in the child's own language. The assessments were done during school hours and the actual testing procedure for each child lasted approximately two hours.

Before formal testing started a standard biographical questionnaire was completed for each child (Appendix I). Hand dominance was determined, by asking the children to throw a ball and write their names.

Experimental tests were then given in the following order, and the results recorded on the Motor test form (Appendix J):

Grooved pegboard

Maze co-ordination

Finger tapping.

6.6 Method of data analysis

The computer programmes SPSS 11 (SPSS, 1999) and STATISTICA 5 (StatSoft Inc., 2002) were employed.

ANOVA models were used to investigate possible between-group differences (groups were divided according to gender and subtype) in raw scores. The test of least significant differences (LSD) was used to perform multiple comparison procedures.

Chapter 7

RESULTS

7.1 Introduction

The aim of this study was to test the theory that poor motor skills are associated with ADHD (Johansen et al., 2002; Meyer and Aase, 2003; Sagvolden, 1999a). The focus was on fine manual motor skills, as these have been associated with ADHD (Pereira et al., 2001a).

The sample consisted of 62 children (31 ADHD and 31 controls) that were chosen after screening. These children were then tested using three tests of fine manual motor skills (Grooved pegboard, Mazes co-ordination and Finger tapping tests).

The results for each test are presented separately and include:

- Descriptive statistics (in table and graph form)
- ANOVA results investigating possible between-group differences (groups were divided according to gender and ADHD subtype)
- The results of the test of Least Significant Differences (LSD) that was performed for statistically significant between-group differences.

These results are presented for both gender groups and ADHD subtypes, for each test.

7.2 Results of the study

7.2.1 Grooved Pegboard test

Table 7.1 represents the descriptive statistics for the results of the Grooved Pegboard Test according to gender groups.

Table 7.1 Grooved pegboard Test – Descriptive statistics for gender groups.

	N	Pegs DH Means	Pegs NDH Means
ADHD boys	23	78.6 ± 20.8	91.9 ± 24.5
ADHD girls	8	99.1 ± 30.9	125.1 ± 53.8
Control boys	23	75.9 ± 11.5	82.3 ± 11.1
Control girls	8	80.7 ± 14.2	91.0 ± 14.9
All Groups	62	80.5 ± 19.8	92.5 ± 28.2

Fig 7.1 illustrates the plot of means for gender groups, for time to complete the Grooved pegboard test.

Figure 7.1

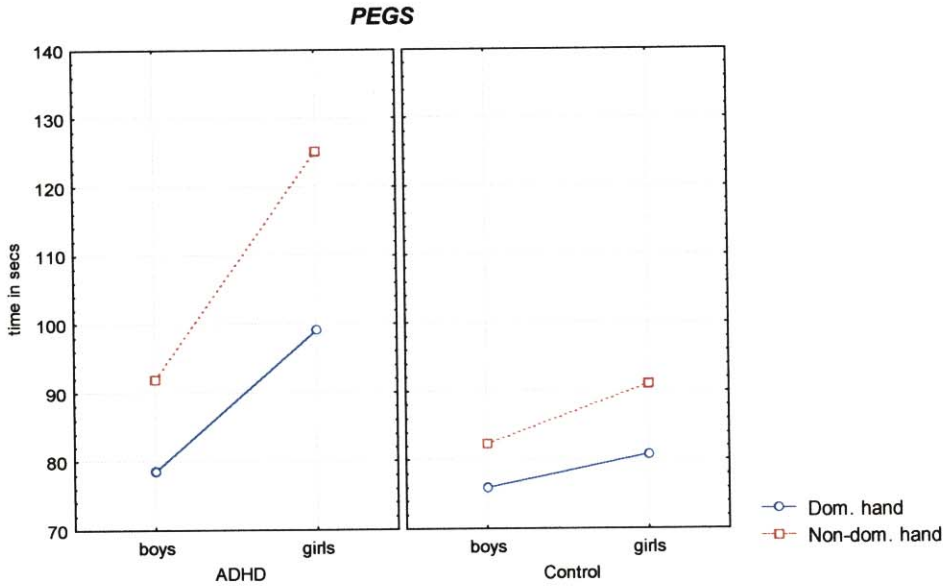


Table 7.2 represents the analysis of variance for the Grooved Pegboard Test for the gender groups.

Table 7.2: Grooved Pegboard test – ANOVA results for gender groups.

	Df	F	p
Pegs: Dom hand	3, 58	3.15	.032*
Pegs: Non-dom hand	3, 58	5.59	.002*

*$p \leq 0.05$

The differences on the dominant hand were not between the clinical groups, but between the genders.

The results of the post-hoc test (LSD) performed on the Grooved Pegboard Test for the gender groups is presented in Table 7.3

Table 7.3: Grooved pegboard test – Post hoc (LSD) results for gender groups (Non-dominant hand)

Group	Non-dom. Hand
	P
Boys	0.21
Girls	0.01*

*p≤ 0.05

Table 7.4 represents the descriptive statistics for the ADHD subtypes on the Grooved pegboard test.

Table 7.4: Grooved pegboard test – Descriptive statistics for ADHD subtypes.

ADHD Subtype	N	DH Means	N-DH Means
Comb	9	95.2 □ 33.9	120.6 □ 56.2
H/I	13	75.7 □ 14.2	91.7 □ 18.9
Inatt	9	83.5 □ 25.9	92.2 □ 26.7
Normal	31	77.4 □ 11.8	84.8 □ 12.2

Figure 7.2 illustrates the plot of means for time to complete the Grooved pegboard test, for ADHD subtypes.

Figure 7.2

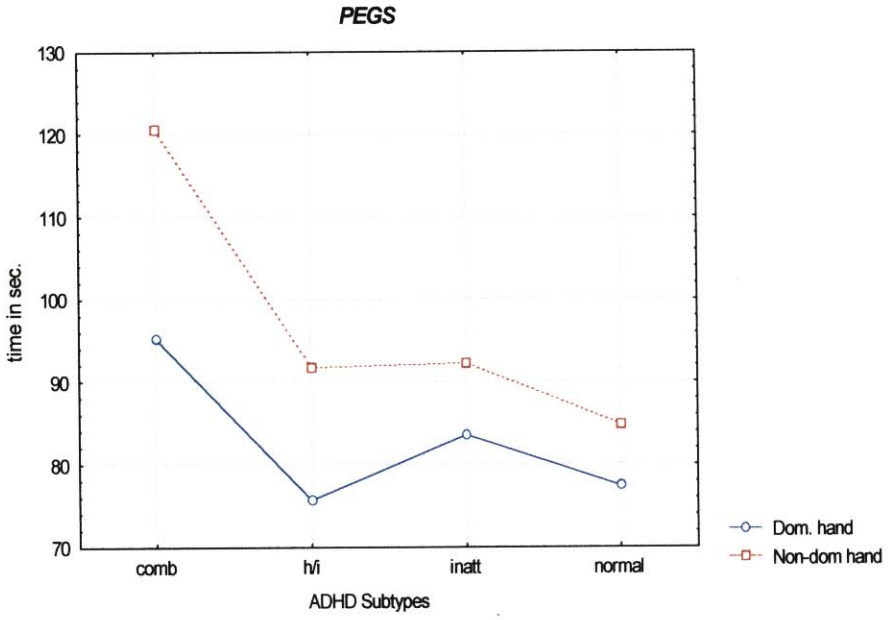


Table 7.5 represents the results of the analysis of variance for the ADHD subtypes on the Grooved pegboard test.

Table 7.5: Grooved pegboard test – ANOVA results for ADHD subtypes

	Df	F	P
Pegs: dom. hand	3, 58	239	0.08
Pegs: n-dom. han	3, 58	4.33	0.01*

*p 0.05

The results of the post-hoc (LSD) test performed on the Grooved pegboard test for the ADHD subtypes, are presented in Table 7.6.

Table 7.6: Grooved pegboard test – Post-hoc results for ADHD subtypes.

Subtype	Non-dom. hand
	P
Combined	0.01*
H/I	0.43
Inattentive	0.46

*p≤ 0.05

7.2.2 Maze Co-ordination test

Table 7.7 represents the descriptive statistics for the number of touches on the Maze co-ordination test, for the gender groups.

Table 7.7: Maze Test – Descriptive statistics for touches for gender groups.

	N	DH Means	N-DH Means
ADHD boys	23	16.5 □ 11.9	36.4 □ 21.3
ADHD girls	8	31.5 □ 27.9	50.5 □ 31.9
Control boys	23	11.3 □ 6.6	18.2 □ 10.4
Control girls	8	16.9 □ 11.8	33.9 □ 18.9
All groups	62	16.6 □ 14.5	31.1 □ 22.0

Figure 7.3 illustrates the plot of means for the number of touches on the Maze co-ordination test, for the gender groups

Figure 7.3

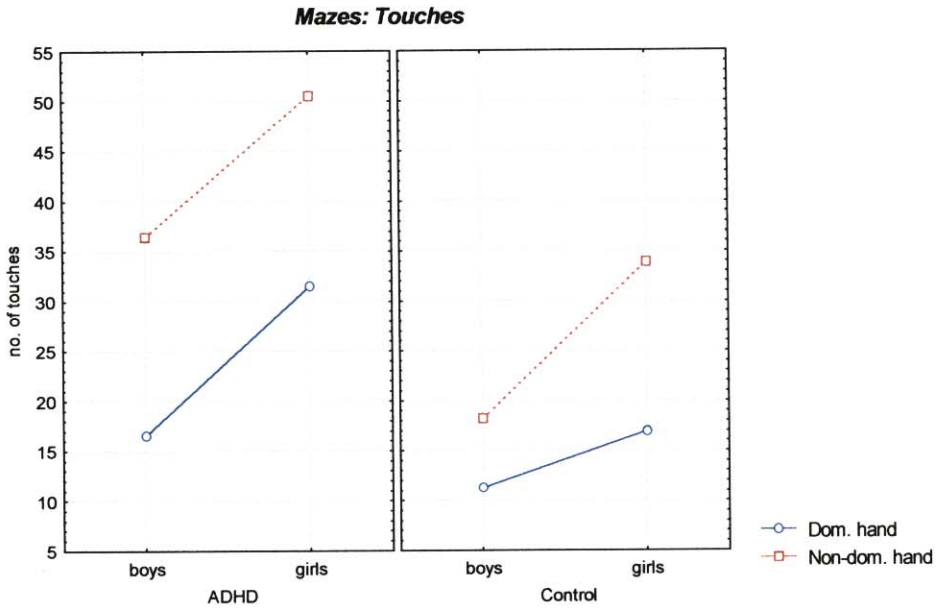


Table 7.8 represents the results of the analysis of variance for the number of touches on the Maze co-ordination test, for the gender groups.

Table 7.8: Maze Test – ANOVA results for touches for gender groups

	Df	F	P
Dom. Hand	3, 58	4.49	.007*
N-dom. Hand	3, 58	6.66	.001*

*p□0.05

The results of the post-hoc (LSD) test, performed on the maze co-ordination test, for gender groups, are presented in Table 7.9.

Table 7.9: Maze Test – Post-hoc results for touches for gender groups

Group	Dominant hand	Non-dom. hand
	P	*p*
Boys	0.19	0.002*
Girls	0.03 *	0.093

*p≤ 0.05

Table 7.10 represents the descriptive statistics for the number of touches on the maze co-ordination test, for the ADHD subtypes.

Table 7.10: Maze Test – Descriptive statistics for touches for ADHD subtypes.

ADHD Subtype	N	DH Means	N-DH Means
Comb	9	23.8 □ 27.9	40.2 □ 25.8
H/I	13	19.0 □ 12.4	37.9 □ 23.8
Inatt	9	16.8 □ 14.9	39.2 □ 29.9
Normal	31	13.3 □ 8.4	23.3 □ 14.6
All Groups	62	16.5 □ 14.5	31.1 □ 22.0

Figure 7.4 illustrates the plot of means for the number of touches on the Maze co-ordination test, for the ADHD subtypes.

Figure 7.4

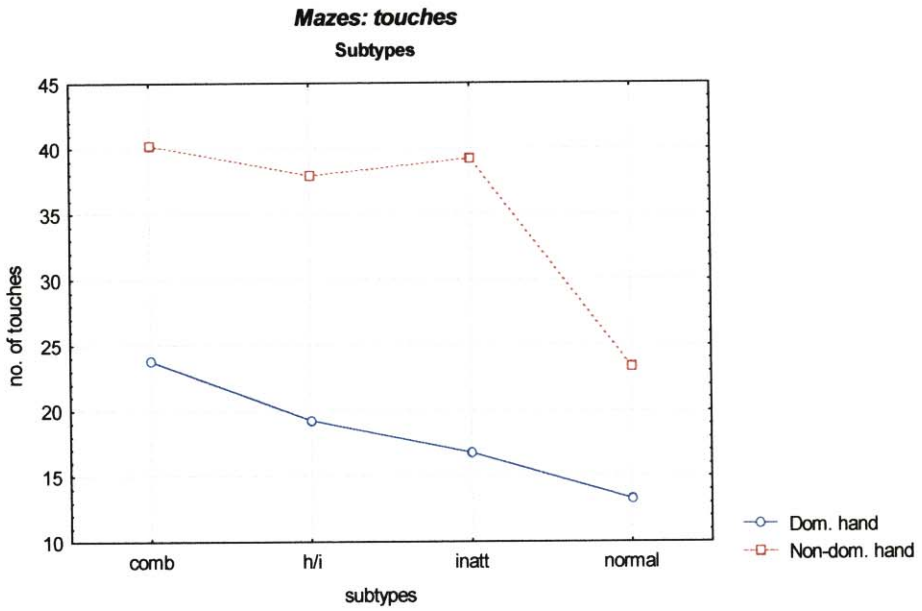


Table 7.11 represents the results of the analysis of variance of the number of touches on the Maze co-ordination test, for the ADHD subtypes.

Table 7.11: Maze Test – Touches ANOVA results for subtypes

	Df	F	P
Dom. hand	3, 58	1.45	.24
N-dom. hand	3, 58	2.87	.04*

*p□0.05

The results of the post-hoc (LSD) test performed for the maze co-ordination test, for ADHD subtypes, are presented in Table 7.12.

Table 7.12: Maze Test – Touches – Post- hoc results for subtypes

Subtype	Non-dom. Hand
	P
Comb.	0.04*
H/I	0.04*
Inatt.	0.05

*p≤ 0.05

Table 7.13 represents the descriptive statistics for time touched on the Maze co-ordination test, for the gender groups.

Table 7.13: Maze Test – Time descriptive results for gender groups.

	N	DH Means	N-DH Means
ADHD boys	23	1.3 □ 1.0	3.6 □ 2.5
ADHD girls	8	2.3 □ 1.9	4.3 □ 3.6
Control boys	23	0.8 □ 0.5	1.4 □ 1.2
Control girls	8	1.3 □ 1.2	3.1 □ 1.9
All Groups	62	1.3 □ 1.1	2.8 □ 2.4

Figure 7.5 illustrates the plot of means for time touched on the Maze co-ordination test, for gender groups.

Figure 7.5

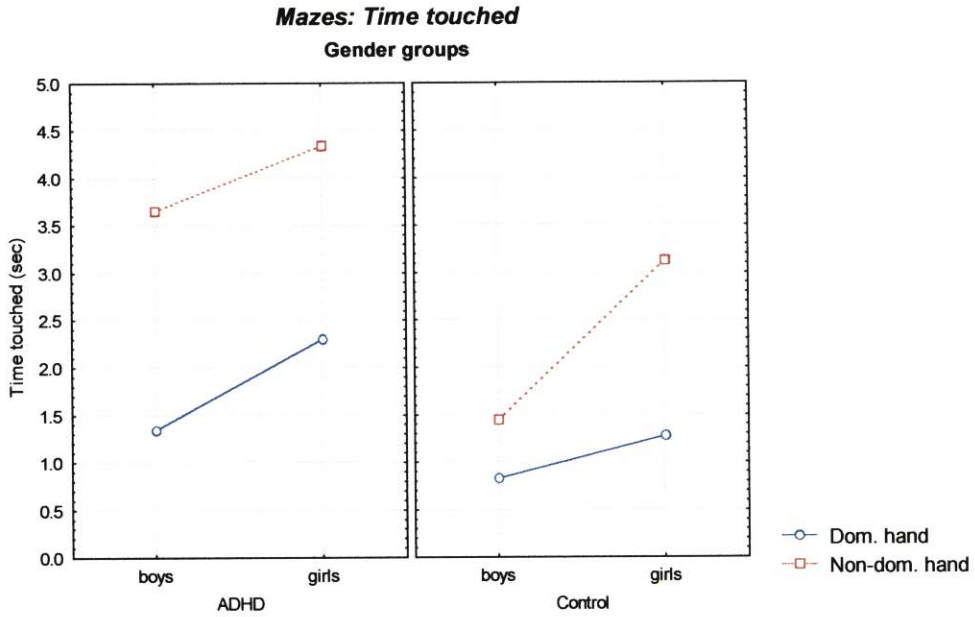


Table 7.14 represents the results of the analysis of variance for time touched on the Maze co-ordination test, for the gender groups.

Table 7.14: Maze test – Time. ANOVA results for gender groups.

	df	F	P
Dom. Hand	3, 58	4.13	.010*
N-dom. Hand	3, 58	5.31	.003*

*p□0.05

The results of the post-hoc (LSD) test performed on the Maze co-ordination test, for the gender groups, are presented in Table 7.15.

Table 7.15: Maze test – Time Post hoc results for gender groups.

Group	Dominant hand	Non-dom. Hand
	P	*P*
Boys	0.09	0.001*
Girls	0.05	0.279

*p≤ 0.05

Table 7.16 represents the descriptive statistics for time touched on the Maze co-ordination test, for the ADHD subtypes.

Table 7.16: Maze test – Time – descriptive statistics for subtypes.

ADHD Subtype	N	DH Means	N-DH Means
Comb	9	1.8 □ 1.7	3.8 □ 3.1
H/I	13	1.5 □ 1.0	3.6 □ 2.6
Inatt	9	1.4 □ 1.4	3.9 □ 3.2
Normal	31	0.9 □ 0.7	1.9 □ 1.6
All Grps	62	1.3 □ 1.1	2.8 □ 2.4

Figure 7.6 illustrates the plot of means for time touched on the Maze co-ordination test, for ADHD subtypes.

Figure 7.6

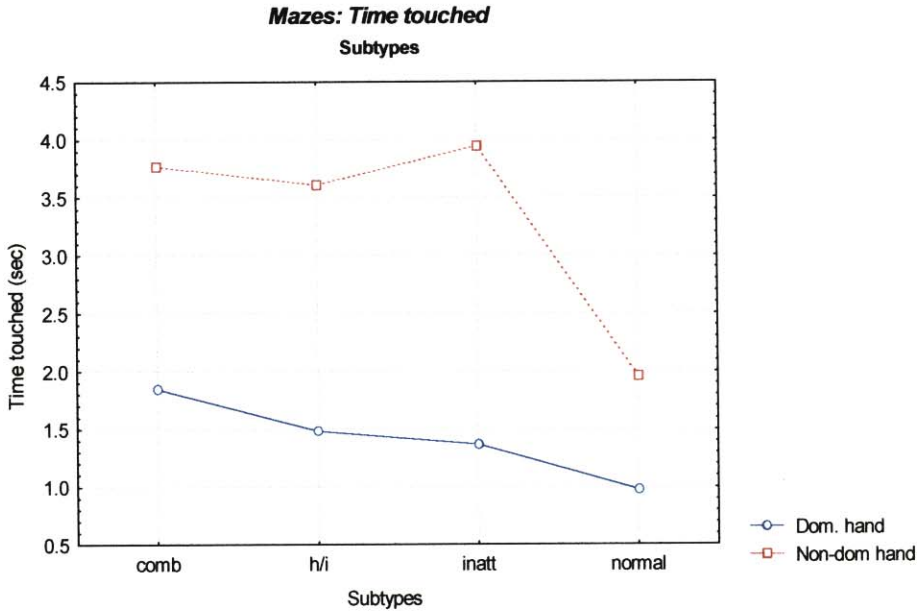


Table 7.17 represents the results of the analysis of variance of time touched on the Maze co-ordination test, for ADHD subtypes.

	Df	F	P
Dom. hand	3, 58	1.80	.16
N-dom. hand	3, 58	3. 15	.03*

*p□0.05

The results of the post-hoc (LSD) test performed on the Maze co-ordination test, for ADHD subtypes, are presented in Table 7.18.

Table 7.18: Maze test – Time. Post-hoc results for subtypes

Subtype	Non-dom. Hand
	P
Comb.	0.044*
H/I	0.036*
Inatt.	0.027*

*p≤ 0.05

7.2.3: Finger Tapping test

Table 7.19 represents the descriptive statistics for the Finger tapping test, for gender groups.

Table 7.19: Finger tapping. Descriptive statistics for gender groups.

	N	DH Means	N-DH Means
ADHD boy	23	42.9 ± 6.2	38.0 ± 6.8
ADHD girls	8	41.5 ± 6.3	37.5 ± 9.2
Control boys	23	44.8 ± 6.2	41.3 ± 6.2
Control girls	8	42.5 ± 6.4	37.5 ± 7.8
All groups	62	43.4 ± 6.2	39.1 ± 7.1

Figure 7.7 illustrates the plot of means for number of presses on the Finger tapping test, for gender groups.

Figure 7.7

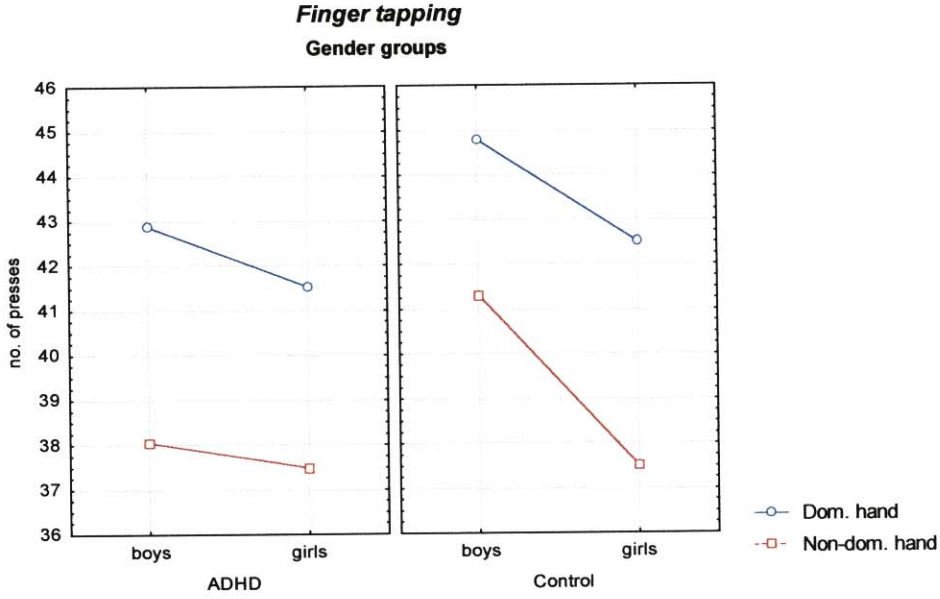


Table 7.20 represents the results of the analysis of variance for the Finger tapping test, for gender groups.

Table 7.20: Finger tapping – ANOVA results for gender groups.

	Df	F	P
Dom. hand	3, 58	0.73	0.54
N-dom. hand	3, 58	1.19	0.32

*p□0.05

Table 7.21 represents the descriptive statistics for number of presses on the Finger tapping test, for ADHD subtypes.

Table 7.21: Finger tapping- descriptive statistics for ADHD subtypes.

ADHD Subtype	N	DH Means	N-DH Means
Comb	9	42.9 □ 6.3	37.2 □ 8.8
H/I	13	44.0 □ 6.5	39.7 □ 6.9
Inatt	9	40.5 □ 5.9	36.3 □ 6.8
Normal	31	44.1 □ 6.1	40.2 □ 6.8
All Group	62	43.4 □ 6.2	39.1 □ 7.1

Figure 7.8 illustrates the plot of means for number of presses on the Finger tapping test, for ADHD subtypes.

Fig.7.8

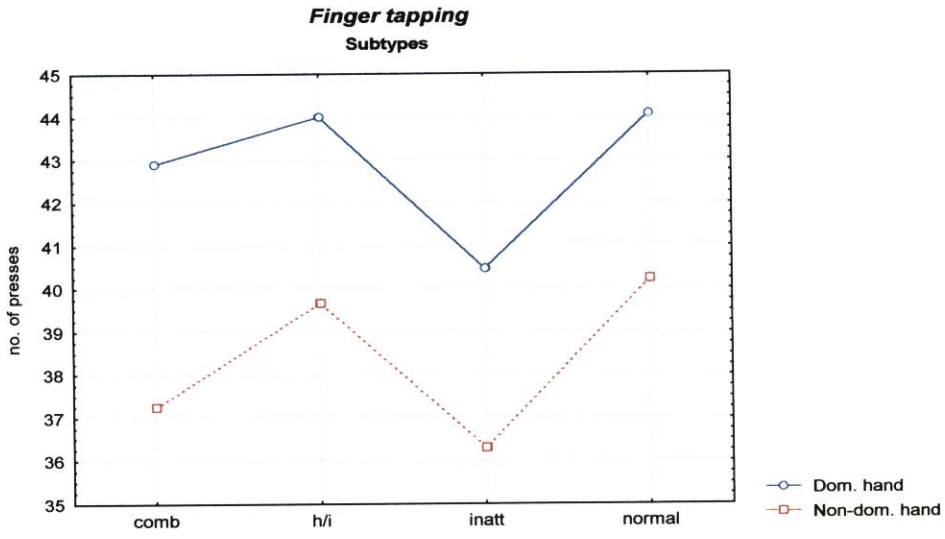


Table 7.22 represents the results of the analysis of variance for number of presses on the Finger tapping test, for ADHD subtypes.

Table 7.22: Finger tapping ANOVA results for ADHD subtypes.

	Df	F	p
Dom. hand	3, 58	.85	.47
N-dom. hand	3, 58	.96	.42

*p□0.05

7.3 Hypothesis testing

Based on the research results, the following conclusions about the research hypotheses can be made:

Research hypothesis 1 can be partially accepted. Children with ADHD performed poorer on two of the motor tests (Grooved pegboard and Maze co-ordination), but the third test (Finger tapping) did not discriminate clearly. There were differences in the performances of the gender groups on the grooved pegboard and maze co-ordination test, while the Finger tapping test again did not discriminate clearly.

The specific null hypotheses can be rejected or accepted as follows:

1.1. Rejected, as the ADHD children performed poorer than the control group on the Grooved pegboard.

1.2. Rejected, as ADHD children performed poorer than the control group on the maze co-ordination test.

1.3. Accepted, as the Finger tapping test did not discriminate clearly between the two groups.

1.4. Rejected, as there were differences between the scores of the gender groups on the Grooved pegboard test.

1.5. Reject, as there were differences between the scores of the gender groups on the maze co-ordination test.

1.6. Accepted, as the Finger tapping test did not discriminate clearly between the gender groups.

Research hypothesis 2 is partially accepted, as there were differences between the scores of the ADHD subtypes and the control group on two of the three motor tests.

The specific null hypotheses can be rejected or accepted as follows:

2.1. Rejected, as there were differences between children with the combined subtype and the control group on the Grooved pegboard test.

2.2. Rejected, as there were differences between the scores of children with the hyperactive-impulsive subtype and the control group on the Grooved pegboard test.

2.3. Rejected, as there were differences between children with the inattentive subtype and the control group on the Grooved pegboard test.

2.4. Rejected, as there were differences between children with the combined subtype and the control group on the maze co-ordination test.

2.5. Rejected, as there were differences between children with the hyperactive-impulsive subtype and the control group on the maze co-ordination test.

2.6. Rejected, as there were differences between children with the inattentive subtype and the control group on the maze co-ordination test.

2.7, 2.8, and 2.9 are accepted, as the Finger tapping test did not discriminate clearly between the groups.

Chapter 8

DISCUSSION OF RESULTS

8.1 Introduction

The purpose of this study was to establish whether poor motor skills are associated with ADHD, based on the neuropsychological model proposed by Sagvolden and co-workers (Johansen et al., 2002; Sagvolden, 1999a; Sagvolden et al., 1998b). Fine motor skills were measured using the Grooved pegboard, Maze co-ordination and Finger tapping tests.

The results of the tests were analysed in terms of the different genders and subtype groups. As expected, the control group performed better than the ADHD group in most of the tests, except for the Finger tapping test which did not clearly discriminate between the groups.

8.2 Discussion of results

8.2.1 Results for tests

8.2.1.1 Grooved Pegboard

There were significant differences between the ADHD group and the control group, with the ADHD group performing poorer.

There were significant differences between the gender groups, with the girls performing poorer, especially in the ADHD group.

There was a significant difference between the combined group and the control group (p=0.01). While there were differences between the inattentive group and control group (p=0.46) and the hyperactive-impulsive group and control group (p=0.43), these differences were not significant.

The differences between the clinical groups as a function of gender were significant only for the non-dominant (p=0.002) hand (For the dominant hand the differences were not significant between the ADHD boys and normal boys, and between the ADHD girls and the normal girls. The significant differences (p=0.03), were between the ADHD boys and normal girls and the ADHD girls and normal boys).

The differences between the subtypes were significant only for the non-dominant hand (p=0.008) (Dominant hand: p= 0.08).

8.2.1.2 Maze Co-ordination test

Touches

There was a significant difference between the ADHD group and the control group, with the ADHD group performing poorer.

There was a significant difference between the gender groups, with the girls performing poorer.

The differences between the gender groups were significant for both the dominant (p=0.007) and non-dominant (p=0.001) hand. For the dominant hand there was a significant difference between the ADHD girls and the other groups (ADHD boys, normal boys and girls (p=0.03)), while on the non-dominant hand the difference was only significant between the ADHD boys and the normal boys (p=0.002).

For the subtypes there was a significant difference between the control group and the three ADHD subtypes, with the three subtypes performing poorer. This difference was only significant for the non-dominant hand (p=0.04). Specifically, on the non-dominant hand, the differences between the control group and combined group (p=0.04) and the hyperactive-impulsive group and control group (p=0.04) were significant, while the difference between the control group and inattentive group leaned very strongly towards significance (p=0.05).

Time

The differences between the ADHD group and the control group were not significant.

There were significant differences between the gender groups, with the girls performing poorer. The differences between the gender groups were significant for both the dominant (p=0.01) and the non-dominant (p=0.002) hand.

There was a significant difference between the ADHD boys and the normal boys (p=0.001).

There were significant differences between the three subtypes and the normal group with the non-dominant hand (p=0.03). Specifically, a significant difference

Between the combined group and control group (p=0.04), the hyperactive-impulsive group and control group (p=0.03) and the inattentive group and control group (p=0.03).

8.2.1.3 Finger Tapping test

There was no significant difference between the ADHD group and the control group.

There was no significant difference between the gender groups (Dominant hand: p=0.54 and non-dominant hand: p=0.32).

There was no significant difference between the subtypes and the control group (Dominant hand: p=0.47 and non-dominant hand: p=0.42).

8.2.2 Summary of results

Motor skills in children with ADHD have previously been assessed by different tests which yielded unreliable to moderately reliable between group differences (Denney & Rapport, 2001). The results of the current study show that there are differences between the groups on the motor tests administered, except for the Finger tapping test, which did not show

significant differences between the groups (Meyer, Aase & Sagvolden, In press).

Both the Grooved pegboard and the Maze co-ordination tests show significant differences between the performances of the ADHD group and the control group, with the ADHD group showing poorer performances, in other words poorer motor skills. This was not seen in the Maze test-Time, where there was no significant difference between the two groups. This indicates that the ADHD group did not move significantly faster or slower than the normal group, but as seen in the results for Maze-Touches, they made significantly more mistakes. Therefore, these tests partially support the hypothesis that children with ADHD will show poorer performances on tests of fine motor skills than children without ADHD. (Research hypothesis 1)

The Finger tapping test was the exception. This test did not clearly discriminate between the two groups. This may be explained by the fact that the Grooved pegboard and Maze co-ordination tests are more complex than the Finger tapping and require better motor co-ordination. This is in accordance with recent studies showing that subtle fine motor skills differentiate ADHD from normal children, while crude tapping tasks do not (Meyer, Aase & Sagvolden, (In press); Steger, Imhof, Steinhausen, & Brandeis, 2000).

There were significant differences between the gender groups on both the Grooved pegboard and Maze co-ordination, with the ADHD girls

performing significantly poorer than the ADHD boys and both the normal boys and girls. These differences were significant for both the dominant and non-dominant hands. The only exception was for the Maze test where this difference between the ADHD girls and the other groups was only significant for the dominant hand, while for the non-dominant hand the biggest significant difference was between the ADHD boys and the normal boys. Once again the Finger tapping test did not clearly discriminate between the groups.

These results were surprising in the sense that the girls performed consistently poorer than the boys, indicating that they may be more severely affected. This warrants further research, as most research tends to focus on boys. Although some studies indicated that girls may be more severely affected, but in a different way than boys (Gaub & Carlson, 1997; Sharp et al., 1999), there is still a serious lack of research data on ADHD in girls.

The results for gender groups for the Grooved pegboard and Maze co-ordination tests support the second part of research hypothesis 1, that there will be differences in performances between the gender groups.

There were significant differences between the combined subtype group and the others on the Grooved pegboard test. The combined subtype group performed significantly poorer than the inattentive, hyperactive-impulsive and normal groups on this test. On the Maze co-ordination test all three subtypes performed significantly poorer than the normal group.

Although these differences appeared for both hands, the difference was only significant for the non-dominant hand. This is an interesting phenomenon that could indicate that the ADHD children might have "learnt or practised" through past experiences, for example writing, and in so doing making the dominant hand stronger. Therefore poor motor skills showed up more with the "unpractised" hand. These findings indicate an interesting area for further study and research. The findings for the subtypes on the Grooved pegboard and Maze co-ordination tests therefore support the hypothesis that there will be differences between the scores of children with the ADHD subtypes (combined, hyperactive-impulsive and inattentive) and the scores of children who do not have ADHD (Research hypothesis 2).

These results can be summarised as follows:

The children with ADHD performed poorer on tests of subtle fine motor skills, than children without ADHD.

Girls appear to be more severely affected than boys, especially in the ADHD group.

The differences in performance between the gender groups and subtypes were significantly larger with the non-dominant hand.

The Grooved Pegboard and Maze co-ordination tests appear to be good measures of fine motor problems.

The Finger tapping test does not appear to be a good measure of fine motor problems.

8.3 Limitations of the study

One of the limitations of this study is the small sample size, especially in the girls. This is typical of many ADHD studies, as girls tend to be underrepresented in the disorder and it is therefore difficult to find a large number of them for clinical population groups.

Another limitation is the fact that only one language group (Afrikaans) was studied, especially in a society consisting of a variety of different language and cultural groups. This limitation can be minimised by comparing these results with the results of other similar studies among other language groups (Meyer & Aase, 2003; Meyer, Aase & Sagvolden, (In press)).

8.4 Possibilities for further research

Further research is recommended to explore the indications that girls may have a more severe disorder, especially in terms of motor problems. As boys are more likely to be referred for treatment, this suggests there may be a population of girls with debilitating symptoms, who are overlooked and thus not treated.

Further research into the significant difference in performance between the dominant and non-dominant hand may provide insight into this phenomenon.

8.5 Concluding remarks

The tests of fine motor skills that were used in this study showed differences between children with ADHD and children without ADHD, especially tests that measure subtle fine motor skills, like the Maze co-ordination test that yielded very promising results. Tests that measure crude motor skills, like the Finger tapping test, do not appear to distinguish clearly. Therefore it appears that it is specifically subtle fine manual motor skills that are associated with ADHD, as illustrated in the Grooved pegboard and maze co-ordination tests.

Not one of these tests were proven to be useful as a single diagnostic instrument for ADHD, but can be included as part of a comprehensive assessment process.

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APPENDIX A: Letter to school principals (Afrikaans)

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Dept of Psychology

Die Hoof

Laerskool.....

Geagte Meneer/Mevrou

Attention Deficit/ Hyperactivity Disorder (AD/HD) is 'n afwyking wat tussen 2% en 5% van laerskool kinders affekteer. Die kind sukkel om aandag te skenk, om sy of haar aktiwiteite te beheer en is impulsief. Dit is egter baie meer as net 'n kwessie van aandagtekort en ooraktiwiteit. Die kind sukkel om sy of haar skoolwerk baas te raak en kom moontlik nie goed oor die weg met ander kinders nie. Hulle is ook nie in staat om take te voltooi sonder toesig nie en kan ontwrigting in die familie veroorsaak. Die probleme kan veroorsaak dat die kind nie kan aanpas by die normale vereistes van die alledaagse lewe nie. Dit word nie ontgroei nie en kan in die toekoms probleme veroorsaak met roekelose gedrag, moontlike risiko vir wetsoortredings en dwelmmisbruik.

Die oorsake van AD/HD is onbekend, maar navorsing dui daarop dat dit oorerflik kan wees. Besoedelende stowwe en ongebalanseerde voeding kan ook 'n rol speel. Dit word nie veroorsaak deur 'n onvermoe om die kind te dissiplineer of beheer nie. Dit is baie belangrik dat hierdie kinders op 'n vroee ouderdom gediagnoseer en behandel word, om sodoende probleme by die huis en skool te voorkom en die risiko vir toekomstige probleemgedrag uit te skakel.

Die diagnose van AD/HD was nog altyd problematies. Tot op hede was die enigste instrumente vir die diagnose, vraelyste wat voltooi is deur ouers en onderwysers. Hierdie vraelyste is egter baie subjektief en die betekenis van sekere konsepte kan verskil tussen kulture en taalgroepe. Daarom beskou ons hierdie vraelyste as onvoldoende vir diagnose.

Hierdie is 'n goedgekeurde departementele projek van die Universiteit van die Noorde, in samewerking met die Universiteit van Oslo, Noorwee. Toestemming is verkry van die superintendent van Onderwys vir die Limpopo Provinsie.

APPENDIX B: Letter to school principal (English)

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Dept of Psychology

2003
The Principal
.....Primary School

Dear Sir/ Madam:

RESAERCH PROJECT: ATTENTION DEFICIT/ HYPERACTIVITY IN THE LIMPOPO PROVINCE

Attention Deficit Hyperactivity Disorder (ADHD) is a developmental disorder, which affects between 2% and 5% of primary school children. It consists of problems with impulse control, attention span, and activity level. However, it is much more than a matter of being inattentive and overactive. The disorder is an obstacle to benefit from normal educational methods and to form acceptable social relations. It is not temporary state that will be outgrown, for most of the children will still be suffering from the disorder as adolescents and adults.

The child usually is disorganized, has problems with planning his/her activities and may be very forgetful. There are severe problems with sustained attention, especially in the classroom situation. The child has also problems with sitting still, is overactive and fidgety. Problems with gross and fine motor co-ordination are frequent.

The cause of ADHD is not known yet, but research suggests a genetic origin. Pollutants and poor nutrition may also play a role. It is not caused by a failure to discipline or control the child.
ADHD children not diagnosed and treated at an early age at risk for the future delinquent behaviour, psychiatric problems and substance abuse. The financial costs for the society will be considerable. The families of these children experience undue stress and it has severe impact on academic activities at schools.

Diagnosis of ADHD has always caused a problem. Up to now, all instruments, which are used for the diagnosis of ADHD, are rating scales completed by teachers and /or parents and usually are culturally biased and have to be translated into all the official languages. These rating scales are mostly inaccurate because of the subjectivity of the rater. Especially in South Africa, with its many culture and language groups, the rating methods is often invalid.

The Department of Physiology, University of Oslo, Norway has therefore developed a culture-free, non-verbal test sensitive to impulsiveness, inattention and motor activity, the three major symptoms of ADHD. Together with tests for planning deficiencies and fine motor co-ordination, we are hoping to have been implicated to play a role in the disorder. This project is funded by the Norwegian Programme for Development related Research and Education (NUFU).

Postgraduate students from both the University of the North and the University of Oslo also form part of the research team.

Method:

The research team will visit the participating school and will screen the pupils for ADHD. The Disruptive Behaviour Disorder Rating Scale- DBD- (Pelham, Gnagy, Greenslade, and Milich, 1992) will be used. This scale, which is standardized for use with all the population groups of the Province (Meyer, Eilertsen, Sundet, Tshifularo, and Sagvolden; 2000) will be filled in by the child's class teacher. The screened children, who comply with the ADHD criteria, will then undergo further testing. The following tests will be administered:

- Biographical data questionnaire
- Tests for fine motor co-ordination

The data will be used for statistical analysis only and in no circumstances will the identity of the child and the school be revealed.

Your approval of this very important study will contribute to the establishment of a valid diagnostic method, which will enable professionals to identify children at risk for educational, social and emotional problems.

Yours Sincerely

Dr. Anneke Meyer
Project Leader

APPENDIX C: Letter to parents (Afrikaans)

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Dept of Psychology

Geagte ouers

Attention Deficit/ Hyperactivity Disorder (AD/HD) is 'n afwyking wat tussen 2% en 5% van laerskool kinders affekteer. Die kind sukkel om aandag te skenk, om sy of haar aktiwiteite te beheer en is impulsief. Dit is egter baie meer as net 'n kwessie van aandagtekort en ooraktiwiteit. Die kind sukkel om sy of haar skoolwerk baas te raak en kom moontlik nie goed oor die weg met ander kinders nie. Hulle is ook nie in staat om take te voltooi sonder toesig nie en kan ontwrigting in die familie veroorsaak. Die probleme kan veroorsaak dat die kind nie kan aanpas by die normale vereistes van die alledaagse lewe nie. Dit word nie ontgroei nie en kan in die toekoms probleme veroorsaak met roekelose gedrag, moontlike risiko vir wetsoortredings en dwelmmisbruik.

Die oorsake van AD/HD is onbekend, maar navorsing dui daarop dat dit oorerflik kan wees. Besoedelende stowwe en ongebalanseerde voeding kan ook 'n rol speel. Dit word nie veroorsaak deur 'n onvermoe om die kind te dissiplineer of beheer nie. Dit is baie belangrik dat hierdie kinders op 'n vroee ouderdom gediagnoseer en behandel word, om sodoende probleme by die huis en skool te voorkom en die risiko vir toekomstige probleemgedrag uit te skakel.

Die diagnose van AD/HD was nog altyd problematies. Tot op hede was die enigste instrumente vir die diagnose, vraelyste wat voltooi is deur ouers en onderwysers. Hierdie vraelyste is egter baie subjektief en die betekenis van sekere konsepte kan verskil tussen kulture en taalgroepe. Daarom beskou ons hierdie vraelyste as onvoldoende vir diagnose.

Hierdie is 'n goedgekeurde departementele projek van die Universiteit van die Noorde, in samewerking met die Universiteit van Oslo, Noorwee. Toestemming is verkry van die superintendent van Onderwys vir die Limpopo Provinsie.

Ons vra eerstens dat u die aangehegde vraelys invul deur af te merk wat die meeste van toepassing is op u kind se gedrag.

As u sou instem dat u kind deelneem aan hierdie projek, sal die navorsingspan u kind se skool besoek en verskeie kinders (seuns en dogters) vanuit drie ouderdomsgroepe (7-8, 9-10, 11-12) kies. Behalwe vir die toets (in die vorm van rekenaarspeletjies) sal ons ook toets vir spierbeheer (AD/HD kinders het dikwels probleme met handskrif en ander motor-vaardighede) en indien u toestem, 'n bloedmonster neem. Die bloedmonster sal geanaliseer word vir industriele besoedelende stowwe en ander aanduidings wat ons mag help om die oorsake van AD/HD te vind.

Die inligting sal gebrui word vir statistiese analise en onder geen omstandighede sal die identiteit van die kind of skool geopenbaar word nie. Die feit dat u kind gekies word vir die toetse beteken nie dat hy of sy aan AD/HD ly nie, maar dit is nodig dat al die kinders in die Limpopo provinsie verteenwoordig word in hierdie ondersoek.

U en u kind se deelname wat hierdie belangrike studie betref sal bydra tot die vestiging van 'n geldige diagnostiese metode wat kundiges in staat sal stel om kinders te identifiseer wat 'n risiko loop vir skolastiese, sosiale en emosionele probleme.

Dankie by voorbaat

Prof. A. Meyer
Projekleier

APPENDIX D: Parental consent form (Afrikaans)

Ek, die moeder/vader/voog van_____

gee hiermee toestemming dat my kind deur die sielkunde span van die Universiteit van die Noorde getoets word.

JA_____ NEE_____

Vir 'n bloedmonster om geneem te word deur 'n geregistreerde verpleegkundige.

JA_____ NEE_____

GETEKEN_____ DATUM_____

APPENDIX E: Letter to parents (English)

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Dept of Psychology

Dear Parents

Attention Deficit/Hyperactivity Disorder or AD/HD is a disorder, which affects between 2% and 5% of primary school children. The child has difficulty paying attention, controlling his or her activity and is impulsive. However, it is much more than a matter of being inattentive and overactive. The child has problems in coping with his or her schoolwork and may not be getting along well with other children. They are also unable to complete assigned tasks without supervision and cause disruptions in the family.

The problems may cause that the child is unable to adjust to the normal requirements of ordinary life. They are not likely to be outgrown and could cause future problems with reckless behaviour, possible risk of law- breaking and drug abuse. The disorder is more common in boys than in girls.

The cause of AD/HD is not known yet, but research suggests that it may be an inherited condition. Pollutants and poor nutrition may also play a role. It is not caused by failure to discipline or control the child. The children benefit from medication.

It is extremely important that these children are diagnosed and treated at an early age so that suffering at home and at school can be prevented and the child may not be at risk for future problem behaviour.

The diagnosis of AD/HD has always caused a problem. Up to now, all instruments, which are used for the diagnosis of AD/HD are questionnaires, completed by teachers and/or parents. However, these questionnaires are very subjective and the meaning of certain concepts may differ among the various cultures and language groups of our society. We therefore, consider them to be inadequate as a method of diagnosis.

The Department of Physiology, University of Oslo, Norway, has developed a culture-free test sensitive to the major symptoms of AD/HD which we would like to try out on the different culture- and language groups of our province. If this instrument proves to be able to successfully identify children who are suffering from AD/HD, it will prevent considerable suffering for children and their parents.

At the same time we will try to establish the role that nutrition and industrial pollutants play in the disorder. This is an approved departmental research project of the University of the North in collaboration with the University of Oslo, Norway. The Superintendent General of Education of the Northern Province has granted permission.

If you should agree in letting your child participate in this project, the research team will visit your child's school and select several children (both boys and girls) from three age groups: 7-8, 9-10 and 11-12. Not more than 10 children from each age group per school will be selected. In addition to the test (which is in the form of computer games), we will also test for muscle control (AD/HD children have frequently problems with handwriting and other motor skills), take height and weight measures, and should you agree to it, take a blood sample. The blood will be analysed for industrial pollutants and other indicators that may help us to find a cause for this condition.

The information will be used for statistical analysis only and in no circumstances will the identity of the child and the school be revealed. The fact that your child is selected for the tests does not mean that he or she is suffering from AD/HD, because we need all the children in the Northern Province represented in this investigation. However, would you like to consult us on any problems your child is experiencing, the University psychologists will provide counselling.

Your and your child's participation in this very important study will contribute to the establishment of a valid diagnostic method, which will enable professionals to identify children at risk for educational, social and emotional problems.

Dr. Anneke Meyer
Project leader

APPENDIX F: Parental consent form (English)

I, the parent/guardian of _____

Hereby give permission for my child to be tested by the psychology team from the University of the North.

YES_____ NO_____

For a blood sample to be taken by a registered nurse.

YES_____ NO_____

SIGNED_____ DATE_____

APPENDIX G: DBD (English version)

Teacher / Parent DBD Rating Scale

Child's name: _____ Form completed by: _____

Sex: M/F Age: _____ School: _____

Grade: _____ Date Completed: _____

Home language: English /Afrikaans/ N-Sotho/ Xitsonga/ Tshivenda/ Other: _____

Check the column that best describes this child.

	Not at All	Just a Little	Pretty Much	Very Much
1. often interrupts or intrudes on others (e.g, butts into conversations or games)				
2. has run away from home overnight at least twice while living in parental or parental surrogate home (or once without returning for a lengthy period)				
3. often argues with adults				
4. often lies to obtain goods or favours to avoid obligations (i.e., "cons others)				
5. often initiates physical fights with other members of his or her household				
6. has been physically cruel to people				
7. often talks excessively				
8. has stolen items of nontrivial value without confronting a victim (e.g. shoplifting, but without breaking and entering; forgery)				
9. is often easily distracted by extraneous stimuli				
10. often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrill-seeking), e.g. runs into the street without looking				
11. often truant from school, beginning before age 13 years				
12. often fidgets with hands or feet or squirms in seat				
13. is often spiteful or vindictive				
14. often swears or uses obscene language				
15. often blames others for his or her mistakes or misbehaviour				
16. has deliberately destroyed others' property (other than by fire setting)				
17. often actively defies or refuses to comply with adults' request or rules				
18. often does not seem to listen when spoken to directly				
19. often blurts out answers before questions have been completed				

	Not at all	Just a little	Pretty much	Very much
20. often initiates physical fights with others who do not live in his or her household (e.g. peers at school or in the neighbourhood)				
21. often shifts from one uncompleted activity to another				
22. often has difficulty playing or engaging in leisure activities quietly				
23. often fails to give close attention to details or makes careless mistakes in schoolwork, work or other activities)				
24. is often angry and resentful				
25. often leaves seat in classroom or in other situations in which remaining seated is expected				
26. is often touchy or easily annoyed by others				
27. often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions)				
28. often looses temper				
29. often has difficulty sustaining attention in tasks or play activities				
30. often has difficulty awaiting turn				
31. has forced someone into sexual activity				
32. often bullies, threatens, or intimidate others				
33. is often "on the go" or often acts as "if driven by a motor"				
34. often loses things necessary for tasks or activities (e.g toys, school assignments, pencils, books, or tools)				
35. often runs about or climbs excessively in situations in which it is inappropriate				
36. has been physically cruel to animals				
37. often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)				
38. often stays out at night despite parental prohibitions, beginning before age 13 years				
39. often deliberately annoys people				
40. has stolen while confronting a victim (e.g., mugging, purse snatching, extortion, armed robbery)				
41. has deliberately engaged in fire setting with the intention of causing serious damage				
42. often has difficulty organising tasks and activities				
43. has broken into someone else's house, building, or car				
44. is often forgetful in daily activities				
45. has used a weapon that can cause serious physical harm to others (e.g. a bat, brick. broken bottle, knife, gun.				

APPENDIX H: DBD (Afrikaans)

ONDERWYSER/OUER DBD VRAELYS

Naam van kind_____ Voltooi deur_____

Geslag M / V Ouderdom_____ Datum voltooi_____

Graad_____ Skool_____

Huistaal:_____

Maak 'n merkie in die kolom wat u/hierdie kind die beste beskryf. Plaas 'n vraagteken na die item waarvan u die antwoord nie ken nie.

	Nooit	Soms	Dikwels	Altyd
1. Onderbreek of steur ander persone dikwels(bv. Val in die rede tydens gesprekke of meng in gedurende spel).				
2. Het minstens twee keer van die huis of plek van versorging weggeloop en oornag weggebly (of een keer vir 'n lang tydperk).				
3. Argumenteer dikwels met volwassenes				
4. Vertel dikwels leuens om artikels of gunste te verkry of om verpligtinge te ontduik (lei ander om die bos).				
5. Inisieer dikwels fisieke bakleiery met ander lede van die huisgesin.				
6. Het persone liggaamlik mishandel				
7. Praat dikwels onophoudelik				
8. Het artikels van geringe waarde gesteel sonder om die slagoffer fisies te bedreig (bv. Winkeldiefstal,vervalsing).				
9. Word dikwels maklik afgelei deur uitwendige prikkels.				
10. Draai dikwels stokkies, beginnende voor 13 jaar oud.				
11. Vroetel dikwels met hande en voete, kan nie stilsit nie.				
12. Is dikwels boosaardig en wraaksugtig.				
13. Blameer ander vir sy of haar foute of wangedrag.				
14. Het ander se eiendom moedswillig vernietig (nie deur brandstigitng nie).				
15. Verontagsaam dikwels opsetlik volwassenes se versoeke of reels.				
16. Lyk of hy/sy nie luister wanneer hy/sy direk aangespreek word.				
17. Roep dikwels antwoord uit voordat vraag voltooi is.				
18. Inisieer fisieke bakleiery met ander wat nie deel van sy huishouding is nie (maats op skool of in sy omgewing).				
19. Ondervind probleme om ontspanningsaktiwiteite op 'n rustige en bedaarde wyse te doen.				
20. Ondervind moeite met aandag skenk aan fyn besonderhede of maak agterlosige foute in skoolwerk of ander opdragte.				

	Nooit	Soms	Dikwels	Altyd
21. Is dikwels kwaad en verontwaardig.				
22. Verlaat dikwels sitplek in die klas of in ander situasies waar daar van hom/haar verwag word om te bly sit.				
23. is dikwels liggeraak of vererg hom/haar maklik vir ander.				
24. Het dikwels probleme om instruksies te volg en voltooi nie skoolwerk, take en opdragte nie (nie a.g.v. opposisionele gedrag of taalonvermoe nie).				
25. Verloor dikwels sy/haar humeur.				
26. Het dikwels probleme om aandag te behou				
27. Vind dit dikwels moeilik om vir sy/haar beurt te wag.				
28. Het iemand gedwing tot seksuele aktiwiteite.				
29. Terroriseer, bedreig of intimideer dikwels ander.				
30. Is voortdurend aan die gang, of tree op asof aangejaag.				
31. Verloor dikwels voorwerpe wat noodsaaklik is vir take of aktiwiteite (bv. Potlode, boeke, sporttoerusting, gereedskap).				
32. Hardloop of klim en klouter dikwels oormatig in situasies waar dit onvanpas is (by adolossente en volwassenes mag dit beperk wees tot subjektiewe gevoelens van rusteloosheid).				
33. Het diere mishandel.				
34. Vermy dikwels, hou nie van, of is onwillig om take uit te voer wat volgehoue verstandelike inspanning vereis (bv. Skoolwerk of huiswerk.				
35. Bly dikwels in die nag weg van die huis, ondanks ouerlike verbod, voor die ouderdom van 13 jaar.				
36. Vererg ander persone dikwels opsetlik.				
37. Het gesteel terwyl hy/sy 'n slagoffer gekonfronteer het (d.m.v. geweld of dwang).				
38. Het opsetlik brand gestig met die doel om ernstige skade te berokken.				
39. Het dikwels probleme om take en aktiwiteite te struktureer en te organiseer.				
40.Het by iemand anders se huis, motor of gebou ingebreek.				
41. Is dikwels vergeetagtig tydens daaglikse aktiwiteite.				
42. Het 'n wapen gebruik wat ernstige beserings aan ander kan veroorsaak (bv. Knuppel, baksteen, gebreekte bottel, mes, vuurwapen).				

APPENDIX I: Biographical questionnaire

BIOGRAPHICAL DATA

Child no. _____

Tested by_____ Date_____

School_____ Grade_____

Language_____ Gender_____

Dominant hand L / R

Medication _____ Computer experience Y / N

Child's name_____

Birthdate_____

Age in months_____

Father's occupation_____

Mother's occupation_____

Are the parents Married_____ Divorced_____

Other children in the family

1_____ 5_____

2_____ 6_____

3_____ 7_____

4_____ 8_____

	yes	no
Does the family have T.V	_____	_____
A car	_____	_____
Electricity	_____	_____
Water	_____	_____

APPENDIX J: Motor test form

MOTOR TEST FORM

Child no.: _____-

GROOVED PEGBOARD

Dominant hand		Non-dominant hand	
Time		Time	
Pegs dropped		Pegs dropped	

MAZE CO-ORDINATION

Dominant hand

	Touches	Time
Trial 1		
Trial 2		
Total		

Non-dominant hand

	Touches	Time
Trial 1		
Trial 2		
Total		

FINGER TAPPING

Dominant hand		Non-dominant hand	
No. of presses		No. of presses	
Mean		Mean	