Sensory processing of learners in the Western Cape diagnosed with attention-deficit/hyperactivity disorder

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Declaration

By submitting this research assignment, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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ABSTRACT

Background

Temperament and sensory thresholds play an important part in how a person processes sensory information. Because people are differently construed, the way we perceive sensory information and act on the information will differ. Any person who suffers from an ailment or condition that interferes with this process of receiving, interpreting and acting on stimuli from our environments may find this process even harder. Behavioural observations that deviate from the "norm" are often found in children with attention-deficit/hyperactivity disorder (ADHD) and sensory processing disorder (SPD). More recent research focused on the relationship between ADHD and SPD. Dunn developed the Sensory Profile Caregiver[1] and Sensory Profile School Companion[2] (SPSC) measures to identify children's sensory processing difficulties. Although many studies have been conducted using the Sensory Profile, no studies have been conducted outside the United States of America (USA) to establish whether Dunn's SPSC will differentiate between children who are considered to be "normal" and those diagnosed with ADHD.

Aim

The aim of this study was to investigate how learners with ADHD in the Western Cape would perform on Dunn's Sensory Profile School Companion (SPSC) and the ADHD Rating Scale-IV[3] in order to assess the sensory processing problems of learners with ADHD in South Africa (see note end of abstract).

Methodology

A descriptive study was conducted using a convenience sample (n=108) from learners in the Western Cape between the ages of five and ten years and diagnosed with ADHD. Data collection consisted of a demographical form completed by the parents/legal guardians of the learners, as well as the completion of two questionnaires by the educator of the learners. The first questionnaire, the ADHD Rating Scale-IV, was used to classify the learners into subtypes of ADHD. The second questionnaire was Dunn's SPSC, which is a teacher-report measure of learners' responses to sensory input in the school environment.

The following statistical analyses were performed:

[1] Dunn W. Sensory profile user's manual. San Antonio, TX: The Psychological Corporation; 1999.
[2] Dunn W. Sensory profile school companion user's manual. San Antonio, TX: The Psychological Corporation; 2006.
[3] DuPaul G, Power T, Anastopoulos A, Reid R. ADHD Rating Scale-IV: Checklists, norms, and clinical interpretation. New York: The Guilford Press; 1998.

- descriptive statistics to provide means, medians and measurements of dispersion of the learners in the Western Cape on the SPSC;
- The Kruskal-Wallis one-way ANOVA probability value to consider if significant differences existed between the medians of the 13 group scores of the SPSC; and
- The Welsh T-test to compare learners with ADHD in the Western Cape with SPSC norms and Dunn's sample of learners with ADHD.

Results

The results showed that there were significant differences (p=0.000) on all 13 group scores of the SPSC in learners with ADHD in the Western Cape showing significantly more behaviours characterising poorer sensory processing, when compared to Dunn's normal sample. The comparison to Dunn's sample of learners with ADHD did not yield significant differences in 11 of the 13 group scores, indicating that learners with ADHD in the Western Cape did not differ from Dunn's ADHD learners. *Avoiding* and *School Factor 4* showed significant differences, with the Western Cape group showing more extreme behaviours related to sensory input than Dunn's group.

The results using the ADHD Rating Scale-IV were less significant and it was found that the rating scale could not differentiate between the two types of ADHD, although some inferences could be made regarding the use (or not) of medication. There was a significant difference ($p < 0.01$) on the inattentive, hyperactive-impulsivity and total scores of the ADHD Rating Scale-IV with learners not on medication showing a higher frequency of ADHD behaviours.

Conclusion

Dunn's SPSC was found to be a good measure to assess learners with ADHD's sensory processing problems. The ADHD Rating Scale-IV, on the other hand, could not classify the learners into the subtypes and therefore cannot be used when learners are already using medication. Further investigation is recommended to try to establish a link between the different subtypes of ADHD and the placement of learners on the different quadrants of Dunn's SPSC as well as the School Factors and Sensory Section Scores.

Authors note: The original research aimed to ascertain whether Dunn's Sensory Profile School Companion could discriminate between the sensory processing of two types of Attention-Deficit/Hyperactivity Disorder, however, after data collection it was found that the ADHD rating scale that was used could not sufficiently discriminate between the subtypes of ADHD. The research was subsequently changed to a descriptive study and approved by the Ethics Committee of Stellenbosch University. Titles on some of the Appendices reflect the original title of the research.

OPSOMMING

Agtergrond

Temperament en sensoriese drempels speel 'n belangrike rol in die wyse waarop 'n persoon sensoriese inligting verwerk. Omdat mense verskillend is, sal die manier waarop ons sensoriese inligting waarneem en dan daarop reageer, verskil. Enige persoon wat aan 'n kwaal of toestand ly wat inmeng met hierdie proses van hoe sensoriese insette uit die omgewing opgeneem, geïnterpreteer en dan op gereageer word, sal dit moeilik vind. Gedrag wat afwyk van die "norm" word dikwels in kinders met aandagafleibaarheid/hiperaktiwiteitsteuring (AAHS) en sensoriese prosesseringsdisfunksie (SPD) waargeneem. Meer onlangse navorsing fokus op die verhouding tussen AAHS en SPD. Dunn het die Sensory Profile Caregiver[4] en die Sensory Profile School Companion[5] (SPSC)-skale ontwikkel om kinders se sensoriese prosesseringsprobleme te identifiseer. Alhoewel baie studies gedoen is wat die Sensory Profile gebruik het, is daar geen studies buite die VSA gedoen om te bepaal of Dunn se SPSC tussen kinders wat as normaal beskou word en dié wat met AAHS gediagnoseer is, kan differensiëer nie.

Doelstelling

Die doel van hierdie studie was om ondersoek in te stel na hoe leerders met AAHS in die Wes-Kaap op Dunn se Sensory Profile School Companion (SPSC) en die ADHD Rating Scale-IV[6] sou presteer om die sensoriese prosesserings probleme van leerders met AAHS te assesseer.

Metodiek

'n Beskrywende studie is gedoen met 'n gerieflikheidsteekproef (n=108) van leerders tussen die ouderdomme vyf en tien jaar oud in die Wes-Kaap wat met AAHS gediagnoseer is. Datainsameling het bestaan uit 'n demografiese vorm wat deur die ouers/wettige voogde van die leerders ingevul is, sowel as die voltooiing van twee vraelyste deur die opvoeder van die leerders. Die eerste vraelys, die ADHD Rating Scale-IV, is gebruik om die subtipes van AAHS te klassifiseer. Die tweede vraelys was die Sensory Profile School Companion (SPSC) wat 'n meting met behulp van die onderwyser se verslag is wat die leerders se reaksie ten opsigte van sensoriese insette in die skoolomgewing meet. Die tweede vraelys (Dunn se SPSC) is deur onderwysers ingevul ten einde leerders se response op sensoriese insette in die skoolomgewing te bepaal.

Die data is aan die volgende ontledings onderwerp:

[1] Dunn W. Sensory profile user's manual. San Antonio, TX: The Psychological Corporation; 1999.

[2] Dunn W. Sensory profile school companion user's manual. San Antonio, TX: The Psychological Corporation; 2006.

[3] DuPaul G, Power T, Anastopoulos A, Reid R. ADHD Rating Scale-IV: Checklists, norms, and clinical interpretation. New York: The Guilford Press; 1998

- beskrywende statistiek wat die gemiddelde, mediane en metings van die verspreiding van leerders in die Wes-Kaap op die SPSC verskaf;
- die Kruskal-Wallis-eenrigting-ANOVA waarskynlikheidswaarde om vas te stel of daar beduidende verskille tussen die mediane van die 13 groeptellings van die SPSC is; en
- die Welsh T-Toets om leerders met AAHS in die Wes-Kaap te vergelyk met die SPSC-norme en Dunn se steekproef van leerders met AAHS.

Resultate

Die resultate het beduidende verskille getoon (p=0.000) op al 13 groeptellings van die SPSC by leerders met AAHS in die Wes-Kaap, wat dui daarop dat hierdie groep aansienlik meer probleme kenmerkend aan sensoriese verwerking toon as wat in Dunn se normale steekproef waargeneem is. Die vergelyking met Dunn se steekproef met AAHS het in 11 van die 13 groeptellings nie beduidende verskille getoon nie wat aandui dat leerders met AAHS in die Wes-Kaap nie veel verskil het van Dunn se AAHS-leerders nie. *Avoiding* en *School Factor 4* het beduidende verskille getoon met leerders in die Wes-Kaapse groep wat meer uiterstes in gedrag getoon het ten opsigte van sensoriese insette as dié van Dunn se groep.

Die resultate waar die ADHD Rating Scale gebruik is, was minder beduidend en daar is bevind dat die skaal nie kon differensiëer tussen die twee tipes AAHS nie, alhoewel daar afleidings gemaak kon word ten opsigte van die gebruik (of nie) van medikasie. Daar was 'n beduidende verskil ($p < 0.01$) in die onoplettende, hiperaktief-impulsiwiteit en totale tellings van die ADHD Rating Scale-IV met leerders nie op medikasie nie, wat 'n hoër frekwensie van AAHS-gedrag getoon het.

Slot

Daar is bevind dat Dunn se SPSC 'n goeie maatstaf is om die sensoriese verwerkingsprobleme van leerders met AAHS te assesseer. Die ADHD Rating Scale-IV aan die ander kant kon nie die leerders in die verskillende subtipes klassifiseer nie en kan dus nie gebruik word wanneer die leerders reeds medikasie gebruik nie. Verdere ondersoek word aanbeveel in 'n poging om 'n skakel te kry tussen die verskillende subtipes AAHS en die plasing van leerders op die verskillende kwadrante van Dunn se SPSC sowel as die School Factors- en Sensory Section-tellings.

Nota van outeur: Die oorspronklike navorsing het ten doel gehad om vas te stel of Dunn se "Sensory Profile School Companion" kon onderskei tussen die sensoriese prosessering van twee subtipes van AAHS, maar na data insameling is gevind dat die skaal gebruik nie voldoende kon onderskei tussen die twee subtipes ADHD nie. Die navorsing is derhalwe verander na 'n beskrywende studie wat goedgekeur is deur die Etiese Komitee van Stellenbosch Universiteit.

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LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ADD	Attention deficit disorder
ADHD	Attention deficit/hyperactivity disorder
HI	Hyperactivity/Impulsivity
IA	Inattention
ADHD Dunn	With ADHD Dunn (Dunn's sample of learners with ADHD)
ADHD WC	With ADHD WC (This study's sample of learners with ADHD in the Western Cape)
ANOVA	Analysis of variance
CNS	Central nervous system
EMSM	Ecological model of sensory modulation
LSEN	Education for learners with special educational needs
MBD	Minimal brain dysfunction
Norms Dunn	Without disabilities Dunn (Dunn's sample of learners without disabilities)
OCD	Obsessive-compulsive disorder
ODD	Oppositional defiant disorder
SCSIT	Southern California Sensory Integration Test
SD	Standard deviation
SI	Sensory integration
SID	Sensory integration dysfunction
SIPT	Sensory Integration and Praxis Test
SPD	Sensory processing disorders
SPM.	Sensory Processing Measure
SPSC	Sensory Profile School Companion

CHAPTER 1

INTRODUCTION

Individuals process sensory information differently according to their temperaments and sensory thresholds, and this can be observed in their behaviour. Attention-deficit/hyperactivity disorder (ADHD) and sensory processing disorders (SPD) are becoming some of the most prevalent disorders in the United States[(1)]**.** In a nationwide study in the United States of America (USA) involving 2 140 typically developing children, it was found that approximately 7.5% of them were diagnosed with SPD and/or ADHD and on further investigation; it was found that in 60% of those cases, the children presented with both SPD and ADHD[(2)]. The relationship between SPD and ADHD is now a major focus area of research in the USA.

1.1 Motivation for the study

This subject is very close to the heart of the researcher for personal and professional reasons. Growing up with ADHD with sensory-seeking behaviour and a having a son with ADHD and SPD, the researcher was motivated to build a career in occupational therapy, dealing with learners diagnosed with ADHD and SPD. During 25 years of practice the researcher witnessed the heartache that parents and educators experience in dealing with children who are often misunderstood because of a different learning style although they can be creative. The strong association between sensory processing problems and ADHD seems to be more than co-incidental.

In the researcher's clinical experience with learners with ADHD and SPD, it became evident that it is often difficult to clinically reason and determine the primary problem. This would lead to conflict in recommending the most appropriate intervention. Parents often opt for either medication or occupational therapy, resulting in a situation where the learner does not receive holistic intervention. The researcher is of the opinion that neither medication nor sensory integration therapy can be stand-alone solutions to the treatment of ADHD.

In the 1990s, Dunn received a significant research grant in the USA to investigate how to distinguish between children with and without disabilities in terms of sensory processing. Based on her findings, the Sensory Profile (consisting of a questionnaire that is completed

by the caregiver) was developed[3-6]. A later development was the Sensory Profile School Companion (SPSC). The SPSC is similar to the Sensory Profile, but is completed by the educator. It was found that these profiles could distinguish sensory processing differences between learners with ADHD and learners without disabilities[7]. Although both of Dunn's profiles have been used extensively in South Africa by occupational therapists, only one study was based in South Africa (caregiver questionnaire)[8] as an outcome measure to describe the sensory processing of learners with ADHD. A study using the SPSC in the Western Cape to investigating whether it will yield the same results found by Dunn will validate the use of the SPSC in South Africa.

In order to understand the learner better, it is important to diagnose and differentiate between the subtypes of ADHD, which were researched by Du Paul and co-workers (see section 2.4.2) in their development of the ADHD Rating Scale-IV. Neither the SPSC nor the ADHD Rating Scale–IV has never been validated for use in South Africa and an investigation into how South African children with ADHD perform on these two measures when compared to their American counterparts, will greatly contribute to validating these two measures for use in the South African context.

Working with learners with ADHD and SPD, service delivery could be enhanced should it be possible to find an association between the different sensory profiles of learners and the subtypes of ADHD. This knowledge would provide caregivers and educators with additional insight into the individual differences in the learning styles of the learners with ADHD. It could also assist occupational therapists' understanding of the sensory processing of these learners and be more specific in planning and execution of treatment programmes. Empowering therapists, teachers and parents to understand the learners' strengths and weaknesses and enabling them to optimise their occupational performance at home, at school and in other living environments would be the goal of occupational therapy intervention.

1.2 Aim of the study

The aim of the current study was to investigate how learners with ADHD in the Western Cape would perform on Dunn's Sensory Profile School Companion (SPSC) and the ADHD Rating Scale-IV in order to assess the sensory processing problems of learners with ADHD in South Africa.

1.3 Research objectives

- to ascertain how learners with ADHD in the Western Cape will perform on Dunn's SPSC;
- to ascertain which school factors will emerge from Dunn's SPSC in the Western Cape that may impact upon classroom function;
- to ascertain whether the ADHD Rating Scale-IV will differentiate between the two types of ADHD; and
- to establish the association between Dunn's SPSC and the ADHD Rating Scale-IV.

1.4 Definition of key concepts

Attention deficit/hyperactivity disorder

Attention deficit/hyperactivity disorder is a pattern of inattention and/or hyperactivity, which is persistently more frequent and severe than that in a typically developing individual of that age[9].

Learner

Learners is the preferred term because this is the accepted term used within the South African education system. The term *learners* will be used to indicate participants.

Sensory integration

Sensory integration is a theory of brain-behaviour relationships and is defined as "the organisation of sensations for use"[10:5].

Sensory processing

Sensory processing is the ability to register, modulate and integrate sensory stimuli through the central nervous system with a behavioural response[10,11].

Sensory modulation

Sensory modulation is the ability to regulate, organise and prioritise incoming sensory input, balancing excitatory and inhibitory inputs to the demands of the situation[11,12].

- ***Sensory threshold***

  Low threshold

  A low threshold indicates that the nervous system responds too quickly (sensitisation) to sensory input[7].

  High threshold

  A high threshold indicates that the nervous system takes longer to detect or respond to sensory input[7].

- ***Behavioural responses or self-regulation***

  These are the strategies which the individual uses to self-regulate. A person's temperament (passive or active) determines his or her behavioural response to sensory input. Individuals who respond passively to their sensory threshold have a tendency to let things happen and only possibly respond later. Individuals who respond actively to their thresholds, respond by actively seeking or avoiding the sensory input[4,7,13].

- ***Sensory responsivity***

  Sensory over-responsivity

  The individual responds faster, with more intensity and for longer duration. This is often referred to as *sensory defensiveness* or *low threshold*[12].

  Sensory under-responsivity

  The individual does not respond to, disregards or appears not to detect sensory stimuli in the environment. These individuals have a high threshold to sensory input[12].

  Sensory-seeking

  These individuals crave and seek an unusual amount of intense sensory input. They have a high threshold to sensory input[12].

1.5 Flow of the research assignment

In Chapter 2, the researcher describes the review of the literature in order to understand ADHD and sensory integration. Attention deficit/hyperactivity disorder is discussed first with regard to the historical development and aetiology of ADHD and differential diagnosis. Sensory integration is discussed with the emphasis on the development of relevant models to the study and clarification of terminology.

Chapter 2 further defines the historical development of sensory integration theory and the work of Dr J Ayres. Terminology in the field of sensory integration is presented as well as pertinent models relevant to the study. Research studies on sensory processing and ADHD are discussed. The relationship between sensory integration and ADHD as found in research studies is described briefly.

The last section of Chapter 2 deals with the selection of measuring instruments for ADHD and sensory processing to be used in the study.

In Chapter 3, the methodology of the study is discussed, including the process of participant sampling, data collection and analysis.

In Chapter 4, the research findings and results are presented and discussed in three parts:

- providing information about the participants;
- describing how the learners performed on the SPSC; and
- describing how the learners performed on the ADHD Rating Scale-IV.

The description of how the learners in the Western Cape performed on the SPSC makes up the bulk of the discussion. The results are discussed under the three subsections of the SPSC, namely *Quadrant scores*, *School Factors* and *Section Scores*. Practical implications of the results for learners in the classroom are further elaborated. This information is presented in tables and figures.

Chapter 5 provides the conclusions and recommendations regarding future research and considerations for interventions for learners with ADHD and sensory processing disorders.

CHAPTER 2

LITERATURE REVIEW

In Chapter 2 an extensive overview of the literature pertaining to ADHD and sensory integration is presented with regard to aetiology, historical overview, relevant theoretical models of sensory processing, and finally, the measurement of ADHD and sensory processing.

2.1 Attention deficit/hyperactivity disorder

Attention deficit/hyperactivity disorder (ADHD) has been defined as "a developmentally disabling disorder of inattention, behavioural dysinhibition, and the dysregulation of activity level to situational demands"[14:ix].

2.1.1 Introduction to attention deficit/hyperactivity disorder

The core feature of attention deficit/hyperactivity disorder is a pattern of inattention and/or hyperactivity, which is persistently more frequent and severe than that in a typically developing individual of that age[9]. The behavioural symptoms need to have been present before the age of seven years and symptoms need to be present in more than one setting, such as home and school. Furthermore, the behaviours need to interfere with the occupational performance of the learner (See Appendix A). Often ADHD is co-morbid with other disorders; therefore, a differential diagnosis is important. There are three sub-classifications of ADHD, namely:

- inattention;
- hyperactivity/impulsivity; or
- a combination of inattention and hyperactivity/impulsivity[9].

The abbreviation ADHD will be used throughout.

2.1.2 Aetiology of ADHD

Researchers differ in their views as to the precise cause of ADHD. Although still under investigation, but receiving wide support, the most common factors appear to be a genetic, neurochemical imbalance and/or a neurologically based disorder[15-18]. Barkley (cited in Rogers)[18] states that the symptoms seen in ADHD are as a result of response dys-inhibition which prevents self-regulation of environmental stimuli. However, there appears

to be consensus that ADHD is a hereditary condition that is expressed in subtle differences in the information-processing functions of the brain. The exact nature of these differences is unclear[15].

The genetic theory is supported by similarities in the symptoms experienced by the child with ADHD and close relatives who manifest the condition. Examples of symptoms noted in adults include restlessness, inattention and a low frustration tolerance. Studies on identical twins support the genetic link[15,19,20].

There are varying opinions as to the specific areas of the brain involved in ADHD, including reduced size of the frontal lobes, the basal ganglia, posterior cerebellar vermis and reticular formation[21,22].

With regard to processing differences, the frontal lobe has been identified as playing a key executive role in screening whether information is appropriate, prioritising and taking future implications into consideration before responding. In a child with ADHD, these steps seem to be omitted, resulting in impulsive responses without going through this executive filtering process.[15] Some researchers report that ADHD is associated with differences in brain chemistry, hence the term *neurobiological disorder*[15-18].

On a tentative model of ADHD pathophysiology, ADHD has also been described as a "neurobehavioral disorder" and according to Rogers,[18] it is the most common childhood neurobehavioural disorder. It has become the most frequently diagnosed behavioural condition amongst school-age children[23].

2.1.3 Historical development of the concept of ADHD

It is evident that ADHD was already apparent in the 18th century. A nursery rhyme known as "Fidgety Phillip"[24] was written in 1863 by Heinrich Hoffman about a boy who was restless, fidgety and hyperactive on account of his behavioural display. The rhyme gives insight into the effect of ADHD on the family[17:5].

"Phil, stop acting like a worm,
The table is no place to squirm."
Thus speaks the father to his son,
Severely says it, not in fun.
Mother frowns and looks around
although she doesn't make a sound.
But, Phillip will not take advice,
he'll have his way at any price.
He turns
And churns
He wiggles
And jiggles
Here and there on the chair,
"Phil, these twists I cannot bear."

This apt description of ADHD demonstrates that it is not a new phenomenon. The rhyme illustrates Phil's "sensory-seeking behaviour" in his need to move and his difficulty sitting still like the other learners do in the classroom. Therapists applying sensory integration theory in their treatment of children may interpret this behaviour as sensory-seeking, which is typically reported by occupational therapists, teachers and parents of these learners. When studying learners who have difficulty processing and integrating sensory input, a variety of similar sensory-seeking behaviours are observed, such as the learner is fidgety or always on the move.

In 1902, George Still, an English paediatrician, was the first to describe a group of children who were hyperactive, impulsive and inattentive. However, he described them as "morally defective" and did not recognise he was diagnosing a medical condition. Most of these children were boys, and they were resistant to discipline[15,25-27].

At the time of the 1918–19 influenza epidemic, some patients went on to develop encephalitis, with a group manifesting dysinhibition and behavioural dysfunction with symptoms similar to those described by Still. At the time, it was thought to be the result of brain damage, at which time the term *minimal brain damage* was coined. When researchers realised that not all these children had suffered brain damage the diagnosis was changed to *minimal brain dysfunction* (MBD)[15]. In the 1930s, it was discovered that psycho-stimulant drugs reduced these signs and symptoms, including learning difficulties, hyperactivity, distractibility, emotional and family problems[17]. In the early 1960s, medical professionals examined aberrant behaviours which were described as hyperkinesis and

hyperactivity[15]. Throughout the 1960s and 1970s, the terms *MBD* and *hyperactivity* were used interchangeably. Later, the term *hyperactivity* came to be used by the popular press and MBD lost favour, as the evidence for underlying organic lesions became more convincing[15,17,26-29].

By 1968, the official term *hyperkinetic reaction to childhood* was used in the North DSM-II[26]. The classification of attention deficit disorder (ADD) with two subtypes – ADD with hyperactivity and ADD without hyperactivity – appeared for the first time in 1980 in the DSM-III[15]. In 1987, the DSM-III was revised and in the publication of the DSM-IIIR, the nomenclature changed to *attention deficit/hyperactivity disorder (ADHD)*. The primary issue was whether distractibility was present or not. The children could manifest any of the three symptoms, namely distractibility, impulsivity or hyperactivity, but they did not have to be hyperactive with all three symptoms in one list. In the DSM-IV (1994), the symptoms were listed in two separate columns, namely attention deficit and hyperactivity/impulsivity as separate conditions under the same umbrella of ADHD[9] (Appendix A).

2.1.4 Prevalence and gender differences

ADHD appears to be prevalent in approximately 3 to 6% of the population[9,15,17,18,25-27,29,30]. In some texts, it is recorded as being even higher, but this was not the general consensus found in the literature. Furman[23] states that 6.8% of children between two and seventeen years of age have been diagnosed with ADHD. Erasmus[31] states that it affects 7 to 8% of all children across the world with a male–female ratio of 3:1. According to Green,[15] 5 to 10% of all males have ADHD.

Silver[17] reported that in clinical samples of patients, the variation in the male–female ratio is reported to be between 2:1 and 10:1, but a ratio of 3:1 is commonly accepted[23,26,29] . Green and Chee[15] reported that 90% of the ADHD population are males. In contradiction to this, Amen[25] states that the prevalence of ADHD is similar in females and males, but that the females are diagnosed four to five times less often. Taylor[28] mentions that boys who have ADHD tend to be overactive, aggressive and disruptive and are thus identified more frequently. The inattentive learner is often more withdrawn and does not disrupt the educator's teaching and is therefore less often identified. The inattentive subtype of ADHD has the lowest boy to girl ratio and a modest variation in boy to girl ratio in the ADHD subtypes.[30]

2.1.5 Diagnostic classification of ADHD

According to Rogers[18], the various subtypes of ADHD vary according to the source of the referring party. For clarity, the DSM-IV classification[9] will be used here (Appendix A). The three main types of ADHD are:

a) predominantly inattentive;
b) predominantly hyperactive/impulsive; or
c) combined.

The symptoms need to be present before the age of seven years, be present in two or more settings, and there needs to be an impairment in occupational performance which should not be accounted for by another mental disorder[9].

2.1.6 Differential diagnosis and co-morbid conditions with ADHD

ADHD is diagnosed on behavioural grounds. In a number of different conditions, similar behaviour and symptoms are seen; so the severity and combination of behaviours culminating in a diagnosis of ADHD vary greatly in each child, making the diagnosis and treatment more challenging. More than half of the children with ADHD have associated conditions[15]. Terminology varies in the literature. The terms *associated conditions*[3] or *co-occurrences of multiple difficulties* is used[16], but the term *co-morbid conditions* is more frequently used[17,19,32].

Misdiagnosis can easily occur, and each case needs to be carefully considered by a medical specialist. Information from all areas of the learners' life including school, home and input from other professionals involved in the learner's development should be reviewed. The medical professional needs to consider differential diagnosis and co-morbidity and then ascertain the primary diagnosis and what the downstream effects are[9]. Frequently, the medical practitioner needs to consider the primary diagnosis and then decide which co-morbid conditions exist, for example anxiety disorder with ADHD. Medical practitioners need to be aware of these symptoms that may co-occur with or without ADHD and that the symptoms and behaviours may present like ADHD. Silver[17] on the other hand suggests that anxiety, depression and learning disabilities often cause the described

behaviours of ADHD. The causes of the presenting behavioural problems need to be identified. Silver cautions that not all children with these symptoms have ADHD.

Besides the co-morbid conditions, one also needs to consider other factors, which affect, or look similar to ADHD. Medical conditions such as allergies, sensitivities, epilepsy, cerebral palsy, thyroid dysfunction and brain diseases may cloud the picture[19,28,31]. Other factors mentioned even less frequently are sleep disorders[19,28,33], and antisocial personality disorders[19,26]. Furman[23] goes even further to state that problems such as "occult mental retardation", hyper-vigilance due to fear or stress, and abuse are not usually co-morbid but often present similarly. Therefore, careful diagnosis by a medical specialist is essential**.**

According to Kutscher[16], the co-occurrence of multiple difficulties or co-morbid conditions is the norm and may include ADHD, autistic spectrum disorder, Asperger's syndrome, anxiety, obsessive-compulsive disorder, depression, learning disability, bipolar disorder, Tourette's syndrome, oppositional defiant disorder, central auditory processing disorder and sensory integration dysfunction.

The co-occurrence of co-morbid disorders is further supported in the Buitelaar[32] summary of a study done on the epidemiology of ADHD and noted a tendency of high occurrence of co-morbid disorders (approximately 25%). ADHD is most commonly associated with:

- Modulation disorders of anxiety, anger and mood[17] .
- Autistic spectrum disorder/pervasive developmental disorder[16,19].
- Asperger's syndrome[16,28].
- Obsessive-compulsive disorder (OCD) [15,17,19,25].
- Tourette's syndrome/tic disorder[15,17,19,25]. Amen[25] notes that there is a strong connection between ADD, Tourette's syndrome and OCD.
- Oppositional defiant disorder (ODD)[15,19,34] – 40% to 60% have ODD with ADHD[15,26].
- Conduct disorder[15,19,23,26,27,34]. Green and Chee[15] mention that 20% of children in North America have conduct disorder, whereas Cooper[26] found this figure to be as high as 45% in the USA. Furman[23] groups conduct and oppositional disorder together and it then ranges from 35% to 60%.

- Anxiety[17,19,23,25,26,31,34]. Cooper[26] quotes a study in the USA as showing the co-occurrence of anxiety disorders and ADHD to be 30%.
- Depression[15,17,19,25,26,35]. Cooper[26] suggests the occurrence is 33% in the USA.
- Bipolar disorder[15,17,19,25,26,31,35].
- Motor co-ordination difficulties[15,17,28,33]. Serfontein[33] mentions that an earlier term for ADHD was *the clumsy child*. The child with a sensory integration dysfunction of developmental dyspraxia would also fall into this category.
- Specific learning disability[17,19,25,31,36]. Silver[17] discusses input, integration, memory and output disabilities as well as motor skills, but he tends to put emphasis on the visual and auditory systems. Amen[25] notes that 40% also have learning/developmental problems. The child with learning problems is mentioned by Ayres[10,37].
- Sensory integration dysfunction (SID)[10,17,19,37]. In discussing SID, Strong[19] emphasises central auditory processing disorder and visual processing disorder as being the main facets of SID. In a nationwide study in the USA, involving 2 140 typically developing children, it was found that about 7.5% of them had sensory processing disorder (SPD) and/or ADHD. On further investigation, it was found that in 60% of those cases, the children presented with both SPD and ADHD[2]. This relationship between SPD and ADHD is now a major focus area of research in the USA. The terms *SID* and *SPD* are often used interchangeably. There is a significant difference between the physiology of a child with SPD and that of a typically developing child. Furthermore, there is significant difference between the physiology of a child with SPD and one with ADHD[38-40]. Further studies on this topic will be discussed later in the literature review regarding sensory integration in section 2.3.

2.2 Sensory integration

Sensory integration is "the organisation of sensations for use"[10:5]. The ultimate goal of sensory integration is the individual's ability to function in the occupational roles in his or her life.

2.2.1 Jean Ayres: Founder of sensory integration

Ayres started her research in the 1960s. At the time, the focus was mainly on perceptual motor function or dysfunction[41]. Ayres was a visionary occupational therapist and educational psychologist, who made it her lifelong ambition to understand children with sensory integration dysfunction[11,41-43]. As a neuroscientist, she systematically investigated the processing of sensory information in the brain[2], as well as the underlying neurological underpinnings of learning, emotions and behaviour. Sensory integration theory was hypothesised by Ayres as a model for assessment and intervention. This theory is currently widely used by occupational therapists in paediatrics and childhood education[44-46].

Ayres researched test development and the treatment efficacy of sensory integration intervention. Ayres developed the Southern California Sensory Integration Tests (SCSIT) in the 1960s[47] and identified and described sensory integration dysfunction. She identified five factors which emerged from statistical analysis of the SCSIT, namely[45,48,49]:

- disorder in postural ocular and bilateral integration;
- apraxia;
- form and space perception deficit;
- auditory language problems; and
- tactile defensiveness.

By the 1970s, Ayres' data was subjected to cluster and factor analyses which validated her theories. In the 1980s, Ayers resolved to provide more comprehensive assessment information in her research mainly into the underlying sensory components and the aspects of praxis. She re-standardised the SCSIT which had been replaced by the Sensory Integration and Praxis Test (SIPT)[43,45,50]. Just before her death in 1988, she used both factor and cluster analysis and identified six clusters, namely[43,45,50,51]:

- bilateral integration and sequencing deficits (subtype of SID);
- somatodyspraxia (subtype of SID);
- visuodyspraxia (subtype of SID);
- dyspraxia on verbal command (not an SID);
- low average SID; and
- high average SID.

The low average and high average SID are degrees of functioning and do not help with diagnosing subtypes. Further studies in this area have been done by Mulligan[45] and according to Smith Roley[51] research is presently being conducted in this area which is lending further support to Ayres' findings.

Ayres trained many occupational therapists who continue her legacy and research in the field of sensory integration. The intervention model has been trademarked as Ayres Sensory Integration®[43,51]. This initiative is based at the University of Southern California and Western Psychological Services (USC/WPS). The South African Institute for Sensory Integration (SAISI) supports the work of Dr Ayres and works in close collaboration with USC/WPS. A research study providing norms on the SIPT for the South African population has recently been completed. It is in the process of being submitted for publication[52]. Research in sensory integration has grown exponentially worldwide as well as in South Africa over the last 10 years.

2.2.2 Sensory integration theory

Ayres[47] based her theory on three principles:

- the brain functions as a whole;
- development is sequential; and
- environment and genetic influences play a role.

Each of these will now be discussed in turn.

Firstly, adaptive human behaviour depends on the premise that the brain functions as a whole[37,42]. All structures of the brain, both cortical and sub-cortical, are interrelated and interact, enabling efficient functioning of the individual[42,48]. The brainstem, specifically the thalamus, is the primary area where incoming sensory pathways converge[37]. Efficient processing of sensory information from the environment is critical for brain development in order for normal development to proceed.

Thus, an SID is not due to frank neurological damage but is attributed to disruptions in the central processing of incoming sensory information. Cortical structures of the central nervous system (CNS) are dependent on the efficient processing of incoming information via the sub-cortical structures of the CNS. Phylo-genetically sub-cortical structures develop from

the primitive reptilian brain, which is situated below the cerebral cortex which developed later in our primate ancestors, and the cerebral cortex is situated above midbrain. This hypothesis is supported by Chugani and Phelps (cited by Parham and Mailoux) as being a key concept in our understanding of SIDs[45]. Current research investigating physiological differences in those with SID by Miller and Fuller[2] who used laboratory studies, suggested that the parasympathetic and sympathetic nervous systems are not functioning typically in children with SID.

Secondly, according to sensory integration theory, sequential development follows a predictable pattern and any deviation would reflect atypical or primitive behaviour patterns[2,37,48]. The CNS organises incoming sensory information and through the complex interconnections results in adaptive sensory-regulatory, emotional and motor responses that increases in complexity as the individual develops[45]. The infant needs to develop sensory regulatory functions in order to adapt to its immediate environment. By six years of age, a typically developing child has learnt to adjust its behaviours and meet its own individual sensory needs, enabling it to function in a wide range of different environments[53]. Ayres[37] stated that the first seven years of a child's life is the time of the most rapid development of sensory integration[37,45].

Thirdly, environmental influences[10,45], either sensory deprived environments[10,37,45,54] or exposure to environmental toxins[10] are seen as important factors which influence the development of sensory integration. Environmental factors and genetic coding[10,37,42,44] are the two main underlying determining factors in the dynamic process of sensory integration in the developing child. Rogers (cited in Miller, Nielsen, Schoen and Brett-Green)[42] found that auditory and tactile over-responsivity occurred significantly more in identical twins than in fraternal twins.

Ayres' theory explored the role of the central nervous system (CNS), which is designed to organise endless streams of sensory information from the environment. Sensory integration is a dynamic process, which occurs throughout development. Any deviation in the interaction of these three principles affects the process of sensory integration. According to Smith Roley, it is an "interplay"[41] between genetics, health, physical capabilities, physiological,[53] CNS[10,37,42,44,45], and environmental influences[10,37,42,44,45]. When sensory information is efficiently integrated, the different parts of the brain work together in a co-ordinated manner enabling the individual to make use of and respond adaptively to new information[45].

Sensory integration is a theory of brain-behaviour relationships[11] and is defined as "the organisation of sensation for use"[10].

> The "use" of sensation may be: a perception of their body or the world, an adaptive response, a learning process, or the development of some neural function. Through sensory integration, the many parts of the nervous system work together so that the person can interact with the environment effectively and experience appropriate satisfaction[10:201].

Sensory processing and Sensory Modulation

Two aspects that have been researched extensively are sensory *processing* and sensory *modulation*. The terms are often used interchangeably.

Sensory processing is the ability to register and process sensory information through the central nervous system[10,11]. Information is processed via an interaction between the individuals' "neurological thresholds" and "behavioural responses"[7]. The following sensory systems are considered: tactile system, vestibular system, proprioceptive system, auditory system, visual system, olfactory system and gustatory system. Dunn has undertaken extensive research into sensory processing. She makes it clear that the use of her Sensory Profile is a means of describing how a specific individual reacts to stimuli from the environment when compared with other typically performing individuals[7,55].

All the information we receive about the world around us reaches us through different sensory systems. Sound, sight, smell and taste are the sensations of which we are most aware. We are not always conscious that our nervous system is also responsible for the processing of tactile and movement sensations, monitoring and directing the position of the body in space, and the effect of gravity on the head and body. Just as visual stimuli are perceived by the eyes and are relayed to the brain for interpretation, all other sensory systems have receptors, receiving information which is sent to the brain for processing via a complex network of nerves. Cells in the skin send information to the brain about light touch, pain, temperature and pressure on the skin. Structures in the inner ear (vestibular system) pick up movement of the head, as well as changing positions of the head in relation to gravitational forces. Receptors in the muscles, joints and tendons provide information on the position of the body in space[10,37,53,56,57].

Sensations such as touch, movement and body position are often overlooked compared to the sensations of vision and sound, but are nevertheless of great importance in our daily functioning. For example, the proprioceptive (sense of joint position) system and the tactile system (together known as the somatosensory system), are responsible for the internal map (body schema) that enables us to find the bed light at night without seeing it. The tactile system warns us of danger when holding our hand above a hot stove plate. The tactile system is the largest sensory system of the body, as it gets information from the total skin surface.

The vestibular system is a very important sensory system, which influences many aspects of our functioning, including feedback from our eye and neck muscles, which assists us in keeping the head upright against gravity and notifies the brain about changes in the position of the head so movements of our eyes, head and body are automatically synchronised by the vestibular system. The vestibular system reacts to the body's movement through space and together with the proprioceptive system is the basis for postural motor control, enabling us to move our limbs without having to visually monitor them and to change our body position while sitting on a chair, without falling. The co-ordination between the two sides of the body, behaviour and academic learning processes are also influenced by the vestibular system[10,37,53,56,57].

Accurate qualitative discrimination of sensory input is hypothesised by Ayres[37] to support the development of praxis. Praxis, from a sensory integrative perspective, is the ability to form an idea, conceptualise it, plan the task and finally, execute the new task[37]. The planning and execution phases are dependent on an accurate body schema that develops as a result of precise information from the sensory systems,

Sensory modulation is the ability to regulate, organise and prioritise incoming sensory input. The learner needs to suppress irrelevant sensations and attend to those sensations relevant to the demands of the situation. This often needs to be done in a graded and adaptive manner, because the learner must continuously adjust to the intensity and duration of sensory input. Sensory modulation has a behavioural component and is therefore observed in the behaviour of the learner. The learner may, for example, attend to irrelevant auditory input, like the sound of a bird outside instead of following the instructions the educator is giving in the classroom. Sensory modulation also has a physiological component which, on a cellular level, has an influence on the transmission through synapses. Sensitisation occurs

when a sensory stimuli is recognised as harmful or unfamiliar by the central nervous system, or habituation occurs when the sensory stimuli is recognised as familiar or unthreatening. As occupational therapists we need to observe behaviour in a child, and make inferences as to what might be the cause of that behaviour in the central nervous system[21,38,41,56,57].

Sensory integration in children develops through participation in everyday activities to which they are exposed. Some children's sensory integration abilities, however, do not develop as effectively as they should. This may result in developmental, motor co-ordination, social, learning, and behavioural problems[48,56,58,59]. SID includes a diverse group of disorders, which reflect subtle, primarily sub-cortical, neural dysfunction involving poor integration of the sensory systems[10,37]. This postulation is supported by other researchers and writers in the field[42,44,60].

Over the last ten years, the understanding of sensory integration has grown exponentially. Due to a concerted research drive, the theory of sensory integration is evolving[43,44]. Ayres originally coined the term *sensory integration dysfunction* (SID) based on her research with the SCSIT and SIPT. This concentrated more on practic dysfunctions[60,61]. Based on Ayres' original work, other models have developed.

Fisher and Murray[62] proposes two major types of SID: dyspraxia and poor modulation[60]. One first has to register the sensory input, thereafter there is a modulatory and discriminatory component to the sensory input. Discriminatory problems tend to lead to postural control and praxis problems, whereas poor modulation tends to lead to emotional and behaviour problems.

More recently the term *sensory processing disorder* (SPD)[42] has been proposed by Dr L Miller for the purpose of diagnostic categorisation[12,60]. Until recently, *sensory integration* and *sensory processing* have been used synonymously. If there is a functional problem, then the person would have a sensory integration dysfunction (SID) or a sensory processing disorder (SPD). The term *sensory modulation dysfunction* or *sensory processing dysfunction* is also often used in studies on ADHD and sensory processing. In a drive for uniformity in the terminology, it has been suggested that the problem rather be described as *difficulty processing and integrating sensory information* rather than *sensory integration dysfunction*

or *sensory processing disorder*[60]. In research on sensory integration, it is important to clarify what part of sensory integration is being researched[49].

In this study, the researcher has decided to use the terms *sensory processing* or *sensory processing disorder*. For the purpose of the research, the SPSC was used. It is a behavioural questionnaire, designed to measure the learner's sensory processing abilities and functional performance in the classroom[7].

2.2.3 Models of sensory processing that have emerged from Ayres

The area of sensory processing has recently received much attention and led to the development of a variety of models, varying form a linear continuum[63] to more complex models. In the latter, behavioural responses to sensory input[4] as well as influence of external factors such as environment and culture[38] on sensory modulation are described[60].

Three models applicable to the study on sensory processing and ADHD will be discussed. They are, namely Dunn's Model of Sensory Processing[4,7], The Ecological Model of Sensory Processing [38]and proposed nosology for Sensory Processing Disorders[12].

2.2.3.1 *Dunn's Model of Sensory Processing*

Dunn developed a *Model of Sensory Processing*. The model consists of a vertical axis continuum depicting neurological thresholds and a horizontal axis continuum depicting behavioural/self-regulation responses. Sensory processing is the interaction between these two continuums, which form the four quadrants as portrayed in Figure 2.1[7].

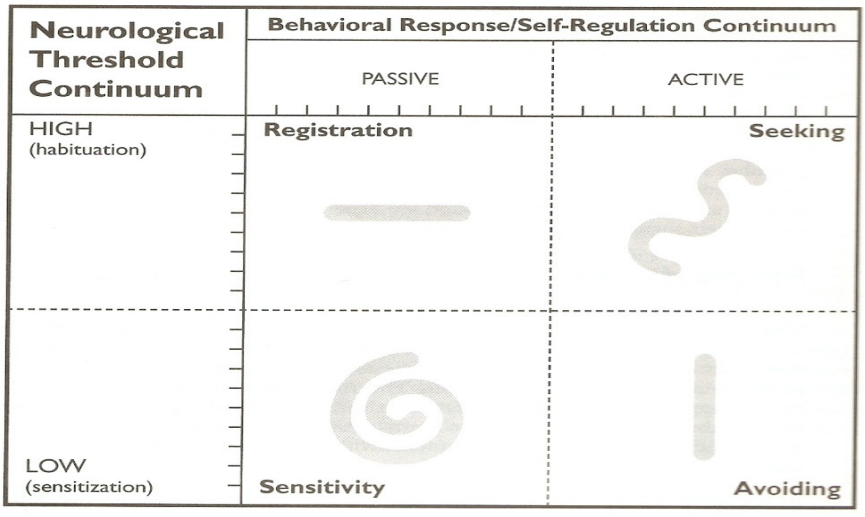

Figure 2.1: Dunn's Model of Sensory Processing. (Source: Dunn, 2006 p8)[7]

The neurological threshold (vertical axis) refers to the amount of stimulation required for a neural system to respond[4,55,64], which differs for each person and within each sensory system. A very low threshold indicates that the nervous system responds too quickly (sensitisation) whereas a very high threshold refers to a slow responder (low registration). Sensory modulation involves responding appropriately to incoming stimuli[4,7,55,64].

The behavioural responses or self-regulation continuum (horizontal axis) depict the strategies which the individual uses to self-regulate[4,7,13]. A person's temperament (passive or active) determines his or her behavioural response to the sensory input. According to Dunn, on the one end of the continuum are individuals who respond passively to their sensory threshold and their systems. They have a tendency to let things happen and only possibly respond later. On the other end of the behavioural continuum, are individuals who respond to counteract their thresholds and respond by actively seeking or avoiding the sensory input[45].

The interaction between the individual's neurological threshold and behavioural/self-regulation responses is a way of explaining the different ways in which people respond to sensory input. This can be seen in their behaviours and gives guidance on intervention. This interaction is depicted in Figure 2.1 and shows Dunn's four sensory patterns, namely *Registration*, *Seeking*, *Sensitivity* and *Avoiding*[4,7,13].

- The *Registration* pattern emerges when a person has a high neurological threshold but because that person is a passive responder - acting in accordance to his or her high sensory threshold - the person either misses the sensory input or does not seek the input required to be alert. These people appear to be daydreamers, bystanders, uninterested and self-absorbed and they miss out on the information around them. They require external help to obtain the intense sensory input from the environment so that they can focus on the task at hand.
- The *Seeking* pattern emerges when a person has a high neurological threshold, but because of an active response tendency - he or she counteracts the high sensory threshold - will seek the sensory input. This often varies with intensity, duration and type of sensory input. These individuals may appear to be hyperactive, on the go and always actively seeking sensory input.

- The *Sensitive* pattern emerges when a person has a low neurological threshold, but because of a passive response - acting in accordance to his or her low sensory threshold - the person does nothing to avoid the irritating sensory input. These people are then easily distracted by this sensory input, are on high alert to their environment, are cautious and easily upset.
- The *Avoiding* pattern emerges when a person has a low neurological threshold but because of an active response - he or she tends to counteract the low sensory threshold - will avoid the sensory input at all costs. These people withdraw from the situation or sensory input, are resistant to change, want a rigid predictable routine, and become stubborn and controlling.[55] They have a defensive reaction to the sensory stimuli.

Not all learners necessarily fit into one of the four sensory patterns of processing. Learners may exhibit a combination of patterns if their thresholds or temperaments do not clearly fall within a category. In this case, a predominant characteristic will be identified with traces of the others. Each sensory system may also have its own pattern. When scoring the results, the occupational therapist needs to rely on clinical experience to interpret the sensory profile in order to identify the learner's strengths and weaknesses and to plan intervention strategies.

Frequently a pattern that emerges may be one where the neurological threshold is either predominantly high or predominantly low. The neurological thresholds may be predominantly low, in which case the person tends to over-respond to sensory input which is known as sensory defensiveness. Such person may be over-responsive in only one system, for example to touch input, or he or she may be over-responsive in more than one sensory system, such as to touch and auditory input. The neurological threshold may be predominantly high, so the person requires more sensory input than others before he or she detects it and may vary with intensity, duration and type of sensory input. The learner will then seek some input, such as auditory, but not other input such as movement, and may be seen making noises or talking incessantly, but be slow to react to movement.

Another combination is found where learners' temperaments are predominantly passive or predominantly active to their thresholds to sensory input. In the scenario where the person's temperament is predominantly passive to his or her threshold to sensory input, the person neither seeks nor avoids the sensory input. The learner may be over-responsive (low threshold) to touch, but under-responsive (high threshold) to vestibular or proprioceptive stimulation. The learner does not seek movement, so play is sedentary, but he or she also does not avoid the irritating light touch. This learner will not be actively involved in classroom activities and will be irritated and distracted by touch input, affecting concentration and participation in schoolwork. In contrast, the learner whose temperament is predominantly active could have a high or a low threshold to different types of stimulation. This is often found in the learner who actively avoids certain sensory input such as touch and sound, but seeks movement. Both seeking movement and avoiding touch can be problematic and interfere with learning in the classroom. Alternately, the learner may be using movement in an acceptable manner to regulate him- or herself from the irritating light touch in an attempt to achieve the calm-alert state, a state of self-regulation.

Another combination frequently seen is the learner who fluctuates from being oversensitive to being under-sensitive from day to day or moment to moment. Even more confusing is the learner whose profile fluctuates between three or four quadrants, in which case he or she may have a high threshold for sensory input, but once the neurological threshold is reached the learner very quickly over-responds to the input. These learners have a narrow window of comfort and this severely impedes their learning and participation in the classroom.

In her research, Dunn developed the Sensory Profile through her investigation into the way children with disabilities could be distinguished from children without disabilities[3-6,55]. Early on, she explained the sensory patterns, but the *Quadrant scores* for the Sensory Profile were only developed and published later[55]. Dunn then went on to develop the Sensory Profile School Companion (SPSC). She used the *Quadrant scores* (sensory patterns) and four *School Factors* which emerged from combinations of these four sensory patterns, further described in section 2.4.1.2. In both the Sensory Profile Caregiver[4] and the SPSC for teachers[7], it was found that differences of sensory processing in the learner diagnosed with ADHD when compared to typical children could be identified because specific sensory processing difficulties manifest in behaviours specific to ADHD.

2.2.3.2 *The Ecological Model of Sensory Modulation*

The Ecological Model of Sensory Modulation (EMSM)[38] builds on (a) the hypothesis continuum as discussed above[4,7,63] and (b) the fact that the individual's capacity for sensory modulation is variable and that it differs between individuals and at different times of the day. The EMSM elaborates on the dynamic process of sensory integration proposed, explaining the influences of genetic factors and the environment of the child on the development of sensory integration[28], as seen in Figure 2.2. It further considers the complexity of sensory modulation, differentiating between the physiological and behavioural elements, as well as the internal and external dimensions. Sensation, emotion and attention are the three internal dimensions which form the individual differences. The four external dimensions are culture, environment, relationships and tasks. This model expands on the role and importance of the context within which the learners find themselves. The learners' responses need to be understood in the context of their life (external dimensions) and the influences these factors have on the learners (internal dimensions)[38].

The internal and external dimensions interact in a multi-directional manner. When the external dimensions are able to hold the internal dimension together, there is a good fit which results in adaptive behaviour. When there is an imbalance between the supports and demands of the external dimension and the adaptive capacities of the internal dimensions the result is maladaptive behaviour from a primary sensory modulation dysfunction (SMD)[38,45]. Learners with SMD have a primary deficit in sensory registration, integration and or regulation, and these sensory processing differences frequently lead to problems in regulation of attention and emotion[38].

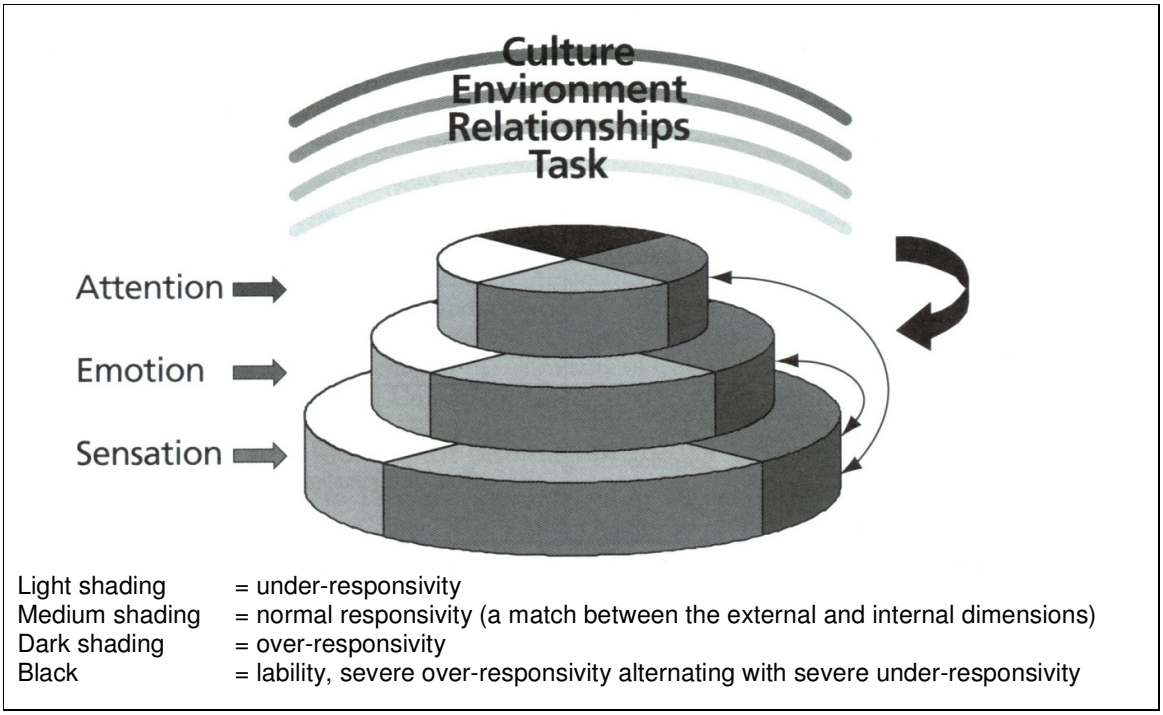

Figure 2.2: The Ecological Model of Sensory Modulation (EMSM) (Source: Miller, Reisman, Mcintosh, Simon, 2001 p61) [38]

Frequently, the learner with SMD or ADHD copes fairly well in one grade and then not in the next. This may be due to the external dimensions not providing support for the internal dimensions as there are many changes from one grade to the next. Some examples are:

- Culturally, the learner and the educator may be very different.
- The classroom environment may be too busy or noisy for the learner, especially if a classroom is very noisy and the learner is sensitive to noise.
- The relationship between learner/educator or learner/other learners can also affect the internal dimensions. Examples could be an educator who lacks empathy with a learner who is hyperactive, or an educator who does not have structure in his/her classroom and a learner who needs structure resulting in a misfit.
- The task at hand can also affect the internal dimensions, as learners with ADHD often have motor or learning problems[65]. If a learner has difficulty with writing and he or she is not coping in the classroom it can lead to problems. A task that is either too difficult or not interesting to the learner could result in frustration or inattention impacting on the internal factors.

In the above scenarios, the external dimensions will not support the learner's internal dimensions. This model also clearly links the internal dimensions with one another, i.e.

sensory regulation forming the foundation onto which emotional regulation is superimposed and then focused attention. Further studies using this model in research and the relevance of the internal dimensions and ADHD will be discussed in section 2.3.

The EMSM is useful in explaining SMD and the extent to which the learner is coping in the classroom or home situation. Occupational therapists can use the EMSM to explain the mismatch between parent/educator and the learner within the different contexts and also the occupational roles the learner takes on. For example, if a learner who is seeking movement, fiddling, making noises, acting impulsively and inappropriately has a sensory sensitive over-responsive educator, the problem will be magnified and the educator could overreact to the learner who feels that he or she is being reprimanded and patronised repeatedly.

A similar scenario unfolds if the educator needs structure in order to function and the learner has a less structured preference (learning style). In this case the educator's external dimensions are not supporting the learner's internal dimensions. The educator finds it difficult to self-regulate in this classroom situation.

According to Weingartner[66] the teacher's perception and expectations can also affect his or her reaction and handling of the learner's behaviour. This in turn would have an effect when the learner is referred for further investigation, and it could influence objectivity when completing questionnaires which professionals use to assist in the diagnosis and treatment of the learner with ADHD. An educator who is over-responsive to noise may report that the learner is always noisy, whereas an educator who is under-responsive to noise may report that the same learner is only occasionally noisy. The therapist needs to be aware of the sensory dynamics between the educator and learner when interpreting questionnaires. See Table 2.1 for observable behaviours of the internal dimensions as this emphasises how carefully the professional needs to interpret a learner's behaviour.

Table 2.1: Observable behaviours in Sensory Modulation Dysfunction. (Source: Miller, Reisman, Mcintosh, Simon p62)[382]

Internal Dimensions	**Under responsiveness**	**Over-responsiveness**
Attention	Perseveration Unaware	Hyperactivity Impulsivity/disinhibition Inattention
Emotion	Flat affect Lack of empathy	Hostility, anger Tearful Withdrawal
Sensation	Responds slowly Poor discrimination	Responds quickly Intense responses Poor habituation Fight-fright-flight responses

2.2.3.3 *Nosology of sensory processing disorders*

The proposal by Miller[42] for sensory processing disorders (SPD) as seen in Figure 2.3 below, suggests that SPD has three subtypes and a learner may have a combination of these subtypes. Sensory modulation disorder and sensory motor-based disorder have further subtypes. A distinction is also made between sensory-based motor disorder and sensory discrimination, and this explains that a sensory discrimination disorder is often found with a sensory-based motor disorder. This is a new model which is currently not used universally by researchers and therapists[2,12,42].

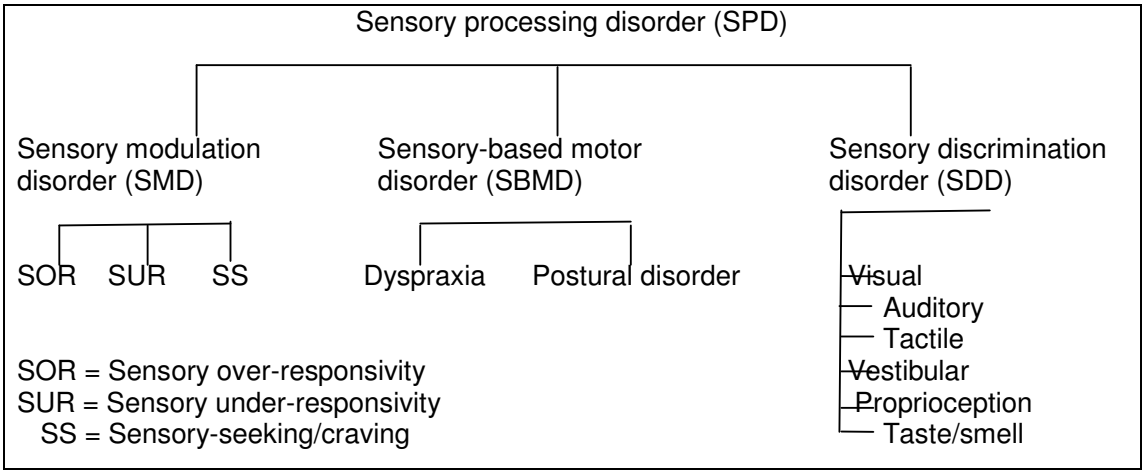

Figure 2.3: A proposed nosology for sensory processing disorder. (Source: Miller, Anzalone, Lane, Cermak, Osten. 2007, 61(2), pp. 135-140)[12]

The proposed nosology clarifies the subtypes of sensory processing disorders, making a distinction between the terminology which is often used interchangeably, particularly *sensory processing* and *sensory modulation*. The proposed nosology also differs from Dunn's model of four sensory processing patterns in that sensory avoiding and sensory sensitivity are now considered as sensory over-responsivity.

2.3 Relationship between sensory integration and ADHD

The ability of the learner to function in the school environment and observation of the learner's behaviour are considered when assessing a learner with ADHD and SPD. As discussed previously (section 2.1.6), co-morbidity exists between SPD and ADHD. Evidence is becoming stronger that there are differences in the sensory processing and integration in the various disorders, for example ADHD, autism and developmental co-ordination disorder (DCD)[67,68]. This highlights the importance of research in sensory processing and various disorders leading to a more comprehensive assessment and understanding of the learner. Symptoms of ADHD and SPD often overlap.[68] Not all children who have SPD have ADHD, and not all children who have ADHD have SPD, but research shows it is clear that a large percentage of children have both.

The fundamental differences between the two disorders need to be clarified to prevent misdiagnosis resulting in incorrect intervention. There are also observable behavioural similarities and differences between the sensory-seeking learner and the learner with ADHD (hyperactive/impulsive subtype) and the sensory under-responsive learner and the ADHD (inattentive subtype) according to Miller and Fuller.[2] See Appendix B which tabulates these differences of the two ADHD subtypes and the two sensory modulation subtypes. For example, both the learner with ADHD and the sensory seeker act impulsively, but the sensory seeker will impulsively seek the specific type of sensory input required, then stop when the sensory input is enough and focus on the task at hand. In contrast, the learner with ADHD will impulsively seek the sensory input, irrespective of the type of sensory input and even often become over-aroused.

Currently, there is very little research on prevalence and gender differences in ADHD and sensory processing in the literature. According to Miller[2], at least one in twenty people are affected by SPD. The prevalence is higher in children with ADHD, autism and fragile X syndrome[2]. As research progresses, more detailed information distinguishing between

learners who have ADHD and SPD will become evident. In one study, using parent questionnaires on a national sample of 2 410 typically developing learners 7.5% had symptoms of either ADHD or SPD or both disorders. Of this group, 28% had SPD, 32% had ADHD and 40% of the learners showed an overlap of ADHD and SPD[2].

By comparison, numerous researchers have investigated sensory processing in learners with ADHD focusing on the use of behavioural and/or physiological methods. It was found that learners with ADHD have problems in many areas of sensory processing and modulation[4,7,8,21,40,69,70].

2.3.1 Physiological measures to understand the sensory processing of the learner with ADHD

The Sensory Challenge Protocol[38,71] is an example of a physiological measure as it measures electro-dermal reactivity and vagal tone to sensory input[72].

The electro-dermal reactivity of the ADHD group had larger orienting reactions on initial sensory stimulation in each domain than the group without ADHD[38,40]. When comparing physiological responses to sensory input, learners with SMD differ from those without SMD[39]. Learners with SMD display slower habituation compared to those with ADHD, who in contrast, show faster than normal habituation[39]. In a study comparing learners with ADHD, SMD and typically developing children, the ADHD group had a large orienting response on the first trial, followed by a clear fast habituation, whereas the children with SMD habituate more slowly to sensory stimuli.

Learners with SMD, ADHD, other disorders and typical development appear to be showing differences in physiological reactions to sensory input[38-40,72]. Boys with ADHD and tactile defensiveness had higher somatosensory-evoked potential amplitudes than boys with ADHD only or typically developing boys[72].

2.3.2 Behavioural measures to understand the sensory processing of the learner with ADHD

The behavioural measures used in research are parent/teacher questionnaires, such as Dunn's Sensory Profile School Companion or sensory motor questionnaires, as well as clinical observations of movement and posture and various standardised tests, such as the Sensory Integration and Praxis Test.

Several studies using behavioural measures of sensory processing found that learners with ADHD presented with sensory processing problems. Most of these studies have used one of Dunn's sensory profiles (Sensory Profile Caregiver) long or short form, or Sensory Profile School Companion)[4,7,8,21,40,70]. Dunn's studies will be discussed in the next section.

To date, more research has been done on over-responsivity to sensory input and ADHD than on the other subtypes of SPD because learners with ADHD frequently over-respond (low threshold) to incoming sensory input[7,8,40,46,69,72,73].

Ayers originally mentioned that tactile defensiveness is often seen as hyperactive and distractible behaviour in the classroom rather than that of tactile defensiveness.[37] Auditory defensiveness[40,69,73], visual defensiveness[38,40,69,73], and tactile defensiveness[38,40,46,72-74] are often found in learners with ADHD. In a study of a group of learners with ADHD, 62% had tactile over-responsivity, 54% had auditory over-responsivity while none reported oversensitivity to movement[69].

The various subtypes, SPD or SMD, are rarely separated in research studies and the term *sensory processing* is used. In various research studies learners with ADHD showed signs of difficulty with auditory processing[8,21,46,55,65,73,75], visual processing[4,7,8,70,75], vestibular and proprioceptive processing (including over- or under-responsivity to gravity or movement and postural control)[7,8,38,40,46,70,75], and tactile processing[7,8,21,46,70,75]. It is important to clarify which subtype of sensory processing or sensory system is being researched[76].

2.3.3 Combination of physiological and behavioural measures to understand sensory processing of the learner with ADHD

Some researchers[38,40,72] have used both physiological measurements and behavioural measurements in studies on sensory processing and ADHD. Mangeot, Miller and McIntosh[40] compared learners with ADHD to typically developing learners. Learners were assessed across a number of sensory domains using electro-dermal responses, the Short Sensory Profile, Leiter International Performance Scale and the Child Behaviour Checklist. The group of learners with ADHD displayed more difficulties with sensory processing and a greater variation in sensory processing. Specific sensory problems such as sensory-seeking, auditory-filtering, oversensitivity to touch, visual, auditory, taste and olfactory input were different between the two groups. Certain of these behavioural problems could be linked to specific sensory processing problems[40].

In a study using the Ecological Model of Sensory Modulation (see section 2.2.3.2), it was hypothesised that learners with SMD would have a core deficit in sensory processing (sensation), those with autistic disorder in regulating emotion and those with ADHD in giving attention. The Sensory Challenge Protocol and the same three parent-report scales (Short Sensory Profile, Leiter-R and Child Behaviour Rating Scale) were used to depict scores relevant to sensation, emotion and attention. The ADHD group did have a core deficit in attention, and sensation was more impaired than emotion. The ADHD group also had severe deficits in the auditory filtering, over-responsivity to touch and vision, and they were either movement-seeking or -avoiding. The ADHD group had a larger orienting reaction to the sensory stimuli, but habituated very quickly to the sensory input. The ADHD group showed hyper-responsivity in all three internal dimensions (emotion, sensation and attention)[38].

Parush, Sohmer, Steinberg and Katz[72] did a study on boys with ADHD, tactile defensiveness and somatosensory function. They could discern ADHD with or without tactile defensiveness on the Touch Inventory of the Preschooler, and Somatosensory-Evoked Potential but not on the SIPT tactile discrimination tests except for *Finger Identification*. The group with tactile defensiveness had significantly higher central somatosensory-evoked potential amplitudes than the group without tactile defensiveness. Parush et al state that these results show evidence of a link between SMD and atypical neural processing.

In another study examining the role of the disturbances in sensory processing on the parasympathetic nervous system, the children with SMD had significantly lower vagal tone. The parasympathetic nervous system is a regulator of reactivity and these are differences in physiological activity. A relationship between physiology and behaviour (sensory responses) was found[77]. These physiological differences were further supported and, according to Ben-Sasson, Carter and Briggs-Gowan, over-responsiveness to sensory input can lead to social-emotional problems in ADHD learners[78]. Over-responsiveness to sensory can also lead to anxiety in ADHD learners[69,73,79]. The learners who had ADHD and sensory over-responsivity had significantly higher levels of anxiety as well as higher physiological responses to anxiety than the other two groups[69,79].

In conclusion, the above studies highlight that sensory processing problems are present in a large percentage of learners with ADHD. Sensory responses differ vastly and there are physiological and behavioural differences between the typically developing learners, those with ADHD and those with SMD. In research, there is always a possibility that some subjects in the sample with ADHD may have co-morbid SMD, or that the sample with SMD may have undiagnosed ADHD or anxiety disorders[38]. This highlights the complexities in designing studies and understanding learners with disabilities.

2.4 Measuring instruments

This section describes measuring instruments used for determining sensory processing differences and distinguishing between the types of ADHD.

2.4.1 Instruments measuring sensory processing

Occupational therapists use information from clinical observation or screening tools that rely on parent- or educator-report measures to collaborate their findings with information from those adults who know the learner's sensory processing intimately. Several measures have been developed, some are standardised while others are non-standardised. Non-standardised checklists include the Occupational Therapy Association, Watertown Clinical Assessment Worksheet[80], Sensory Observation Guide[80], and Building Bridges Checklists[56]. As the validity and reliability of these non-standardised tests have not been tested, they were not considered for review in this section.

Standardised questionnaires for the measurement of sensory processing include the Sensory Profile Caregiver Questionnaire (long and short form)[55], Sensory Profile School Companion[7], Sensory Processing Measure[81], Touch Inventory for Preschoolers, Touch Inventory for Elementary School[11] and Sensory Integration Inventory[82]. Only the Sensory Profile School Companion (SPSC) and Sensory Processing Measure (SPM) are reviewed as the other checklists were either not suitable for the ADHD population or they focus on tactile defensiveness only.

2.4.1.1 Sensory Processing Measure (SPM)

The SPM[81] is a recently USA-developed measurement tool with limited research behind it. It is a questionnaire that examines behaviours and characteristics related to sensory processing issues, praxis, and social participation in the home and school environments. Each item is rated according to how frequently a particular behaviour is observed on a 4-point Likert scale. The SPM consists of the SPM Home Form, which has 75 items and is completed by the parent or caregiver, and the SPM Main Classroom Form, which has 62 items and is completed by the educator. It provides scores in social participation, vision, touch, body awareness, balance and motion, planning and ideas and a total sensory score. The SPM home and school versions were standardised on 1 051 children between the ages of 5 and 10 years[81]. Median internal consistency is .86 for SPM School and the median test–retest reliability was .97. Two pilot studies were conducted over a period of two years and found that the SPM School accurately distinguished between typically developing learners and those with sensory issues in 82.4% of the cases[81].

2.4.1.2 Sensory Profile School Companion (SPSC)

The first part of this section will give an overview of the development and research done on the Sensory Profile and research in the field of ADHD. In the second section, the Sensory Profile School Companion will be discussed in full as well as ADHD studies in which the SPSC was employed.

2.4.1.2.1 Overview of sensory profiles

Winnie Dunn developed the model of sensory processing (see section 2.2.3.1). She initially developed the Sensory Profile Caregiver (short and long form). Research was done on how learners with disabilities could be distinguished from learners without disabilities. An ADHD worksheet was developed for the Sensory Profile to be used to validate assessment findings and for analysis and ADHD. This consisted of the three factor scores (sensory-seeking, emotionally reactive and inattention/distractibility) as well as a cluster of visual and tactile scores as these items were found to be common with ADHD[4]. In developing the Infant/Toddler Sensory Profile and the Adolescent/Adult Sensory Profile, Dunn's model was used as a theoretical framework. *Quadrant scores* depicting the four sensory processing patterns of Dunn's model were then developed as part of the scoring system. This led Dunn to develop *Quadrant scores* for the Sensory Profile, which was later published in a supplementary manual[3-6,55].

The Sensory Profile was used in studies to measure the patterns of sensory processing in learners with ADHD. Significant differences were found in learners with ADHD compared to typically developing learners with lower scores for auditory, touch, multisensory processing, emotional/social responses and behavioural outcomes. The Sensory Profile can be used to discriminate between learners with and without disabilities[5,21,83]. This research has been helpful in the assessment and discrimination of different disabilities, specifically autism, Asperger's syndrome and ADHD. Although most studies on SPD and ADHD have been conducted in the USA, a few studies have been done outside the USA such as in South Africa[8], Israel[65,70] and Hong Kong[75].

The only study in South Africa on the Sensory Profile and ADHD was done in Manguang by fourth-year occupational therapy students under the guidance of an experienced sensory integration therapist. According to this study, learners with ADHD presented with sensory processing dysfunction. Scores with more than one standard deviation or more below the norm were considered as constituting a deficit. Significant dysfunctions were found in 92.31% of the learners for oral, in 84% for auditory, in 80.77% for vestibular, and in 73.08% for touch. In the modulation categories, significant dysfunctions were found in 76.92% for modulation of sensory input affecting emotional responses, 76.92% for modulation related to body position and movement, 65.38% for sensory processing related to endurance/tone, 61.54% for modulation of visual input affecting emotional responses and activity levels, and

57.69% for modulation of movement affecting activity level. In the behaviour and emotional categories, significant dysfunctions were found in all three categories: 88.46% for behavioural outcomes of sensory processing, 84.62% for emotional/social responses and 73.08% for items indicating threshold for response. Five of the nine factors were above 50% of the sample in the dysfunction range, namely 92% for sensory-seeking, 88.46% for emotionally reactive, 88.46% for inattention/distractibility, 84.62% for oral sensory sensitivity and 73.08% for low endurance/tone. Finally, of the four quadrants 92.31% for Sensory-seeking, 88.46% for Low Registration were found to be the most dysfunctional. Sensory-seeking and Sensory Avoiding were also above 50%, but specific percentages were not given. The learners with ADHD showed dysfunctions in the majority of the scores on the Sensory Profile[8].

In the Israeli study, learners with ADHD had statistically more sensory processing problems, with the ADHD group being lower than the typically developing learners in the following group scores: Auditory, Visual, Touch, Multisensory, Oral. On the Sensory Profile, which the caregiver completed, scores with more than 1.5 standard deviation below the norm, were considered as a deficit. Significant differences were found between the two groups with the scores of modulation related to body position and movement, movement affecting activity level, visual input affecting emotional responses, activity level, emotional/social, behavioural outcomes of sensory processing, items indicating thresholds to responses, sensory-seeking, emotionally reactive, oral sensory sensitivity, inattention distractibility, sedentary and fine motor perception. Learners with ADHD had significantly more sensory processing problems than the typically developing learners[65].

In a study done in Hong Kong using the Chinese Sensory Profile (same items as the Sensory Profile), learners with ADHD had significant sensory processing deficits, particularly in auditory processing but also in most other aspects of sensory processing. In this study, all the sensory sections of auditory, visual, activity level, taste/smell, body position, movement, emotional/social responses the ADHD subjects displayed significant differences. In this study, individual items were discussed in more detail in the section, modulation, behaviour or factor scores than in other studies[75]. The Sensory Profile Caregiver and Short Sensory Profile do not distinguish between high and low threshold scores for each sensory system. Results are then combined in discussing processing within each sensory system.

The above research findings clearly support one another on the prevalence of sensory processing disorder in learners with ADHD using the Sensory Profile.

The Sensory Profile School Companion is the fourth sensory profile Dunn developed in her research. The SPSC has not been used in any other study known to the author except for the development of the SPSC. In the development of the SPSC, Dunn validated the group items and scoring structure on the SPSC providing evidence for reliability and validity. The SPSC manual reports that Cronbach's alpha coefficient yielded a good internal reliability for the various groupings - ranging from .83 to .95 - which indicates a high degree of internal consistency. Test–retest reliability coefficients ranged from .80 to .95, reflecting good to excellent stability between the scores of the first and second ratings on the same learner. Dunn studied educators' rating patterns considering education level, years of experience and frequency of contact with the learner and found that the differences were negligible[7].

In developing the SPSC, Dunn did extensive research to establish how learners without disabilities would differ in their performance to learners with ADHD, Asperger's syndrome and autism[55]. The results of the groups with Asperger's syndrome and autism are not included or discussed here as they are beyond the scope of the study. The results of two studies where ADHD learners were compared to learners without disabilities, are reported in the SPSC manual[7]:

- In the first study the scores obtained from a sample of 59 ADHD learners were compared to those of a sample of 585 typically developing learners in attempt to standardise the SPSC. The results were visually displayed on a continuum of potential scores, showing the mean and standard deviations of the different groups
- In the second study, Dunn used the scores of the same sample of 59 learners with ADHD and compared them to those of a paired sample of 59 learners selected from the normal sample of 585 typically developing learners (paired for age and gender). The comparison revealed significant differences between the two samples on 11 of the 13 group scores. Only *Seeking* and *School Factor 4* were similar in learners without disabilities and the ADHD sample.

2.4.1.2.2 Description of the SPSC

The SPSC is a standardised questionnaire for measuring the learner's sensory processing ability and the way this may possibly affect the learner's functional performance in the classroom and school environment. The SPSC is completed by a teacher who has known the learner for at least six months and takes about 15 minutes to complete. The questionnaire consists of 62 items which describe the learner's behavioural responses to sensory experiences, which are rated according to how frequently the behaviour occurs, using a 5-point Likert scale:

1	Almost always	90% or more of the time
2	Frequently	75% of the time
3	Occasionally	50% of the time
4	Seldom	25% of the time
5	Almost never	10% or less of the time

Lower scores indicate that the behaviours are more frequently found, as *Almost Always* behaviours are awarded 1 point, in comparison to *Almost Never* receiving 5 points.[7] The 62 items measure behavioural aspects and are divided into three categories and further yield 13 group scores. The three categories are:

1. The four sensory processing pattern scores are grouped into four Quadrants, namely *Registration*, *Seeking*, *Sensitivity* and *Avoiding* (Figure 2.1). These originate from Dunn's Model of Sensory Processing which investigated the interplay between self-regulation responses and neurological thresholds[7], each being on a linear continuum.
2. Four *School Factor* scores, numbered one to four, which provide information on the learner's sensory processing factors as well as the educators distinctive perception of the learner.
3. Five *Section Scores*, which consist of the four sensory sections (*Auditory, Visual, Movement and Touch*) and a fifth section for *Behaviour*.

Dunn defined the categories to provide therapists and researchers with a clear understanding of what is measured by each grouping obtained by the SPSC. Table 2.2 details the 13 group scores obtained with direct quotes from the SPSC manual with added explanations of each by this researcher.

Table: 2.2: Explication of Dunn's groupings on the Sensory Profile School Companion

Groupings	Dunn's definition[7]	Explication*
Quadrant scores		
Registration	"awareness of all types of sensations available"	Learner often misses sensory input as he or she has a high threshold to sensory input and do not seek the input required to regulate themselves to attend to the task. Appear to be daydreaming.
Seeking	"interest in and pleasure with all types of sensation available"	Learner also has a high threshold to sensory input, but he or she actively seek and enjoy the sensory input.
Sensitivity	"interest in and pleasure with all types of sensation"	Learner has a low threshold to sensory input and detects the input easier and is then distracted by it. Does not actively avoid it.
Avoiding	"need for controlling the amount and type of sensations available at any time"	Learner has a low threshold to sensory input, which bothers him or her and he or she avoids this at all costs, often appearing stubborn and controlling.
School Factors		
School Factor 1	"need for external supports to participate in learning"	Mostly seeking and registration items (high threshold) so the educator needs to provide more sensory input to keep the learner focused on the task.
School Factor 2	"awareness and attention within the learning environment"	Mostly seeking and sensitivity items and learner appears to be hyper alert which often interferes with his or her ability to focus on the task.
School Factor 3	"tolerance within the learning environment"	Mostly sensitivity and avoiding items (low threshold) and learner have difficulty in tolerating the sensory input which limits his or her engagement in the task.
School Factor 4	"availability for learning within the learning environment"	Mostly registration and avoiding items and the learner appears inattentive and remote from the task.
Section scores		
Auditory	"responses to things heard"	Consists of items such as being bothered by noise, making noises or not responding to instructions.
Visual	"responses to things seen"	Consists of items such as being bothered by bright lights or movement, adding more detail to work or leaving blank spaces, not watching instructions and being organised with his or her materials.
Movement	"responses to sensations of movement"	Consists of items which show whether the learner is clumsy, seeks movement, fidgets, is slow to participate or withdraws from active games. Also provides information on postural control.
Touch	"responses to stimuli that touch the skin"	Consists of items showing over- or under-reaction to tactile input such as being bothered by others touching them, not noticing if they are dirty, fiddling and touching objects or avoiding touch in messy play or peers being to close to them such as standing in the line.
Behaviour	"group of items associated with sensory responses".	Consists of behavioural reactions linked to sensory input such as being inefficient, inactive, little emotion and more curious,

**added by author*

Table 2.3 was compiled from the SPSC manual by the researcher to explain the practical implications of the *School Factor scores* and the way they relate to the quadrants as well as the way the educator perceives the learner's behaviour to sensory input in the classroom setting. It is also used to plot, interpret and plan intervention strategies from the results of SPSC, assessment and parent interviews.

Table 2.3: Sensory patterns and *School Factors (SF)* – features and interventions. Compiled by the researcher in table format for personal use from the Sensory Profile School Companion Manual [7:9-10,21-24]

REGISTRATION	**SEEKING**
• Misses sensory input • Bystander • High neurological threshold • Passive response *Intervention:* ***Less than others*** *(high scores) – provide more familiarity* ***More than others*** *(lower scores) – provide more intensity* SF1 – needs more sensory input to notice the sensory stimuli. *Learner needs educator's direction and support to stay focused on learning activities.* *GOAL – identify strategies that educator can use to provide learner with more sensory input during learning activities.* SF4 – disengaging because they do not notice stimuli. *Learner appears to be uninvolved, preoccupied, or withdrawn from learning activities.* *GOAL – identify strategies that the educator can use to keep learner engaged in learning throughout the day.*	• Obtains sensory input • Seeker • High neurological threshold • Active response *Intervention:* ***Less than others*** *(high scores) – provide variety* ***More than others*** *(lower scores) – provide more opportunities* SF1 – needs more sensory input to meet learners need for sensory input *Learner needs educator's direction and support to stay focused on learning activities.* *GOAL – identify strategies that educator can use to provide learner with more sensory input during learning activities.* SF2 – engaging in behaviours to meet sensory needs. *Learner appears very alert and attentive during learning activities, but heightened attention may interfere with ability to maintain focus.* *GOAL – identify strategies that educator can use to reduce attention to random sensor experiences and increase attention to learning activities.*
SENSITIVITY	**AVOIDING**
• Detects sensory input • Sensor • Low neurological threshold • Passive response *Intervention:* ***Less than others*** *(high scores) – increase awareness* ***More than others*** *(lower scores) – provide more structured input* SF3 – noticing and reacting to very low levels of sensory input. *Learner exhibits limited tolerance to sensory input during activities, which may interfere with ability to engage in learning.* *GOAL – identify strategies that educator can use to reduce the amount and types of sensory inputs available during critical learning periods.* F2 – engaging in behaviours as a reaction to sensory input. *Learner appears very alert and attentive during learning activities, but heightened attention may interfere with ability to maintain focus.* *GOAL – identify strategies that educator can use to reduce attention to random sensor experiences and increase attention to learning activities.*	• Bothered by sensory input • Avoider • Low neurological threshold • Active response *Intervention:* ***Less than others*** *(high scores) – provide organised input* ***More than others*** *(lower scores) – make less input available* SF3 – trying to reduce sensory input. *Learner exhibits limited tolerance to sensory input during activities, which may interfere with ability to engage in learning.* *GOAL – identify strategies that educator can use to reduce the amount and types of sensory inputs available during critical learning periods.* F4– disengaging in order to reduce sensory input. *Learner appears to be uninvolved, preoccupied, or withdrawn from learning activities.* *GOAL – identify strategies that the educator can use to keep these learners engaged in learning throughout the day.*

2.4.2 Instruments to measure attention deficit/hyperactivity disorder

The three questionnaires that are viewed in literature as being capable of differentiating between the subtypes of ADHD, are the ADHD Rating Scale-IV[84], the Conner's Scale and the Attention-Deficit/Hyperactivity Disorder Test[85]. The 1998 ADHD Rating Scale-IV is a standardised rating scale, comprising two versions (home and school) and is a revision of a previous ADHD Rating Scale designed in 1991. It consists of 18 scale items based on DSM-IV criteria, using a 4-point Likert scale[84].

1	Never or rarely
2	Sometimes
3	Often
4	Very often

The even numbered items on the scale are indicative of the *Hyperactivity-Impulsivity* subscale *(HI)* and the odd numbered items are indicative of the *Inattention subscale (IA).* This results in three scores, namely *IA, HI* and *Total* score, which are plotted on a scale and expressed in percentiles[84]. The higher the raw score the bigger the indication of a problem.

Du Paul and his co-workers[84] used the DSM-IV criteria when researching the ADHD Rating Scale-IV. They found that it was possible to differentiate learners of the inattentive and the combined type, but were unable to identify the hyperactive/impulsive subtype. The optimal cut-off scores to diagnose the subtypes were:

- Inattentive subtype: *IA* ≥ 90th percentile and *HI* ≤ 80th percentile
- Combined subtype *IA* ≥ 90th percentile and *HI* ≥ 80th percentile[84]

The internal consistency of the ADHD Rating Scale-IV school version was .94 for the *Total* score, .96 for *IA* and .88 for *HI*, whilst the ADHD Rating Scale-IV home version was .92 for the *Total score*, .86 for *IA* and .88 for *HI*. Test–retest reliability was done 4 weeks apart using the Pearson product-moment correlation and yielded a coefficient of .90 for the *Total score*, .89 for *Inattention* score and .88 for *Hyperactivity/Impulsivity* score[84].

The Attention-Deficit/Hyperactivity Disorder Test has less research backing than the ADHD Rating Scale-IV, has four scores (inattention, hyperactivity, impulsivity and a total score) but it does not have the same number of items per scoring section, making comparisons more difficult[85].

The Conner's Parent and Conner's Teacher rating scales are of the most studied and used scales[86]. In a study by Faries, Yalcin, Harder and Heiligenstein[86], comparing the Conner's rating scale and the ADHD Rating Scale-IV, it was concluded that the latest ADHD Rating Scale-IV was a useful clinical tool for testing the severity of ADHD and for researchers to use it in research of ADHD. According to Du Paul et al.,[84] the ability to differentiate between the two subtypes of ADHD is higher (75%) if both the parent and teacher rating scales are used. However, the teacher rating scales were better at predicting the subtypes than the parent rating scale. Simonsen and Bullis[1] supported the finding that the ADHD Rating Scale-IV was more reliable if school and home rating scales were used together and concluded that this rating scale could assess the subtypes relatively effectively.

CHAPTER 3

METHODOLOGY

This chapter will describe the methodology followed in this research. In the selection of the sample as well as in determining the criteria for the selection of the most appropriate measures for ADHD and for sensory processing in this study, due consideration was given to the findings of international and local studies as were highlighted in Chapter 2. The methodology is summarized in Figure 3.1

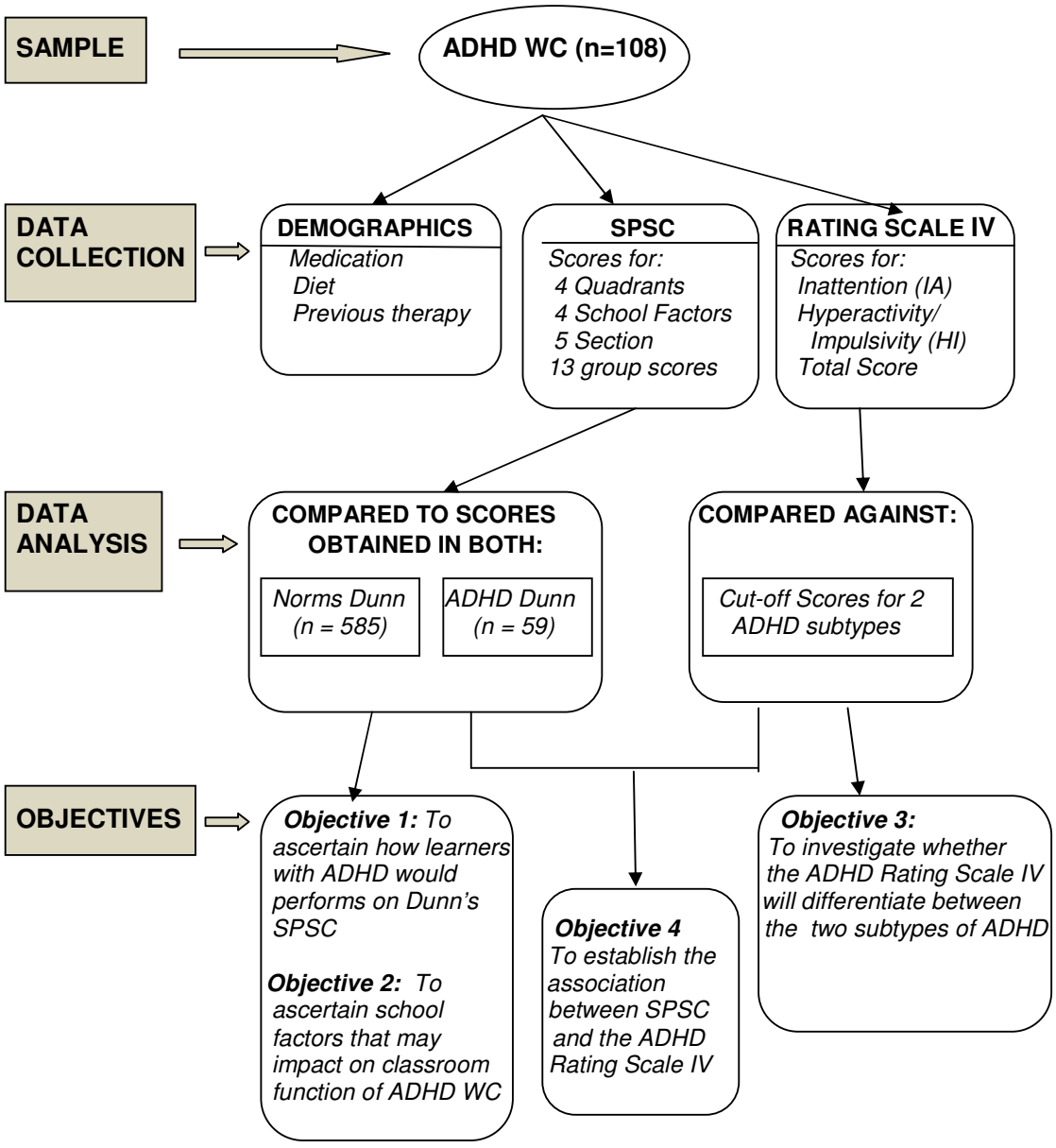

Figure 3.1 Summary of Methodology

3.1 Aim

The aim of the study was to investigate how learners with ADHD in the Western Cape will perform on Dunn's SPSC and the ADHD Rating Scale-IV in order to assess the sensory processing problems of learners with ADHD in South Africa.

3.2 Objectives of the study

The following objectives were set:

- to ascertain how learners with ADHD in the Western Cape will perform on Dunn's SPSC.
- to ascertain which school factors will emerge from Dunn's SPSC that may impact on classroom function of learners with ADHD in the Western Cape;
- to investigate whether the ADHD Rating Scale-IV will differentiate between the subtypes of ADHD as set out in the manual; and
- to establish the association between scores obtained on Dunn's SPSC and the ADHD Rating Scale-IV.

3.3 Study design

A descriptive study design was used to answer objectives one to three and a cross-sectional methodology to answer objective four[87]. Measurements on the SPSC and ADHD Rating Scale-IV were scored according to the procedures set out in the manuals.

3.4 Sampling

Learners in the Northern suburbs of the Western Cape metropolitan area were targeted for the purpose of this study. After obtaining permission from the Western Cape Department of Education (Appendix C) and the principals of the selected schools (Appendix D) a convenience sampling method was employed to select 100 learners from mainstream primary schools and private occupational therapy practices. Learners for inclusion and exclusion were identified according to the criteria set out below by the LSEN (Education for learners with special educational needs) educators and occupational therapists in the schools and practices respectively.

Inclusion criteria:

- Learners aged 5 to 10 years;
- Diagnosis of ADHD by medical practitioner (or informed to this aspect by the parents).

Exclusion criteria:

- Learners with a diagnosis of autism, cerebral palsy and any other physical or psychiatric disability.

The sample (n=100) drawn will be referred to as the ADHD WC group (Attention Deficit/Hyperactivity Disorder Western Cape) throughout.

3.5 Instrumentation and data collection

Prior to the collection of data, an information package (Appendix E) containing information on the research study, consent forms and measuring instruments was compiled and handed to educators and parents of the sample of learners. Consent from each learner's parent/legal guardians (Appendixes F and G), and LSEN educators (Appendix H) was then obtained.

Three sets of information were needed for the purpose of this study:

3.1 Demographic data on each of the learners in the sample relating to issues such as medication, diet and whether the learners had received sensory integration therapy before commencement of the study. A form to collect this information on each learner was designed by the researcher and completed by the parent/legal guardian(s) of the learner (Appendix I).

3.2 An instrument to measure the learners' sensory processing, and

3.3 An instrument to differentiate between the subtypes of ADHD.

The following general criteria were applied in the selection of measures for 3.2 and 3.3 above:

- cost and availability;
- reliability and validity of instruments;
- sub-measurements and information pertinent to the research question;
- availability of normative data;
- completion time and ease of recording by educator and scoring by researcher; and
- previous use in research.

Based on the above criteria, as well as the review of the literature (Chapter 2), behavioural as opposed to physiological measurements were selected as the latter did not meet the above criteria.

For the purpose of determining the learner's sensory processing, the SPSC was selected rather than the SPM due to the additional and useful sensory processing disorder classification potential of the SPSC into the four quadrants (*Registration, Seeking, Sensitivity* and *Avoiding*).

The ADHD Rating Scale-IV was chosen to differentiate between the two subtypes of ADHD, namely *inattentive* and *combined* based on evidence of its extensive use in related studies highlighted in Chapter 2. In addition, it proved to be a more cost-effective tool compared to the Conner's scale and could be completed by the educator together with the SPSC.

Both the SPSC and ADHD Rating Scale-IV are standardised measures.

The two standardised measures were administered by the educators for all learners whose parents/legal guardians had returned the informed consent and demographical information forms. All educators involved had a minimum of six month's contact with the learner as suggested by the SPSC manual [(7)].

3.6 Scoring of the SPSC:

Scoring of the SPSC was done by the researcher according to the same method used by Dunn in the SPSC manual[(7)] when discussing how learners in the USA performed on the SPSC. Dunn used the following five cut score categories, plotted on a normal distribution curve:

- An average score referred to as *Similar to Others* (raw score between +1 SD and -1 SD)
- On the right hand side of *Similar to Others* are two categories indicating that the behaviour occurs more frequently, although the scores are lower. This may indicate that the functioning of the learner in the classroom may be affected. The two categories are:

- *More Than Others* (-1 SD or more); and
- *Much More Than Others* (-2 SD or more).

- *On the left hand side of Similar to Others* are two categories indicating that the scores are higher, meaning that the behaviours occur less frequently. The categories are:
  - *Less Than Others* (+1 SD or more); and
  - *Much Less Than Others* (+2 SD or more) and reflects higher scores with behaviours occurring less frequently.

In her standardisation of the results Dunn reported that each of the 13 group scores has a maximum score and that the calculation of the z-score in the latter two categories was often above the obtainable score. Dunn also assumed the scores to be normally distributed, and the shape of the observed observation was then further investigated for skewness, robustness and the presence of outliers.

Scores for the following three subsections of the SPSC were calculated according to Dunn's method:

- 4 *Quadrant scores*(or sensory processing patterns);
- 4 *School Factors*; and
- 5 *Section scores*, consisting of 4 sensory scores (*Auditory*, *Visual*, *Movement*, and *Touch*) and a *Behaviour* score.

A total of 13 scores were therefore obtained from the administration of the SPSC for each individual learner in the ADHD WC sample.

Administration of the ADHD Rating Scale-IV School Version[(84)] yielded two sets of scores for each learner - namely the *inattention* scores (IA) and *Hyperactivity-Impulsivity* scores (HI) - which could be compared against the suggested cut-off scores used to differentiate between the two subtypes of ADHD. The cut-off scores for classification of the two subtypes are:

Inattentive subtype: *IA* ≥ 90th percentile and *HI* ≥ 85th percentile

Combined subtype: *IA* ≥ 90th percentile together with the *HI* ≥98th percentile.

All scores calculated for the ADHD WC group were recorded and submitted for statistical analyses.

3.7 Data analysis

All data capture and analyses were conducted by an independent statistician.

The 13 scores obtained from the three subsections of the SPSC for the entire ADHD WC group were subjected to descriptive analysis for calculation of central values (means, medians) and dispersion (standard deviation, range and inter-quartile ranges).

Values generated by the descriptive analyses were then compared to Dunn's sample of 585 learners without disabilities (referred to as Norms Dunn) as well as her paired sample group of learners with sensory processing problems (referred to as ADHD Dunn)[7]. The 13 group SPSC scores of the ADHD WC group were compared to those of both the Norms Dunn and ADHD Dunn groups by means of the Kruskal-Wallis one-way ANOVA and the Welsh T-test to determine whether differences between the groups exist. This was done for all three subsections of the SPSC (*Quadrant*, *School Factors* and *Section scores*).

The same two non-parametric tests were used to compare the ADHD WC groups' IA, HI and Total Scores on the ADHD Rating Scale-IV.

Statistical significance will be accepted at the .05 level.

3.8 Addressing bias

The researcher is an experienced occupational therapist that has been using the SPSC extensively the last five years and also lecture on the administration and interpretation of various sensory processing measures. The procedures set out in the Manual was followed conscientiously.

3.9 Ethical considerations

Permission to conduct the study was granted by the Health Research Ethics Committee (HREC) at the Faculty of Health Science, Stellenbosch University (Ethics reference number: N08/08/219) and the Western Cape Department of Education (Appendix C) and principals of the schools (Appendix D). Informed consent was obtained from the LSEN educator (Appendix H), the educator of the participating learner (Appendix J), and the parent/legal guardian of the participating learner (Appendix F and G).

The learner's names were put on the questionnaires as explained to the HREC, since some of the learners were in treatment and this would enable the researcher to give feedback to parents/legal guardians when requested. All information was kept secure in a locked safe and confidentiality was upheld. Once the data was captured and the questionnaires scored, the learners' names were replaced with codes (e.g. A1 where A depicted the school and 1 depicted the learner from that school).

This researcher requested a waiver of child consent of/by the learners in this study. Two reasons were given. Firstly, learners could react differently to their usual behaviour in the classroom were it known that they were being observed by the educator. Secondly, the learners were not required to participate actively in the study and the information required from the educators did not require active observation. The information could be answered with prior knowledge and observation of the learner. The waiver was granted by the HREC.

The researcher also agreed to abide by the ethical guidelines and principles of the international Declaration of Helsinki, the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. A signed investigator's declaration is attached (Appendix K).

As a health professional who is subjected to the ethical guidelines of the HPCSA (Professional Boards for Occupational Therapy, Medical Orthotics/Prosthetics and Arts Therapy), the researcher undertook to abide by the ethical principles of the profession.

CHAPTER 4

RESULTS AND DISCUSSION

This section will be presented in three parts:

(1) information about the learners, gained from the biographical questionnaire;

(2) description of how the learners performed on the SPSC; and

(3) description of how the learners performed on the ADHD Rating Scale-IV.

4.1 The Sample (ADHD WC)

This section will discuss the recruitment and demographics of the learners included in this study.

4.1.1 Recruitment

The selected learners used in the study consisted of 108 learners (n=108). Ten schools in the Western Cape were approached but three schools declined participation. Of the seven schools participating in the research, six were in the northern suburbs and one was on the Atlantic seaboard. Schools were visited fortnightly and forms collected over a period of nine months. Of the 310 learners who were identified by the LSEN educators, 202 could not be included due to various reasons, 3 were excluded when the exclusion criteria were applied, 111 forms were not returned, 78 parents/legal guardians did not give permission for inclusion and 9 forms were incomplete. The reasons are presented in Table 4.1. The inclusion rate was 34.84%.

Table 4.1: Recruitment of learners

Source school or private	Selected by LSEN educator	No consent	Forms not returned	Incomplete forms	Exclusion criteria applied	Other	Research sample
A	43	27	0	2	0	0	**14**
B	20	4	12	0	0	0	**4**
C	7	2	2	0	0	0	**3**
D	73	13	40	0	1	0	**19**
E	79	20	13	6	2	1*	**37**
F	64	12	33	1	0	0	**18**
G	5	0	0	0	0	0	**5**
P	19	0	11	0	0	0	**8**
TOTAL	**310**	**78**	**111**	**9**	**3**	**1**	**108**

* Learner left school after selection but before the questionnaires could be completed

4.1.2 Gender

There were 33 females and 75 males in the study showing a 1:2.3 ratio, which is similar to that found in previous research on learners with ADHD[26]. The mean age was 8 years. In the 5-year age group, only two male learners were included.

4.1.3 Age

The median age for both males and females was 8 years. However, males had a bigger range for age (from five years to ten years), whereas the youngest female in the study was six years old (Figure 4.1). This could indicate that males are possibly diagnosed at an earlier age than females. The distribution of male learners was more even with fewer learners within the lower and higher age ranges. The highest concentration of male learners was at the median at eight years of age. In contrast, the female learners had an unevenly distribution with the highest concentration at about eight years and six months to nine years of age. There was no significant difference between male and female with regard to age (p=0.333).

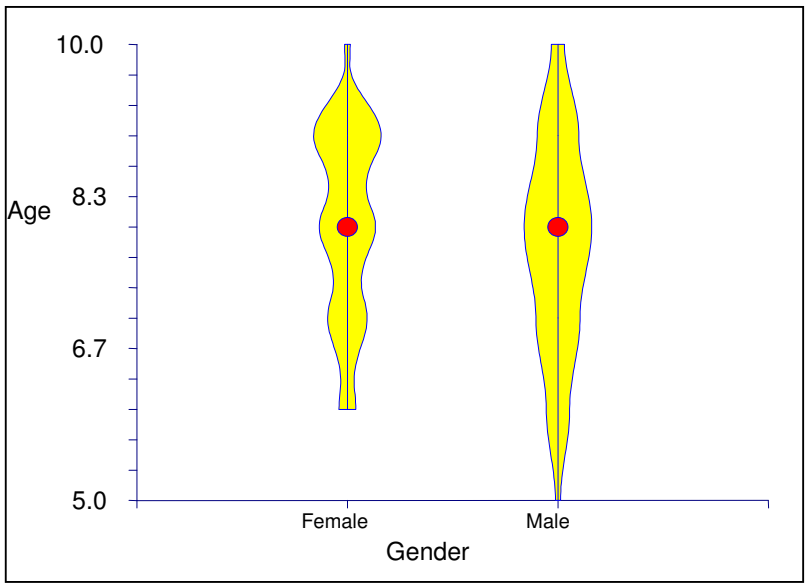

Figure 4.1: Distribution of gender and age

4.1.4 Medication and diet

Of the 108 learners, 87 (80.5%) were on medication and 21 (19.5%) were not on medication at the time parents and educators completed the questionnaires. Ritalin was the most commonly prescribed medication (see Table 4.2).

Table 4.2: Distribution of types of medication

Medication	Female	Male	Total
Ethipramine	1	0	1
Concerta	7	11	18
Ritalin & Concerta	1	1	2
Ritalin Generic	0	1	1
Ritalin	16	40	56
Ritalin & Resperdal	0	1	1
Ritalin & Straterra	0	1	1
Straterra	2	5	7
Total on prescribed medicine	27	60	87
No medication	6	15	21
TOTAL	**33**	**75**	**108**

Dunn[7] did not investigate the effect of medication on the SPSC scores. In an email letter, Dunn suggested that the learners' sensory processing would still show variability whether they were on medication or not[88].

4.1.5 Other

Many parents are opposed to medication and choose to use diet to control the symptoms of ADHD[15,24,25,28,89]. In order to investigate the role of a specific diet for ADHD, a diet question was included. The variation in the response was so great (from cutting down on sweets to gluten-free diets) that no measurable outcome was possible.

4.2 Performance of learners in the Western Cape (ADHD WC) on the SPSC

The results of the 13 group scores will be introduced in tabular format, and thereafter the findings will be discussed. These results will be discussed under the three subsections: *Quadrants, School Factors* and *Section* Scores.

Firstly, a comparison of the results of the how the learners diagnosed with ADHD in the Western Cape (ADHD WC), fell within the Gaussian curve as described by Dunn in the

SPSC manual is discussed (based on a normal sample of 585 learners (see Table 4.3). Secondly, the results of the comparison between the means and standard deviations of the ADHD WC and the normal sample (585 learners) described by Dunn in the SPSC manual (Norms Dunn) are discussed. Lastly, the results of the comparison between the ADHD WC learners and Dunn's ADHD learners (ADHD Dunn) are presented.

4.2.1 Results: 13 Group scores of the Western Cape ADHD learners on the SPSC

In Table 4.3, the ADHD WC learners' scores on the 13 group scores are presented in percentages, following the same scoring procedure suggested by Dunn (see 3.6). Cases where the score could not be calculated because the z score fell above the obtainable score, are indicated by either 'X' or 'XX'.

A flat distribution can be noted when the percentages are evenly distributed in all five categories and does not depict a bell curve (as seen in Figure 4.3 in the *Sensitivity* quadrant score). A skewed distribution to the right is noted if higher percentages are reported in the *More Than Others* and *Much More Than Others* categories (as seen in Figure 4.3 in *Registration* and *Avoiding*). The majority of ADHD WC learners scored within the *More Than Others* and *Much More Than Others* ranges, skewing the curve to right. These results will be further discussed in section 4.2.1.1 to 4.2.1.4.

Table 4.3: Performance of ADHD learners in the Western Cape on the SPSC (percentages)

Group Scores	*Much Less Than Others*	*Less Than Others*	*Similar to Others*	*More Than Others*	*Much More Than Others*
	+2 SD	+1 SD	Mean $\bar{x}$	-1 SD	-2 SD
Quadrant					
Registration	XX	1.9%	36.1%	29.6%	32.4%
Seeking	XX	X	49.1%	31.5%	19.4%
Sensitivity	3.7%	16.7%	51.9%	20.4%	7.4%
Avoiding	XX	X	41.7%	27.8%	30.6%
School Factor					
Factor 1	XX	X	41.7%	27.8%	30.6%
Factor 2	XX	2.8%	51.9%	31.5%	13.9%
Factor 3	XX	X	35.2%	26.9%	38.0%
Factor 4	XX	X	53.7%	27.8%	18.5%
Section					
Auditory	XX	1.9%	28.7%	34.3%	35.2%
Visual	XX	4.6%	28.7%	40.7%	25.9%
Movement	XX	X	40.7%	26.9%	32.4%
Touch	XX	X	33.3%	25.0%	41.7%
Behaviour	XX	0.9%	38.9%	30.6%	29.6%

x, xx = indication that Dunn did not record any scores for these sections

Table 4.4 shows the results of the comparison between ADHD WC and ADHD Dunn, and ADHD WC and Norms Dunn?[Note7]. When the behaviour occurs more frequently the mean is lower, which may indicate possible clinical problems.

ADHD WC learners showed significantly (p=0.000) more sensory processing behaviours than Dunn's normative data of the SPSC (the shaded column in Table 4.4). ADHD WC learners have more sensory processing problems such as seeking or avoiding sensory input than the normative data on the SPSC. The Welsh T-test was applied to investigate significant differences comparing the ADHD WC group with Dunn's normative and ADHD samples (shown in the last column). For this study, significance was accepted on the 5% level and high significance on the 1% level.

Table 4.4 Descriptive statistics for the three groups: Norms Dunn, ADHD Dunn and ADHD WC

Group Scores	Norms Dunn n=585		ADHD Dunn n=59		ADHD WC n=108		ADHD WC versus Norms Dunn	ADHD WC versus ADHD Dunn
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	p value	p value
Quadrant								
Registration	74.3	11.1	61.6	11.5	58.4	12.9	0.0000**	0.1632
Seeking	51.5	9.3	41.5	10.4	42.2	11	0.0000**	0.6757
Sensitivity	73.8	9.3	60.2	11.5	56.9	12.2	0.0000**	0.0853
Avoiding	82.1	9.4	73.3	12.5	66.3	11.5	0.0000**	0.0006**
School Factor								
SF1	92.2	14.5	74.5	15.3	73.2	17.0	0.0000**	0.6167
SF2	53.8	10.4	44	9.2	45.0	10.5	0.0000**	0.5387
SF3	77.8	8.8	65.3	12.3	64.1	12.5	0.0000**	0.5524
SF4	48.8	7.5	45.4	7.9	41.0	8.7	0.0000**	0.0013**
Section								
Auditory	43.2	6.5	34.4	7.4	33.6	8.0	0.0000**	0.5199
Visual	45.6	7.7	35.8	7.0	35.6	8.7	0.0000**	0.8724
Movement	62.6	8.0	53.5	9.4	52.8	10.3	0.0000**	0.6591
Touch	55.5	5.9	48.9	8.4	47.1	8.0	0.0000**	0.1836
Behaviour	65.8	8.8	56.4	11.0	54.2	10.8	0.0000**	0.2189

** p <0.05 significantly different on the 5% level

In calculating the median and quartiles, skewness can be observed if there is a difference of two or more units. The difference between interquartile ranges is measured by the formula (Q2-Q1)-(Q3-Q2) and is depicted in the last column of Table 4.5. The relevance of this indicates a difference in variation of scores. Measures that are negative depict more

Note[7] *In developing the SPSC, Dunn did extensive research to establish how learners without disabilities would differ in their performance to learners with ADHD, Asperger's syndrome and autism. Dunn depicted this in tabular format as well as on a continuum of the scores with means and standard deviations for the different groups. Dunn included 59 subjects in her sample of ADHD learners (presented in this study as ADHD Dunn). The normative sample consisted of 585 learners (presented in this study as Norms Dunn)[(7)]. The results of the groups with Asperger's syndrome were not included in this results section, because this study focused solely on the performance of learners ADHD.*

concentrated scores at the lower end than at the upper end of the distribution and vice versa for a positively skewed interquartile range. If the interquartile range is skewed negatively, then the educator reported that behaviours to sensory input were not evenly distributed, with more concentrated distributed scores at the lower end (more problematic sensory behaviours) of the range. Table 4.5 depicts the Q1, median (Q2) and Q3 of each group score as well as the interquartile ranges.

Table 4.5: Three quartiles scores of ADHD WC observing skewness between Q1 and Q3, interquartile range and the length of distribution

Group Scores ADHD WC	Quartile 1 (Q1)	Quartile 2 (Median)	Quartile 3 (Q3)	Interquartile range	(Q2- Q1) – (Q3-Q2)
Quadrants					
Registration	50.0	59.0	66.3	16.3	1.7
Seeking	35.0	42.0	52.0	17.0	-3.0#
Sensitivity	50.0	56.0	63.3	13.3	1.3
Avoiding	60.0	67.0	74.3	14.3	0.3
School Factor					
Factor 1	61.0	74.5	86.3	25.3	1.7
Factor 2	37.0	44.5	51.3	14.3	0.7
Factor 3	55.0	65.0	74.0	19.0	1.0
Factor 4	36.0	42.0	47.0	11.0	1.0
Section					
Auditory	29.0	33.5	39.0	20.0	1.0
Visual	30.0	34.0	40.0	10.0	-2.0#
Movement	45.0	53.0	61.0	16.0	0.0
Touch	42.0	46.0	53.0	11.0	-3.0#
Behaviour	47.0	56.0	61.0	14.0	4.0#

Interquartile skewness when (Q2-Q1)-(Q3-Q2) ≥ 2.0.

4.2.1.1 *Performance on the Quadrants of the SPSC*

The following groupings of the *Quadrants* will be discussed: *Registration*, *Seeking*, *Sensitivity* and *Avoiding*.

Registration

Registration reflects a high threshold to sensory input and the learners act in accordance to their system, for example they do not obtain enough sensory input to attend to the task at hand.

As seen in Table 4.3, 36.1% of the ADHD WC group did not display problems with *Registration*, since their scores fell in the *Similar to Others* category. It also shows that 29.6% displayed *More Than Others* and 32.4% displayed *Much More Than Others.* Only 1.9% fell in the *Less Than Others* category. This implies that behaviours of poor

registration to sensory input occurred more frequently in ADHD WC learners than was the case in Dunn's normative sample.

The mean of Dunn's group without disabilities (Norms Dunn) was significantly higher (Table 4.4) than the ADHD WC group (Norms Dunn $\bar{x}$=74.3; ADHD WC $\bar{x}$=58.4; p=0.0000) and is graphically illustrated in Figure 4.2. This shows that learners with ADHD in the Western Cape demonstrate lowered registration of incoming sensory input from their environment. This finding is further supported by Dunn's study where a matched sample of learners with ADHD and a sample without disabilities were compared and a significant difference on *Registration* was found[7].

There was no significant difference between the distribution of ADHD WC ($\bar{x}$=58.4) and ADHD Dunn ($\bar{x}$=61.6), as p=0.1632. ADHD WC indicated no significant interquartile skewness as (Q2-Q1)-(Q3-Q2) = 1.7.

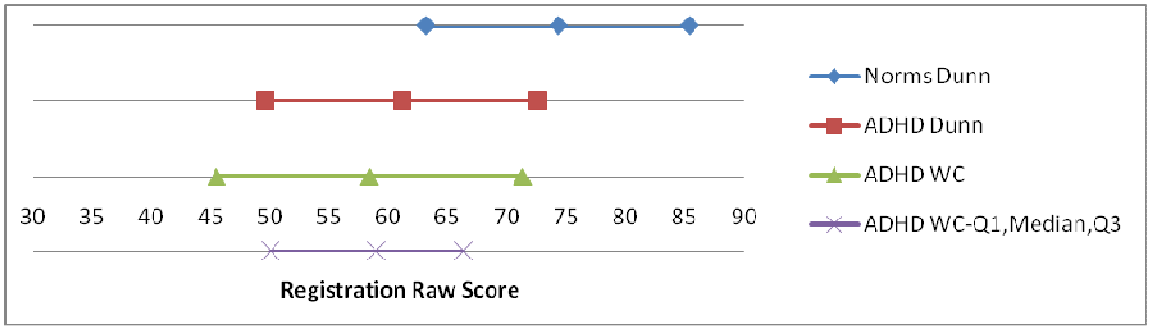

Figure 4.2: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Registration*

ADHD WC learners showed more low registration behaviour than Norms Dunn which represented typically developing learners. ADHD WC learners did not seek the relevant input to stay focused in the classroom situation and thus showed behaviours of inattentiveness, day-dreaming, missing important information, seemed disinterested, overly tired and self-absorbed. These learners may have been oblivious to what was going on around them. Their educators may misinterpret this behaviour, labelling learners as being lazy, not caring about their work and not completing tasks. Such learners may thus also present as an inattentive subtype of ADHD. These learners are slow to respond and can therefore not actively participate in the classroom so struggle to give an answer quickly or when doing a task involving speed such as times tables tests. The learners are

thus not available to take in the information and participate in the classroom situation as their higher than average sensory needs are not being met.

In conclusion, these results indicated agreement with Dunn's study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Registration* quadrant[7]. These findings are also in accordance with a study done in South Africa using the Sensory Profile where the learners with ADHD showed more behaviours of low registration than Dunn's norm[8].

Seeking

Seeking reflects a high threshold that the learner counteracts by actively seeking sensory input. However, these learners also need more sensory input to remain focused on the task at hand.

As seen in Table 4.3, 49.1% of the ADHD WC group did not display problems with *Seeking*, since their scores fell in the *Similar to Others* category. It also shows that 31.5% displayed *More Than Others* and 19.4% displayed *Much More Than Others.* This implies that seeking behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample.

In support of this finding, the mean of Dunn's group without disabilities was significantly higher than that of the ADHD WC group (Norms Dunn $\bar{x}$=51.53; ADHD WC $\bar{x}$=42.2; p=0.0000), which is graphically illustrated in Figure 4.3. In contrast, Dunn's matched sample of learners with ADHD and without disabilities did not show a significant difference for *Seeking*[7]. There was no significant difference between the distribution of ADHD WC ($\bar{x}$=42.2) and ADHD Dunn ($\bar{x}$=41.5), p=0.6757.

ADHD WC indicated a negative interquartile skewness for *Seeking* ((Q2-Q1)-(Q3-Q2) = -3) with the quartile below the median showing a more concentrated distribution. The deduction that can be made from this is that there is less variability in the educator's report of excessive sensory-seeking behaviours.

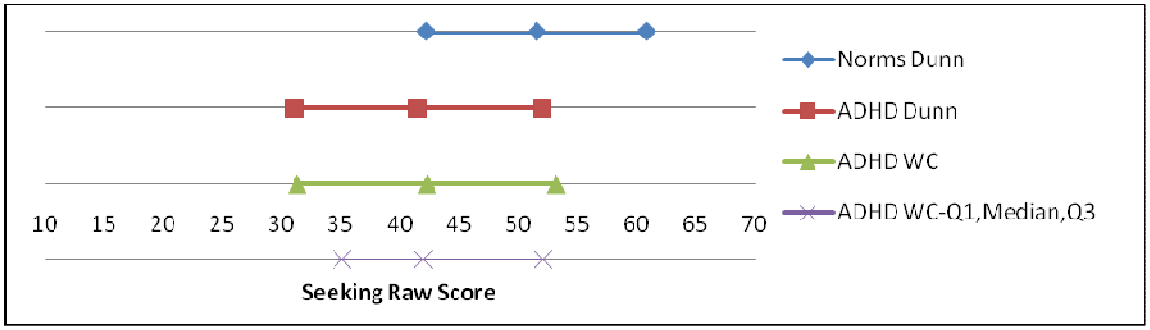

Figure 4.3: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Seeking*

There was no significant difference in *Seeking* in Dunn's matched sample between the ADHD groups and her normative group. However, there was a significant difference between the ADHD WC group and the Norms Dunn, although the ADHD Dunn results and those of ADHD WC did not show a significant difference. The researcher did not use a matched sample, and Dunn's matched sample only comprised 59 subjects, which could possibly have contributed to the discrepancy in the findings.

However, in other studies using the Sensory Profile, learners with ADHD have been found to exhibit sensory-seeking behaviours more than learners without disabilities[5,8,21,40]. Of note is that the sensory-seeking scores are taken from the factor scores of the Sensory Profile and not from the *Quadrant scores* of the Sensory Profile. When analysing the *Quadrants* of the Sensory Profile and the SPSC, there was no significant correlation between the *Seeking* quadrant on the Sensory profile and the *Seeking* quadrant of the SPSC[7]. In research, it is important to look at these various possibilities before making assumptions and generalising findings to any environment, such as from home to school. In practice, the Ecological Model of Sensory Modulation (see section 2.2.3.2) needs to be applied when interpreting results of the Sensory Profile and SPSC as the influence of the external dimensions need to be taken into consideration when interpreting the results of questionnaires such as the SPSC.

ADHD WC learners displayed more sensory-seeking behaviours than the Norms Dunn group. ADHD WC are described as being more active, fidgety, on the go, taking risks with no regard to safety, and this often results in impulsive behaviour. They seek novel sensory input, so anything that is new needs to be explored and fiddled with. They are often loud and noisy, bumping into others as they seek physical contact. They often disturb the other learners whilst the educator is conducting the lesson. Educators may interpret this behaviour as "naughty", that these learners are disrespectful of rules, disruptive and that

they are actively trying not to conform to the group norms during the lesson or when the class is doing written work. They may also present as the hyperactive/impulsive ADHD subtype. In spite of their behaviour, these learners may be able to absorb what the educator is saying whilst their sensory needs are being met. In a typical classroom, learners are expected to sit still and listen, which in the case of the sensory seeker whose sensory needs dictate the need to move, touch and vocalise to be in an optimal state of arousal, are not being tolerated.

In conclusion, the ADHD WC group scored significantly differently to Norms Dunn for *Seeking*. The ADHD WC and ADHD Dunn distribution was similar. The difference was seen when reviewing Dunn's matched sample group, in which there was no significant difference between learners without disabilities and those with ADHD[7]. This difference could be attributed to the sample group being matched by age and gender (n=59), whereas this research (ADHD WC) was not a matched sample. The findings that seeking behaviour is significantly more in learners with ADHD than typically developing learners, is in accordance with a recent study conducted in South Africa[8].

Sensitivity

Sensitivity reflects a low threshold to sensory input where the learner acts in accordance with his or her sensory system. The learner is thus over responsive to sensory input and easily distracted which may then interfere with his or her ability to focus on the task at hand.

As seen in Table 4.3, 51.9% of the ADHD WC group did not display problems with *Sensitivity*, since their scores fell in the *Similar to Others* category. It also shows that 20.4% displayed *More Than Others* and 7.4% displayed *Much More Than Others.* On the other end of the continuum, 16.7% displayed *Less Than Others* and 3.7% displayed *Much Less Than Others.* It is the only group score which is represented in all five categories in Dunn's cut scores. This implies that ADHD WC had a wider variance (both more and less than typical) in their behaviour regarding *Sensitivity* than Norms Dunn.

It is also evident when considering Table 4.4, where the mean for Norms Dunn was significantly higher than that of the ADHD WC group (Norms Dunn $\bar{x}$=73.8: ADHD WC $\bar{x}$=56.9; p=0.0000). This is also graphically illustrated in Figure 4.4 and is further supported

by Dunn's matched sample of learners with ADHD and without disabilities for *Registration*, showing a significant difference[7].

There was no significant difference between the distribution of ADHD WC ($\bar{x}$=56.9) and ADHD Dunn ($\bar{x}$=60.2), p=0.0853. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 1.3.

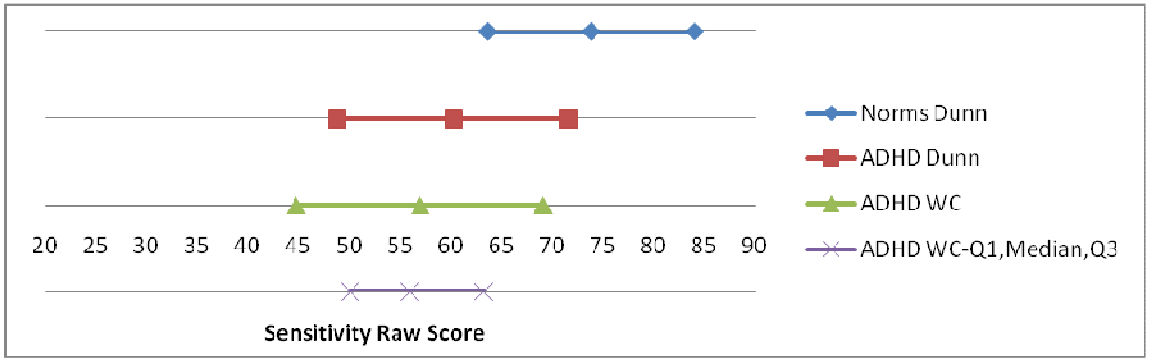

Figure 4.4: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Sensitivity*

ADHD WC learners therefore showed behaviours of sensory sensitivity both more than and less than that of the typical learner as described above. On the one end of this continuum, learners may show less detection of sensory input and they are not distracted or overwhelmed by sensory input and often struggle to remain focused on the task or notice smaller details. The educator needs to increase the learner's awareness and detail to the task. On the other end of the continuum, the learner shows increased detection of sensory input. The learner is thus more inattentive, distractible, irritable and agitated and notices the slightest sensory stimulus. In this case, the educator needs to provide more structured input, as the learner is easily distracted by the sensory information[55]. In the ADHD WC group of learners, there were learners who detected more sensory input than typically developing learners and others who detected less.

In conclusion, these results indicated agreement with Dunn's study, where ADHD WC was significantly different to Norms Dunn, but at the same time in agreement (no significant differences) with Dunn's ADHD group for *Sensitivity* on the SPSC[7]. In contrast, learners in the study group in Manguang (South Africa) did not show a significant difference to the norms of the Sensory Profile in the *Sensitivity* factor or the *Sensory Sensitivity* quadrant[8].

Avoiding

Avoiding reflects a low threshold to sensory input and the learner acts against his or her sensory threshold by actively avoiding the incoming sensory input.

As seen in Table 4.3, 41.7% of the ADHD WC group did not display problems with *Avoiding*, since their scores fell in the *Similar to Others* category. It also shows that 27.8% displayed *More Than Others* and 30.6% displayed *Much More Than Others.* This implies that sensory avoiding behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample.

The mean of Norms Dunn (Table 4.4) was significantly higher than that of the ADHD WC group (Norms Dunn $\bar{x}$=82.1; ADHD WC = $\bar{x}$=66.3; p=0.0000). This is graphically illustrated in Figure 4.5 and is further supported in Dunn's matched sample of learners with ADHD and without disabilities for *Avoiding*, showing a significant difference[(7)].

The distribution of ADHD WC ($\bar{x}$=66.3) was significantly different to that of ADHD Dunn ($\bar{x}$=73.3), p=0.0006. The mean was lower, meaning that the scores of ADHD WC were lower than that of ADHD Dunn, implying that ADHD WC learners were reported to have significantly more sensory-avoiding behaviours than the ADHD Dunn group. ADHD WC quartiles indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 0.3.

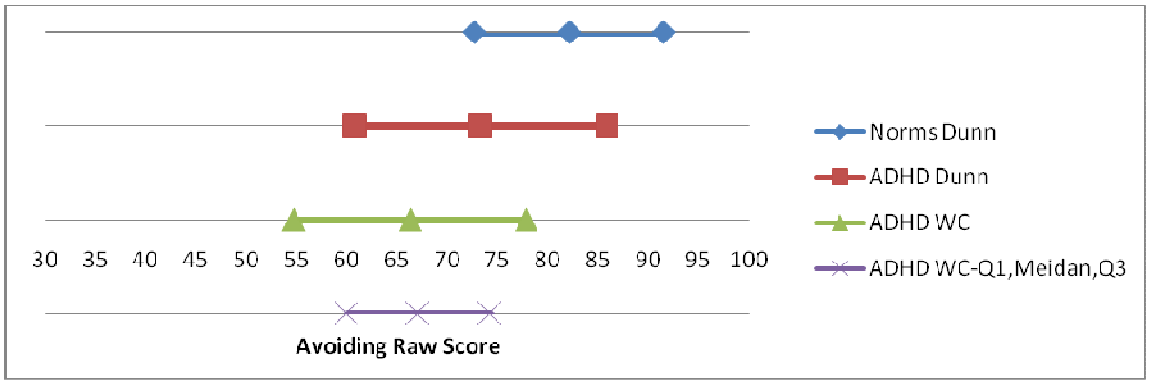

Figure 4.5: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Avoiding*

ADHD WC learners showed significantly more sensory-avoiding behaviours than Dunn's typically developing learners, and it can be deduced that they were thus more actively avoiding the sensory input which bothered them. They may become demanding, stubborn,

defiant, obstinate, emotionally reactive, anxious, withdrawing from others, and they resist change and rely on rituals and structure to cope. Any change in routine or a task done in a different way may be upsetting to them. For example, if learners are over-sensitive to noise or touch, they may refuse or avoid participating in group activities where their peers may accidentally touch them or when other learners are noisy. They may even have a tantrum to avoid a situation which may be perceived as being threatening for the learner.

In conclusion, these results indicated agreement with Dunn's study where ADHD WC was significantly different to the Norms Dunn group differentiating learners with ADHD from learners without disabilities in the *Avoiding* quadrant[7]. There was a significant difference between ADHD WC and ADHD Dunn with ADHD WC showing more sensory-avoiding behaviours. Other researchers have mentioned overresponsiveness in learners with ADHD[7,8,40,46,69,72,73], but this will be discussed in *School Factor 3* as it includes both sensory processing patterns of oversensitivity (sensory-sensitive and sensory-avoiding), which have a low threshold to sensory input.

Quadrant conclusion

Learners with ADHD in the Western Cape (Table 4.3) had higher percentages in the *More Than Other* and *Much More Than Others* categories than Dunn's normal population in the *Registration*, *Seeking*, *Sensitivity* and *Avoiding* quadrants, implying that these behaviours were more frequently observed in all four sensory patterns than was the case with Dunn's normative sample. The percentage distribution of *Sensitivity* in Table 4.3 was very different to the others as it was a flatter distribution (from *Much Less* to *Much More Than Others*) with more variance in learners' behaviour towards sensitivity with fewer learners scoring in the typical range (*Similar to Others*).

The significant difference in the sensory processing of learners in this study (ADHD WC) and a normative sample on the SPSC when plotted with Dunn's cut scores is illustrated in Table 4.3. A significant difference (p=0.000) between the scores of ADHD WC and Norms Dunn in all four sensory processing patterns (*Registration*, *Seeking*, *Sensitivity* and *Avoiding*) was found (Table 4.4). In her matched sample, Dunn found the difference between the ADHD group and the group without disabilities in all the quadrants except *Seeking*[7]. A matched sample study would be helpful to further substantiate these findings, as well as to standardise the SPSC on the South African population.

From these results it can be deduced that learners with ADHD in the Western Cape presented with more sensory processing problems than Dunn's typically developing learners. The behaviours of learners with ADHD in the Western Cape may reflect that they detect less sensory input, and/or seek to obtain more sensory input, and/or detect more sensory input and are bothered more by sensory input. This does not imply that each learner will react like this, but as a group they may show behaviours in one or more of the sensory patterns.

The learners with ADHD in the Western Cape (ADHD WC) followed the same pattern found by Dunn (ADHD Dunn) in three of the quadrants, namely *Registration*, *Seeking* and *Sensitivity*. *Avoiding* was significantly different with more avoiding behaviours displayed more frequently in the ADHD WC group. Only *Seeking* showed positive interquartile skewness, showing less variability in the quarter below the median for sensory seeking behaviour

Some contrasts were found in sensory processing patterns of learners with ADHD in South Africa. The study done in Manguang used the Sensory Profile and showed that most of the learners scored in the *Much More Than Others* for *Registration* and *Seeking* sensory patterns. Dunn conducted a study on the correlation between the Sensory Profile (home) and the SPSC and found that there was no significant correlation between *Seeking* on the SPSC and the Sensory Profile, but there was a significant correlation between *Avoiding*, *Sensitivity* and *Registration* on the SPSC and the Sensory Profile[7]. This could explain the difference found in the between the Manguang study (using the Sensory Profile) and the current study (using the SPSC).

Dunn suggested that sensory seeking behaviour is more observable in an unstructured environment, such as the home, than in the structured environment of the classroom.[7] The educator filling out the form also has a sensory system, which might be in contrast to that of the learner. This is often more noticeable for the educator, as seeking behaviour can be disruptive to the teaching in the classroom. If an educator needs to get a lesson done and the learner's seeking behaviour, such as noise or fiddling, is challenging for the educator, that behaviour will be more noticeable and irritating to the teacher. This may result in her scoring the learner as *more* frequently on the SPSC.

Overall, ADHD WC and the ADHD Dunn group had lower scores in the *Quadrants* (*Registration, Seeking, Sensitivity and Avoiding*), showing that the learners with ADHD had more sensory processing problems than those without disabilities. The SPSC can therefore be regarded as a valid and reliable measure to ascertain in which quadrants learners with ADHD in WC may perform.

4.2.1.2 *Performance on the School Factors of the SPSC*

School Factor 1 (SF 1) reflects the *Registration* and *Seeking* quadrants, which both have a high threshold to sensory input.

As seen in Table 4.3, 41.7% of the ADHD WC group did not display problems with *SF 1*, since their scores fell in the *Similar to Others* category. It also shows that 27.8% displayed *More Than Others* and 30.6% displayed *Much More Than Others.* This implies that *SF 1* behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample. Adding the percentages of the categories (1 SD and more from the mean) in which the learners showed behaviours more frequently (*Much More Than Others* and *More Than Others)*,*SF 1* was the highest of the *School Factors.* Together, *SF 1* and *Auditory* had the highest percentage (69.5%) in the latter two categories. Of the 13 group scores, there was a higher incidence of behaviours present in the *SF 1* and *Auditory* categories.

Table 4.4 shows that the mean of Dunn's group without disabilities was significantly higher than the ADHD WC group (Norms Dunn $\bar{x}$=92.2; ADHD WC $\bar{x}$=73.2; p=0.0000). This is also graphically illustrated in Figure 4.6. This is in agreement with the findings in both *Quadrant scores*, *Registration* and *Seeking,* which also showed significant differences between ADHD WC and Norms Dunn. This finding is further supported by Dunn's study where a matched sample of learners with ADHD and a sample without ADHD were compared and a significant difference on *SF 1* was found[(7)].

There was no significant difference in the distribution between ADHD WC ($\bar{x}$=73.2) and ADHD Dunn ($\bar{x}$=74.5), p=0.6167 but there was a significant difference compared to the Norms Dunn. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 1.7.

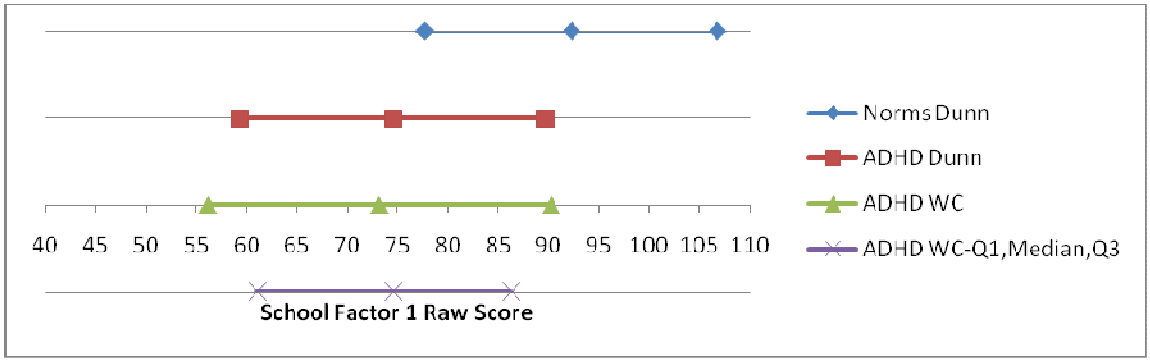

Figure 4.6: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *School Factor 1*

The ADHD WC group showed more behaviours indicative of a high threshold to sensory input. The learners need the educator to assist them in participating in the learning environment to obtain the sensory input required in an acceptable manner in the classroom situation. The educator needs to ensure that the learners receive the sensory input before and during class. These learners may seek the input themselves, which may interfere with classroom functioning. In cases like this, the educator needs to provide and allow learners to use more acceptable methods such as sitting on a ball or using bright colours in the presentation of the lesson material. The educator needs to remind the learner who needs more sensory input, but does not seek it, to use the ball or use bright colours when studying because this learner does not actively seek the sensory input. If the educator does not use extra sensory stimuli to assist the learner to participate, he or she will not participate and be available to focus and learn in the classroom.

To conclude, these results are in agreement with Dunn's study, where ADHD WC was significantly different to the Norms Dunn group. There was agreement (no significant difference) between ADHD WC and Dunn's ADHD group in SF1[(7)]. These results are also in accordance with another study in South Africa using the Sensory Profile with learners with ADHD in which both *Registration* and *Seeking* (*SF 1)* consists of registration and seeking items) had the highest percentage in more behaviours than a group of typically developing learners[(8)].

School Factor 2 (SF 2) reflects the *Seeking* and *Sensitivity* quadrants, which reflect the awareness and attention of the learner in the classroom environment.

As seen in Table 4.3, 51.9% of the ADHD WC group did not display problems with *SF 2,* since their scores fell in the *Similar to Others* category. It also shows that 31.5% displayed *More Than Others* and 13.9% displayed *Much More Than Others.* Only 2.8% fell in the *Less Than Others* category. This implies that *SF 2* behaviours occurred more frequently in ADHD WC learners than was the case with Dunn's normative sample.

Table 4.4 shows that the Norms Dunn group scored significantly higher than the ADHD WC group. (Norms Dunn $\bar{x}$=53.8; ADHD WC $\bar{x}$=45.0; p=0.0000). This is graphically illustrated in Figure 4.7 and is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *SF 2*, showing a significant difference, p=0.029[(7)].

The distribution of ADHD WC ($\bar{x}$=45.0) was similar to that of ADHD Dunn ($\bar{x}$=44.0), p=0.5387. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 0.7.

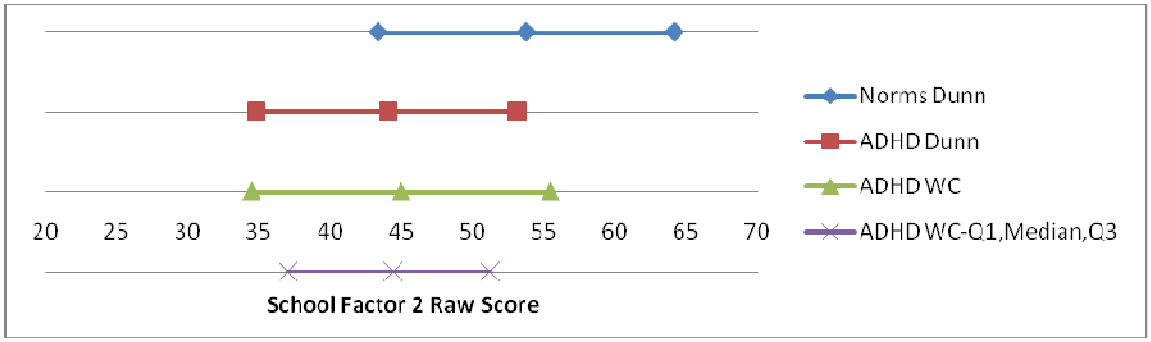

Figure 4.7: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *School Factor 2*

ADHD WC showed more behaviours indicative of seeking and sensitivity. The learners therefore may engage in behaviours in response to meet their sensory needs (seeking) or as a reaction to sensory input (sensitivity). These learners appear busy, alert and attentive, but this heightened level of attention interferes with their ability to stay focused on the task in the classroom. The educator needs to find strategies to reduce their attention to non-relevant/random sensory experiences and increase their attention to the learning task. Another combination is sensitivity (learners' temperament is predominantly passive to their overresponsivity to touch and noise) but then seeking (engage in sensory seeking behaviour such as fiddling and fidgeting which are vestibular and proprioceptive inputs) to regulate themselves. The latter sensory input is used to regulate themselves to achieve the calm–alert state, but the educator may interpret it as sensory seeking behaviour.

The results on *SF 2* confirmed that learners with ADHD in the Western Cape mirrored Dunn's results differentiating learners with ADHD from learners without disabilities in *SF 2*[7] in that learners with ADHD show more behaviours indicative of sensory seeking and sensory sensitivity.

School Factor 3 (SF 3) reflects *Sensitivity* and *Avoiding* quadrants. Both have a low threshold to sensory input. The learners' tolerance to sensory input is very low and they have difficulty coping in the classroom environment.

As seen in Table 4.3, 35.2% of the ADHD WC group did not display problems with *SF 3*, since their scores fell in the *Similar to Others* category. The table also shows that 26.9% displayed *More Than Others* and 38% displayed *Much More Than Others.* This implies that *SF 3* behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample.

Table 4.4 shows that the mean of Norms Dunn was significantly higher than the ADHD WC group (Norms Dunn $\bar{x}$=77.8; ADHD WC $\bar{x}$=64.1; p=0.0000). This is graphically illustrated in Figure 4.8 and is further supported by Dunn's matched sample of learners with ADHD and those without disabilities for *SF 3*, showing a significant difference ($p < 0.001$)[7].

The distribution of ADHD WC ($\bar{x}$=64.1) was similar to that of ADHD Dunn $\bar{x}$=65.3), p=0.5524. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 1.0.

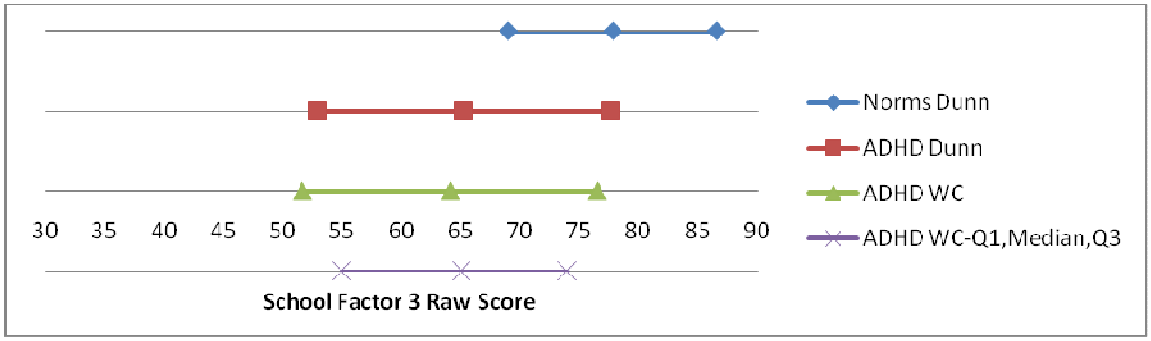

Figure 4.8: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *School Factor 3*

ADHD WC learners showed more behaviours indicative of a low threshold to sensory input (overresponsiveness). They notice, react or try to avoid very low levels of sensory input and have reduced tolerance to the sensory input. This interferes with their ability to engage in the classroom and to learn. They are so busy trying to cope with the uncomfortable sensory input that it prevents them from attending to the relevant information of the lesson. The educator needs to reduce the amount of sensory stimuli in the classroom to keep this learner in the calm but alert state and thus reduce anxiety. Learners with ADHD with overresponsiveness to sensory input often have social and emotional problems[78] and anxiety,[69,73,79] which in turn affect their ability to participate and learn in the classroom environment. Considering the correlation between ADHD, over-responsiveness and anxiety, learners with ADHD and anxiety need to be evaluated for overresponsiveness to sensory input. Learners with ADHD, who score in the deficit range in *SF 3* (sensitivity and avoiding items), also need to be monitored for anxiety. The importance of the team (parent, educator, psychologist and medical practitioner) cannot be overemphasised, as a holistic approach is required in the intervention programme.

In conclusion, these results indicated agreement with Dunn's study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group for *SF 3*.[7] This further supports previous studies that learners with ADHD frequently have overresponsiveness (low threshold) to sensory input[7,8,40,46,69,72,73].

School Factor 4 (SF 4) reflects the *Registration* and *Avoiding* quadrants. The learners appear inattentive and remote for the task at hand and are therefore not available for learning within the classroom situation.

As seen in Table 4.3, 53.7% of the ADHD WC group did not display problems with *SF 4,* since their scores fell in the *Similar to Others* category. It also shows that 27.8% displayed *More Than Others* and 18.5% displayed *Much More Than Others.* This implies that *SF 4* behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample. Table 4.4 shows that the mean Norms Dunn was significantly higher than the ADHD WC group (Norms Dunn $\bar{x}$=48.8; ADHD WC $\bar{x}$=41.0; p=0.0000). This is graphically illustrated in Figure 4.9. In contrast, Dunn's matched sample of learners with ADHD and

without disabilities had similar scores for *SF4* with p=0.333[7]. As discussed in the *Seeking* section, this research in the Western Cape did not use a matched sample, which could possibly have contributed to the discrepancy in the findings.

The distribution of ADHD WC ($\bar{x}$=41.0) was significantly different from ADHD Dunn ($\bar{x}$=45.4), p=0.0013, with *SF4* behaviours occurring more frequently in the ADHD WC group. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 1.0.

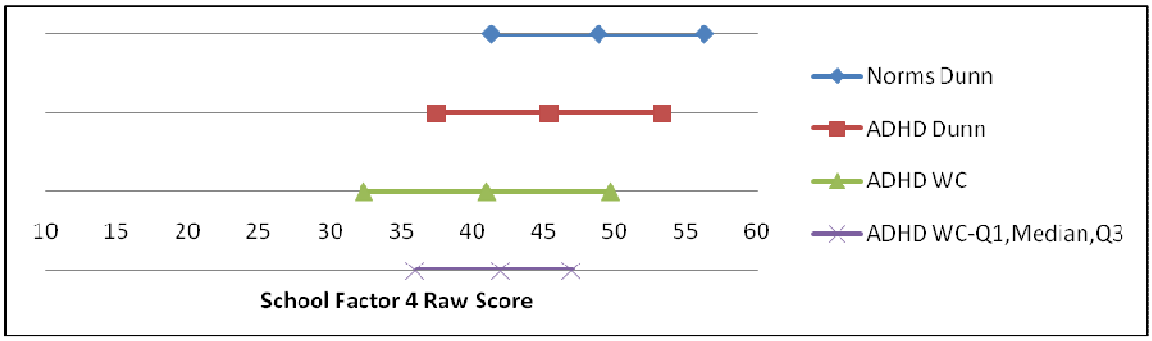

Figure 4.9: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *School Factor 4*

ADHD WC showed more low registration (under-responsive) and sensory-avoiding behaviours. They may tend to separate themselves from the classroom learning environment, either not noticing the stimuli or trying to avoid the overload. They appear to be uninvolved, preoccupied or withdrawn. The educator needs to find strategies to keep the learner engaged in the classroom activities.

In conclusion, ADHD WC scored significantly different to the Norms Dunn for SF4. ADHD WC also scored significantly different to the ADHD Dunn group. In both cases, the ADHD WC showed more behaviours of the *SF 4* items (poor registration and sensory avoiding) of learners being inattentive and remote for the task at hand were more frequently observed. The difference was seen when reviewing Dunn's matched sample group (n=59), for age and gender, in which there was no significant difference between learners without disabilities and those with ADHD[7], whereas this research (ADHD WC) was not a matched sample.

Conclusion of School Factors

Learners with ADHD in the Western Cape (Table 4.3) had higher percentages in the *More Than Others* and *Much More Than Others* categories than the normal distribution for all four *School Factors* (*SF 1, SF 2, SF 3, SF 4*), implying that these behaviours were more frequently observed in all four *School Factors* than was the case in Dunn's normative sample. This was further supported by the significant difference found between ADHD WC and Norms Dunn (p=0.000) for all four *School Factors*. In her matched sample, Dunn found a difference between the ADHD group and the group without disabilities (Norms Dunn) in all the *School Factors*, except *SF 4*[(7)]. ADHD Dunn and ADHD WC *School Factors 1, School Factors 2* and *School Factors 3* were similar ($p > 0.5$), but *School Factor 4* had a significant difference on the 1% level as $p < 0.01$ (Table 4.4). The ADHD WC group showed more frequent behaviours of being inattentive and remote to the task in the classroom.

The difference above found in the School Factors between ADHD WC and Dunn's matched sample when comparing learners with ADHD and learners without disabilities could be due to this researcher not having a matched sample or that the *SF 4* showed significant differences between the ADHD Dunn and ADHD WC group. No known studies have been found on the SPSC in other countries to further support or refute these findings (the studies in Hong Kong and Israel used the Sensory Profile, which does not have *School Factors*, and not the SPSC).

When comparing the *School Factor* results, it was evident that the ADHD WC group had more sensory processing problems than the Norms Dunn group. The scores for ADHD WC were significantly lower than those of Dunn's four *School Factors.* This shows the teacher's perspective of the learner and that these sensory processing behaviour hamper his/her engagement in the classroom. This needs to be studied further in order to see how it affects the learner's ability to engage in the schoolwork and classroom, as well as how the educator can use effective teaching strategies so that the learner is more available to the learning environment.

Overall, both ADHD WC and the ADHD Dunn group had lower scores in the *School Factors* than Norms Dunn, showing that the learners with ADHD had more sensory problems, interfering with the learners' participation in the classroom than those without

disabilities. No significant skewness was noticed in the interquartile range of ADHD WC *School Factors*, showing symmetry in the quartiles on either side of the median.

Therefore it may be concluded that the SPSC can be used in the Western Cape to indicate School Factor problems and assist in understanding and intervention strategies for the learner by the educator.

4.2.1.3 *Performance on the Section Scores of the SPSC*

When analysing the sensory sections, it is important to note that the questions are categorised into one of the four sensory quadrants. This is depicted by an icon on the score sheet used to analyse the predominant feature of each learner's response in each sensory system. Varying responses in the different sensory systems (*Auditory*, *Touch*, *Movement* or *Visual*) may emerge as predominant.

The learner may for example be over-responsive (low threshold items) to touch and may actively avoid touch input or conversely, the learner may have a high threshold to tactile input. One learner may seek tactile input to counteract the high threshold, another may avoid it, another may act in accordance with his or her under-responsive profile, another may be distracted or irritated by it and yet another learner may fluctuate between over- and under-responsiveness. Only total raw scores are obtained, so it is the responsibility of the occupational therapist to analyse the items and use his or her clinical reasoning to relate this to the learner's functioning in the classroom. As only total scores are obtained, the researcher can only consider how the learner responds to that particular type of sensory system, such as touch.

In a few studies on sensory processing and ADHD, a differentiation was made between sensory processing and sensory over-responsiveness. Tables 4.6 to 4.10 present features of behaviours that may be found in learners with different responses to sensory stimuli (under-responder, seeker and over-responder). The information in these tables were compiled using various sources[7,10,38,43,55,56,58,81,90-94] with additions from the researcher's clinical experience, lectures and notes from lectures on sensory integration and related topics by the South African Institute for Sensory Integration in South Africa.

The *Auditory* score reflects the learner's responses to auditory stimulation.

As seen in Table 4.3, only 28.7% of the ADHD WC group did not display problems with *Auditory* since their scores fell in the *Similar to Others* category. It also shows that 34.3% displayed *More Than Others* and 35.2% displayed *Much More Than Others.* Only 2.8% fell in the *Less Than Others* category. *Auditory* showed a reversed curve as the percentages were reversed with the lowest percentage being in the *Similar to Others* and increasing to *More than Others* and the highest percentage in *Much More than Others.* This implies that learners' behaviours to auditory stimuli occurred more frequently in ADHD WC learners than in Dunn's normative sample.

Table 4.4 shows that the mean of Dunn's group without disabilities was significantly higher than that of the ADHD WC group (Norms Dunn $\bar{x}$=43.2; ADHD WC $\bar{x}$=33.6; p=0.0000). This is graphically illustrated in Figure 4.10 and is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *Auditory* showing a significant difference, $p < 0.001$[(7)].

The distribution of ADHD WC ($\bar{x}$=33.6) was similar to that of ADHD Dunn ($\bar{x}$=34.4), p=0.5199. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 1.0.

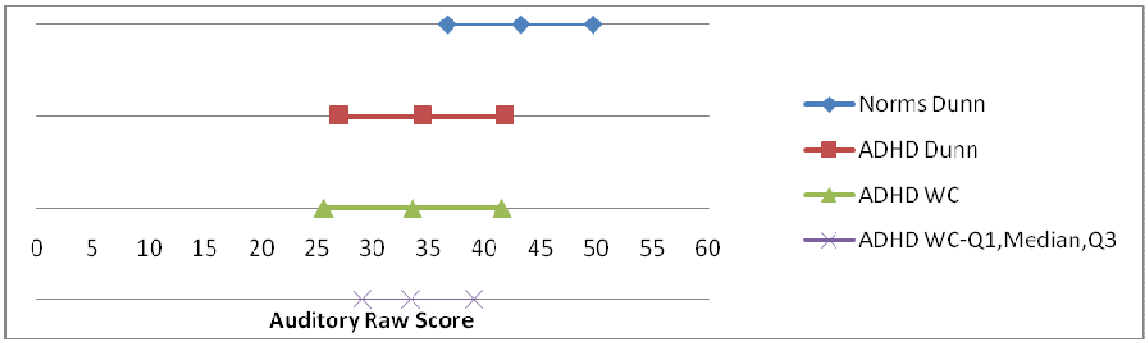

Figure 4.10 Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Auditory*

ADHD WC learners showed more behavioural responses to auditory stimuli than the Norms Dunn group. On the one end of the continuum, they overreacted to auditory input, such as over-responding to other learners talking or reacting to the school bell ringing. These learners with ADHD in the Western Cape may show excessive emotion to sudden noises such as the bell, thunder, or even an increase in noise level in the classroom or

high/low frequency sounds. Even the sound of chalk on the blackboard can disturb these learners who may cover their ears with their hands or put their fingers in their ears to block out the noise. Therefore, these learners have trouble concentrating and working in noisy environments.

At the other end of the continuum, the learner may have a high threshold to auditory input and may then either under-respond to auditory input or seek auditory input. The under-responder is unaware of the typical sounds in the classroom. They would not respond to, or follow, verbal instruction from the educator, pay little attention to loud noises and be unaware of what is going on around them. The educator needs to ensure that these learners have time to respond to instructions or may need additional cues, and educators may need to check on such learners more frequently than others, or allow a longer time to respond. The auditory seekers may talk loudly, sing or make sounds. They frequently like to make a noise, such as banging and clapping objects. Clearly, these learner disrupt teaching and other learners, particularly those who over-respond to sensory input. The educator needs to be aware that poor auditory processing may lead to the behaviours listed in Table 4.6 and that it is not necessarily a learner with a behavioural problem.

Table 4.6: Features of learners with auditory processing difficulties

UNDERRESPONDER	SEEKER	OVERRESPONDER
Unaware of typical sounds in classroom Responds slowly or not at all to verbal requests, voices or new sounds. Unaware of what is going on around him or her. Only pays attention to very loud sounds or music with a boisterous or unusual rhythm	Makes noisy sounds with objects, e.g. clapping, banging, moving chair noisily, tapping pencil on table, clicking pen, banging doors. Makes unusual noises to self, shouts, hums or sings Talks very loudly. Enjoys high-pitched noises Turns volume up – music loud Craves common noises, e.g. toilet flushing	Excessive emotions of distress with sudden noise, e.g. bell, thunder, alarm, door banging, siren Distressed when noise level in room increases. Hands on or fingers in ears to drown out noise Upset by common noises, e.g. toilet flush, water running, Distracted by sounds of birds singing, aeroplane, telephone ringing or others talking. Excessive emotion with either high- or low-frequency sounds, e.g. whistling, chalk on board or metal clinking Distressed at sound of singing or musical instruments

In conclusion, these results indicated agreement with Dunns' study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Auditory* section[7]. The results are also in accordance with recent studies done in South Africa and abroad, namely that learners with ADHD have auditory processing difficulties[8,21,46,55,65,73,75]. Auditory defensiveness is

often found in learners with ADHD who overreact to auditory stimuli as discussed above[40,69,73].

The *Visual* score reflects the learner's responses to visual stimuli.

As seen in Table 4.3, only 28.7% of the ADHD WC group did not display problems with visual processing, since their scores fell in the *Similar to Others* category. It also shows that 40.7% displayed *More Than Others* and 25.9% displayed *Much More Than Others.* Only 4.6% fell in the *Less Others* category. This implies that behaviours related to visual processing occurred more frequently in ADHD WC learners than was the case with Dunn's normative sample.

Table 4.4 shows that the mean for Dunn's group without disabilities was significantly higher than that for the ADHD WC group. (Norms Dunn $\bar{x}$=45.6; ADHD WC $\bar{x}$=35.6; p=0.0000). This is graphically illustrated in Figure 4.11 and is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *Visual*, showing a significant difference, p=0.001[7].

The distribution of ADHD WC ($\bar{x}$=35.6) was similar to that of ADHD Dunn ($\bar{x}$=35.8), p=0.8724. ADHD WC indicated a negative interquartile skewness for *Visual* ((Q2-Q1)-(Q3-Q2) = -2) with the quartile below the median showing a more concentrated distribution. The deduction that can be made from this is that there is less variability in the educator's report of problematic behaviour to visual input.

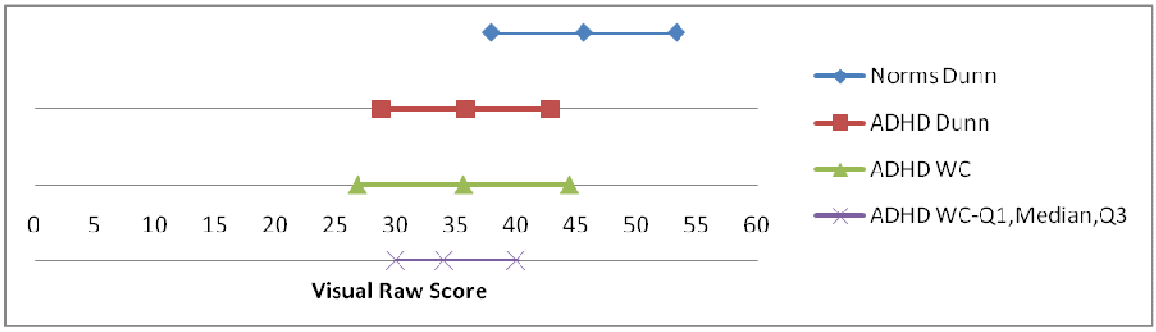

Figure 4.11: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Visual*

ADHD WC learners either over- or underreacted to visual input, such as other learners moving around in the classroom. They did not respond to or follow nonverbal instructions

given by the educator. They often looked around and were distracted by anything going on in the classroom and frequently avoided eye contact. There is a strong inter-sensory link between the vestibular and visual systems. For example, when a learner has to bend down to pick up something of the floor, the vestibular system reacts to the movement in the semi-circular canals as well as the force of gravity, but then the visual system is also involved as the learner sees the movement of the objects as they move his or her body up and down. Both visual and vestibular systems are therefore involved and it may be registered in either or both systems depending on the learner's sensory predominance. The educator needs to be aware that poor auditory processing may lead to the behaviours listed in Table 4.7 and that it is not necessarily indicative of a learner with a behavioural problem.

Table 4.7: Features of learners with Visual processing difficulties

UNDERRESPONDER	SEEKER	OVERRESPONDER
Unaware of new objects or people in his or her environment Stares at objects without responding Difficulty in finding his or her possessions such as pencils or in keeping school materials organised Slow to respond or misses demonstrations or written instructions Does not notice or forgets to copy work off the blackboard Looks around rather than looking at educator speaking or working at the blackboard Leaves spaces blank on page or fills all answers in Falls over or bumps into objects Poor ball catching or moving out of way of people because of slow response time	Stares at bright or flickering lights or direct sunlight Watches educator or learners when they move around Stares intensely at people or objects Holds objects close to face, spins objects, flicks objects or moves fingers in front of eyes Moves around or shakes head in fine motor activities Drawings have more detail Uses more, especially bright, colours in drawings and writing	Distressed by bright light or sunlight Refuses group activities Motion sickness with too much visual activity Difficulty working from his or her book to blackboard or vice versa continuously or fast Avoids eye contact Headaches, nausea with overuse of eyes Closes eyes with ball moving towards them Rubs eyes Notices or is upset by small changes in classroom or on his or her desk Startles at unexpected movement near him or her such as a book falling or learner standing up Looks away from task to notice other activity in the classroom Distracted by things outside such as a person walking past or leaves moving in the wind

In conclusion, these results indicated agreement with Dunns' study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Visual* section[7]. It is further confirmed by other research that learners with ADHD showed signs of poor visual processing [4,8,55,65,75] or even visual defensiveness[38,40,69,73].

The *Movement* score reflects the learner's response to sensations of movement, including both vestibular and proprioceptive stimuli.

As seen in Table 4.3, 40.7% of the ADHD WC group did not display problems with *Movement* since their scores fell in the *Similar to Others* category. It also shows that 26.9% displayed *More Than Others* and 32.4% displayed *Much More Than Others.* This implies that *Movement* behaviours occurred more frequently in ADHD WC learners than in Dunn's normative sample.

Table 4.4 shows that the mean of Dunn's group without disabilities was significantly higher than the ADHD WC group (Norms Dunn $\bar{x}$=62.6; ADHD WC $\bar{x}$=52.8; p=0.0000). This is graphically illustrated in Figure 4.12 and is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *Movement*, showing a significant difference, p=0.006[(7)].

The distribution of ADHD WC ($\bar{x}$=52.8) was similar to that of ADHD Dunn ($\bar{x}$=53.5), p=0.6591. ADHD WC indicated no interquartile skewness with respect to (Q2-Q1)-(Q3-Q2) = 0.0.

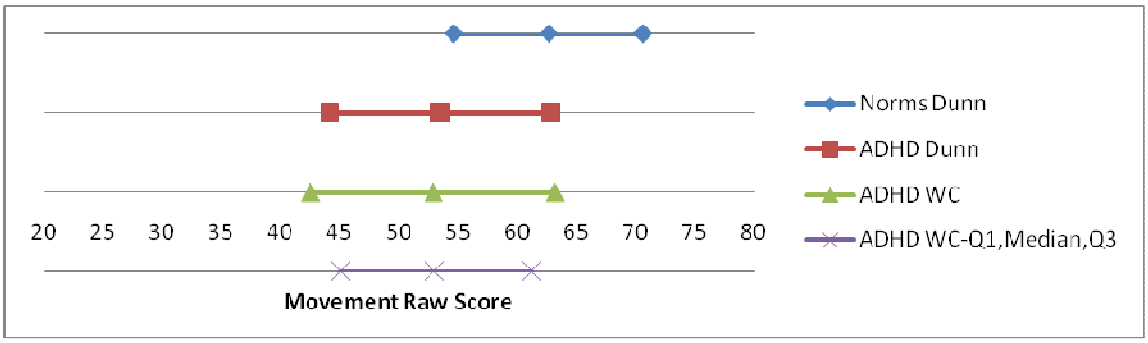

Figure 4.12: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Movement*

ADHD WC learners had difficulty processing vestibular and proprioceptive input. This could either have been due to poor modulation of vestibular and propioceptive input or it could have been due to poor discrimination of either vestibular or proprioceptive input. As poor discrimination forms the foundation of good body schema, this could lead to a sensory-based motor disorder. A sensory-based motor disorder can either be a postural disorder or dyspraxia and the learner will then require a full sensory integration

assessment using a test like the SIPT to identify the type of sensory processing problem. A postural disorder leads to poor postural control and the learner has difficulty in sitting upright and writing at the desk. With dyspraxia, the learner will have difficulty in ideation, organising, planning and executing the motor task. Organising their materials in the classroom, poor fine motor skills and poor participation in sporting activities are found. The learners appear clumsy and movements are awkward. The educator needs to be aware that poor movement processing may lead to the behaviours listed in Table 4.8 and that it does not necessarily indicate a learner with a behavioural problem.

Table 4.8: Features of learners with *Movement* (vestibular and proprioceptive) processing difficulties

UNDERRESPONDER	SEEKER	OVERRESPONDER
Accident prone, bumps into things or people Poor co-ordination, clumsy and awkward in movements Poor gross and fine motor skills Does not notice if swinging or climbing too high Rather sits, stands or lies than move around. Slouches in chair, lies on desk or rests head on arms Falls of chair or does not sit in centre of chair Appears lazy or tired Unaware if bumped or suffers injuries Slow to learn dressing or physical sports	Takes safety risks inside and outside Cannot sit still; always "on the go" Does things impulsively Runs rather than walks In constant motion – fidgets, rocks on chair, bounces Pushes movement experiences to extreme Spins excessively without getting dizzy Enjoys and seeks movement that interferes with classroom activities. Finds reasons to approach teacher or move around. Fidgets with objects during activities. Enjoys crashing into walls, people or objects, moving into other learners' personal space Enjoys falling, e.g. off chair Bites nails, sucks fingers, chews clothes, objects, pencils Aggressive behaviour – hits, punches or kicks Ties shoes tightly, wears clothes tight or pants high Stomps when walking	Timid and cautious with movement Fearful on playground equipment Stands/sits on outskirts of the playground or during movement classes Withdraws or is slow to participate in busy or physical activities Often retreats to quiet areas in the classroom Refuses to participate in team sports such as rugby Poor self-esteem – cannot play with others Arrive carsick at school. Afraid of stairs Fearful of feet off ground Clumsy, uncoordinated Appears lazy, overly tired and avoids physical activity (running, jumping, skipping, hopping) Dislikes others moving their bodies Avoids weight-bearing positions such as – animal walks, push ups Avoids bending down to pick things up Gets dizzy or avoids looking up to blackboard and down to book repetitively

In conclusion, these results indicated agreement with Dunns' study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Movement* section.[7] This is further supported by research, as learners with ADHD showed signs of poor movement (vestibular and proprioceptive processing), including over- or underresponsivity to gravity or movement and postural control[7,8,38,40,46,65,75].

The *Touch* score reflects the learner's response to sensations of touch.

As seen in Table 4.3, 33.3% of the ADHD WC group did not display problems with *Touch*, since their scores fell in the *Similar to Others* category. It also shows that 25.0% displayed *More Than Others* and 41% displayed *Much More Than Others.* This implies that *Touch* behaviours occurred more frequently in ADHD WC learners than was the case with Dunn's normative sample.

It is also supported when considering Table 4.4 where the mean of Dunn's group without disabilities was significantly higher than that of the ADHD WC group (Norms Dunn $\bar{x}$=55.5; ADHD WC $\bar{x}$=47.1; p=0.0000), illustrated in Figure 4.13. This is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *Touch*, showing a significant difference, p=0.036[(7)].

The distribution of ADHD WC ($\bar{x}$=47.1) was similar to that of ADHD Dunn ($\bar{x}$=48.9), p=0.1836. ADHD WC indicated a negative interquartile skewness for *Touch* ((Q2-Q1)-(Q3-Q2) = -3) with the quartile below the median showing a more concentrated distribution. The deduction that can be made from this is that there is less variability in the educator's report of problematic behaviours to touch sensations.

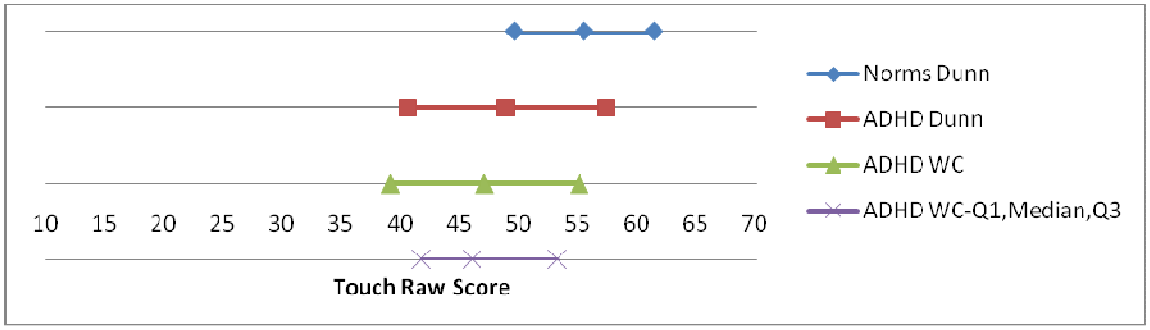

Figure 4.13: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Touch*

ADHD WC learners had difficulty processing tactile input. This could either be due to poor modulation or to poor discrimination of tactile stimuli. As poor tactile discrimination forms the foundation of good body schema, this could lead to praxis problems as discussed in the *Movement* section. Learners who are oversensitive to tactile input find group situations like the classroom or playground environment very threatening as other learners may accidentally touch them or bump into them. The educator needs to be aware that poor

touch processing may lead to the behaviours listed in Table 4.9 and a behavioural problem.

Table 4.9: Features of learners with touch-processing difficulties

UNDERRESPONDER	SEEKER	OVERRESPONDER
Unaware of messy hands or face Unaware when school clothes are twisted on body and appears untidy Does not notice dirty or wet clothes Does not respond to being touched or stands in others' personal space Lacks interest in creative arts Unaware of different textures in art Does not steady objects such as holding paper when writing Poor manipulation or dressing Difficulty finding things in a bag	Puts objects in mouth Seeks messy experiences Bumps, pushes, rubs or touches others to the point of irritation Fiddles, touches or plays with school objects such as pencils, books or ruler Fiddles and plays with toys Constantly touching furniture and walls with different textures Pulls or rubs hand against wall when walking in the passage Stands close to others	Avoids messy play and tasks and uses fingertips Dislikes kissing, hugs and touch Becomes distressed standing in lines and moves out, hits others or prefers to stand in front or at the end Flinches when anyone is too close to him or her or walks past him or her whilst he or she is sitting Group situations where the learner may be touched accidently are either avoided or disrupted Clean hands frequently Excessively ticklish Refuses to hold hands Overreacts to bumps or cuts Irritated by labels, seams of socks or school uniform Concert times are stressful and the learner will not dress up or wear makeup

In conclusion, these results indicated agreement with Dunns' study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Touch* section.[7] This is further supported by other research where learners with ADHD showed signs of poor tactile processing[7,8,21,46,65,75] or over-responding to tactile input[38,40,46,69,72,73].

The *Behaviour* section reflects behavioural reactions linked to sensory input.

As seen in Table 4.3, 38.9% of the ADHD WC group did not display problems with *Behaviour*, since their scores fell in the *Similar to Others* category. It also shows that 30.6% displayed *More Than Others* and 29.6% displayed *Much More Than Others.* Only 0.9% fell in the *Less Than Others* category. This implies that behavioural reactions to sensory input occurred more frequently in ADHD WC learners than in Dunn's normative sample.

It is also supported when considering Table 4.4, where the mean of Dunn's group without disabilities was significantly higher than the ADHD WC group (Norms Dunn $\bar{x}$=65.8; ADHD

WC ($\bar{x}$=54.2; p=0.0000). This is graphically illustrated in Figure 4.14 and is further supported by Dunn's matched sample of learners with ADHD and without disabilities for *Behaviour* showing a significant difference, p=0.026[(7)].

The distribution of ADHD WC ($\bar{x}$=54.2) was similar to that of ADHD Dunn ($\bar{x}$=56.4), p=0.2189. ADHD WC indicated a positive interquartile skewness for *Behaviour* ((Q2-Q1)-(Q3-Q2) = 4) with the quartile above the median showing a more concentrated distribution. The deduction that can be made from this is that there is more variability in the educator's report of problematic behavioural reactions to sensory input in the quarter below the median.

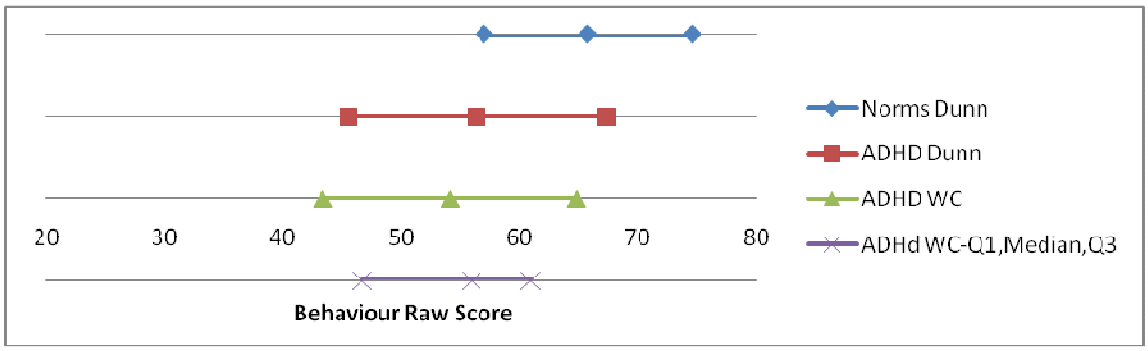

Figure 4.14: Performance of Norms Dunn, ADHD Dunn and ADHD WC: *Behaviour*

ADHD WC learners displayed more behavioural responses related to sensory input and this is often confused with a behavioural problem. It is important to note that ADHD also leads to behavioural problems and careful diagnosis is required to differentiate between sensory processing and ADHD. The fundamental differences between the two disorders need to be clarified to prevent misdiagnosis resulting in the incorrect intervention. There are also observable behavioural similarities and differences between the sensory-seeking learner and the learner with ADHD (hyperactive/impulsive subtype) and the sensory under-responsive learner and the ADHD (inattentive subtype) according to Miller and Fuller.[(2)] (See Appendix B for details on these similarities and differences.) For example, both the learner with ADHD and the sensory seeker act impulsively. The sensory seeker will impulsively seek the specific type of sensory input required, then stop when the sensory input is enough and focus on the task at hand. The learner with ADHD will impulsively seek the sensory input, irrespective of the type of sensory input and even often become over-aroused. The educator needs to be aware that poor sensory processing may lead to

the behaviours listed in Table 4.9 and does not necessarily point to a learner with a behavioural problem.

Table 4.10: Features of learners with behavioural response to sensory input

UNDERRESPONDER	SEEKER	OVERRESPONDER
Behaviour consistent with *Registration* Appears to be dull, apathetic and uninterested Low energy levels and appears overly tired often Self-absorbed. Shows limited emotion or dull affect Slow/delayed/inefficient with following instructions, task completion, transition from one task to the next, processing of information Slow to initiate a task but can complete if prompted to do so. In contrast to the inattentive subtype ADHD learner who can start activities, but cannot not stick with the activity Often makes careless mistakes, has difficulty following a long list of verbal instructions (not motor) and gets lost in the middle of the task	Behaviour is consistent with *Seeking* Active and continuously engaged in his or her environment to point of interfering with education Adds sensory input while educator is teaching or instead of working Appears excitable, impulsive and lacks consideration for safety to seek the sensory input Usually seeks vestibular or proprioceptive input and is more organised after receiving intense sensory input. In contrast, the ADHD learner is impulsive, irrespective of the type of sensory input, and often becomes over-stimulated, not more organised. More curious than other learners	Behaviour consistent with *Sensitivity* and *Avoiding* Overreactive and dramatic Upset when rules are broken Upset or withdraws when routine, plans or tasks are suddenly changed. Difficulty adapting to new situations such as new educator, classmates or school. Appears to be inflexible with changes May be bossy and controlling Stubborn or unco-operative Poor sense of humour Easily frustrated Emotionally oversensitive

In conclusion, these results indicated agreement with Dunns' study, where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to Dunn's ADHD group in the *Behaviour* section.[7] This is further supported by research that learners with ADHD and sensory processing often have secondary behavioural problems[8,21,40,55,65,75].

Conclusion on sections

Learners with ADHD in the Western Cape (Table 4.3) had higher percentages in the *More Than Others* and *Much More Than Others* categories for all five *Section* scores than Dunn's normative sample on the SPSC. Most of the sensory sections were above 60%. *Movement* was very close at 59.3% when adding the *More Than Others* and *Much More Than Others* categories. This was further supported by the significant differences (p=0.000) between the scores of ADHD WC and Norms Dunn in all the five *Section* scores (*Auditory*, *Visual*, *Movement*, *Touch* and *Behaviour*), with the ADHD WC group showing more problems in the processing of the *Sensory sections* and *Behaviour* than Norms Dunn. ADHD WC mirrored the findings of the ADHD Dunn group with both showing

significantly more frequent behaviours to sensory input in all five *Section* scores than the Norms Dunn group.

Interquartile skewness was observed in three of the five *Section* scores, namely *Visual*, *Touch* and *Behaviour*. All three were positively skewed, showing less variability in the quarter below the median for more problematic responses to sensory input of touch and vision as well as more problematic behaviours to sensory input.

Overall, the results of the *Section* scores indicated agreement with Dunn's study where ADHD WC was significantly different to the Norms Dunn group, but at the same time in agreement (no significant difference) to the ADHD Dunn group in all the *Section* scores. Learners with ADHD had more sensory processing problems than those without disabilities. The SPSC can therefore be regarded as a valid/reliable measure to ascertain in which sensory sections learners with ADHD in the Western Cape may have difficulty and whether their behaviour to sensory input observed in the classroom situation may be affected by sensory processing problem. The *Sensory* S*ection* scores will indicate which sensory systems are the learner's weak sensory system and which is the stronger sensory system. This information could assist the occupational therapist in recommending the most appropriate learning style for that learner.

4.2.1.4 Summary of performance by learners in the Western Cape on the SPSC

Only one learner in the current study sample of 108 learners had all 13 groups scores in the *Similar to Others* category of the SPSC.

ADHD WC learners showed significantly more frequent behaviours, indicating poorer sensory processing, than Dunn's normative sample, as seen in Table 4.3. The normal distribution curve was skewed, with the height of the typical group being lower. This further supports the findings that the learners showed more sensory processing problems. Sensory sensitivity had greater variance with behaviours being more and less frequent than the typical group.

This was further supported by the Welsh T-Test when comparing the performance of learners in the Western Cape to that of the SPSC norms. There was a significant difference between ADHD WC and Norms Dunn with the p=0.0000 for all 13 group scores.

This differed from Dunn's matched sample which found a significant difference in all 13 group scores, except for *Seeking* and *SF 4* between learners with ADHD and learners without disabilities. Most of the 13 group scores were similar between ADHD Dunn and ADHD WC, except for *Avoiding* and *SF 4* which showed significant differences, with ADHD WC demonstrating frequent behaviours to sensory input.

Negative skewness was noted in the interquartile ranges of *Seeking*, *Visual* and *Touch* with less variance in the educator's report of problematic behaviours of seeking and response to visual and touch sensations. Positive skewness was noted in the interquartile ranges of *Behaviour* with more variance in the educator's report of problematic behavioural responses to sensory input (Table 4.5).

The learners diagnosed with ADHD in the Western Cape showed significant differences in sensory processing in all 13 groups scores of the SPSC. They presented with behaviours indicative of poor sensory processing. The SPSC could thus be considered a good measure to be used on learners with ADHD in the Western Cape. The study was a convenience sample in the Western Cape and caution should be taken not to generalise these results to all learners with ADHD in South Africa. The SPSC could be given to the educator when assessing learners with ADHD or when the possibility of ADHD is suspected. This will enable the therapist (after interpreting the SPSC) to assess for possible sensory processing problems, plan intervention and design or create classroom strategies to optimise the learners' performance and availability to learn[69].

4.2.2 Performance of learners in the Western Cape on the ADHD Rating Scale-IV

Applying the norms on the ADHD Rating Scale-IV, 15 (13%) of the 108 learners could be classified as manifesting the combined subtype, while only five learners (4.6%) could be classified for the inattentive subtype. Both groups together only constituted 18.6% of the study group, indicating that the ADHD Rating Scale-IV was possibly not the best tool to use to categorise learners into the different subtypes of ADHD.

A possible reason for the inability of the ADHD Rating Scale-IV to differentiate between the two subtypes could be attributed to the fact that 80.5% of the learners in this study received medication which therefore influenced the blurring between the subtypes of

ADHD. As suggested by the manual[84] of the ADHD Rating Scale-IV, no medication was prescribed at the time of the study to identify ADHD and to discern how the rating scale could classify learner into the different subtypes. Although 82.5% of the learners in this study could not be classified into the different subtypes by the ADHD Rating Scale-IV, they had been diagnosed with ADHD by their medical practitioner.

A rating scale is only one of the tools that may be used used when making a diagnosis of ADHD. The medical practitioner will also take a detailed history and collect collateral information from the involved team members such as the educator, occupational therapist or psychologist. It can be concluded that the ADHD Rating Scale-IV should not be used when learners are on any type medication for an ADHD subtype diagnosis.

4.2.2.1 Performance of learners on the ADHD Rating Scale-IV regarding prescribed medication

The ADHD Rating Scale-IV provides three scores, namely for *IA, HI* and a *Total* score. The performance of ADHD WC learners on ADHD scores (*IA, HI* and *Total*) were analysed against whether medication was prescribed (Medication – Yes, n=21) or not (Medication – No, n=87) and presented in Table 4.11. A higher raw score or mean is indicative of more problematic behaviour and the learner presents with more behaviours typically found in learners with ADHD.

The Welsh T-test was applied to investigate the differences between the *IA, HI* and *Total* scores with the learners who were on medication (Medication – Yes, n=87) or not (Medication – No, n=21). For this study, significance was accepted on the 5% level and high significance on the 1% level. The learners not on medication showed significantly more attention-deficit/hyperactivity behaviours on the 1% level, confirming that learners not receiving medication for a condition like ADHD may display more observable behavioural indicators.

There was a significant difference (p=0.0016) in the *Inattention* (*IA*) scores between learners who were on medication or those who were not, indicating that the learners **not** on medication showed significantly more behaviours reflecting inattentiveness than learners on medication.

Table 4.11 Descriptive Statistics for the ADHD Rating Scale-IV and medication

ADHD Rating Scale-IV Scores	Medication Yes (n=87)		Medication No (n=21)		Yes versus No
	$\bar{x}$	SD	$\bar{x}$	SD	p-value
Inattention	12.25	7.45	18.00	6.72	0.0016**
Hyperactivity-Impulsivity	7.76	6.34	14.24	9.65	0.0002**
Total	19.99	12.26	32.24	15.04	0.0001**

**p <0.01

There was also a significant difference (p=0.0002) between whether the learners were on medication or not for *Hyperactivity-Impulsivity* (*HI*), indicating that the learners **not** on medication showed significantly more behaviours reflecting hyperactivity and impulsivity than learners on medication. The *Total* scores are the sum of the *IA* and *HI* scores which reflect ADHD behaviours. There was also a significant difference (p=0.0001) between whether the learners were on medication or not for the *Total* scores indicating that learners **not** on medication showed significantly more behaviours reflecting ADHD than learners on medication.

4.2.2.2 Reported skewness regarding the use of medication (or not)

Table 4.12 depicts the Q1, median (Q2) and Q3 for each of the ADHD Rating Scale–IV scores (*IA, HI* and *Total*) as well as the interquartile ranges. The difference between interquartile ranges is measured by the formula ((Q2-Q1)-(Q3-Q2)) and is depicted in the last column of Table 4.12. In calculating the median and quartiles, interquartile skewness can be observed if there is a difference of two or more units. The relevance of this indicates a difference in variation of scores. Measures that are negative depict more concentrated scores at the lower end than at the upper end of the distribution, and vice versa. If positively skewed, then the educator reported that behaviours relevant to attention deficit were not evenly distributed, with more densely distributed scores at the upper end (more problematic attention deficit behaviours) of the range. Note that there are both positive and negative skewness present.

Table 4.12: Skewness reported for use of medication for *IA, HI* and *Total*

ADHD Rating Scale-IV Scores	Quartile 1 (Q1)	Quartile 2 (Median)	Quartile 3 (Q3)	Interquartile range	(Q2-Q1)-(Q3-Q2)
Inattention					
Medication – Yes	7.0	13.0	17.5	10.5	1.5
Medication – No	14.0	18.0	24.0	10.0	-2.0#
Hyperactivity-Impulsivity					
Medication – Yes	2.0	7.0	12.5	10.5	-0.5
Medication – No	3.0	16.0	21.0	18.0	8.0#
Total					
Medication – Yes	11.0	19.0	31.0	20.0	-4.0#
Medication – No	19.0	37.0	45.0	26.0	10.0#

Interquartile skewness when (Q2-Q1)-(Q3-Q2) ≥2.0

The results for *IA* indicate significant skewness in the group **not** receiving medication (= -2) indicating concentrated scores below the median and a greater variance in the quartile above the median as the interquartile range of *IA* is negatively skewed. The deduction that can be made from this is that there is more variability in the educators report of frequency of inattentive behaviours which are problematic. This difference is also displayed in Figure 4.15, where the yellow section represents the interquartile range with the centre red line representing the median. The whiskers represent the highest and lowest raw scores reported. The higher the raw score the higher the frequency of the behaviour reported, as seen with the learners not on medication.

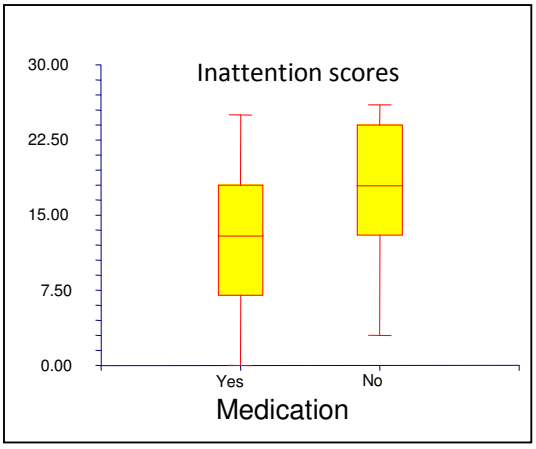

Figure 4.15: *IA* scores on ADHD Rating Scale-IV and medication

The results for *HI* indicate a significant skewness in the group **not** receiving medication (= + 8.0), indicating more concentrated scores above the median. This depicts a smaller variance of hyperactive and impulsive behaviours which are problematic as reported by the educator. This is displayed in Figure 4.16. There was a difference of 7.5 between the

interquartile range of learners **on** medication (10.5) and learners **not** receiving medication (18.0) showing that the range of the behaviours of the learners **not** on medication was larger for *HI*. The educator's reported more variance with the frequency of behaviours of learners **not** on medication for hyperactivity and impulsivity than learners on medication.

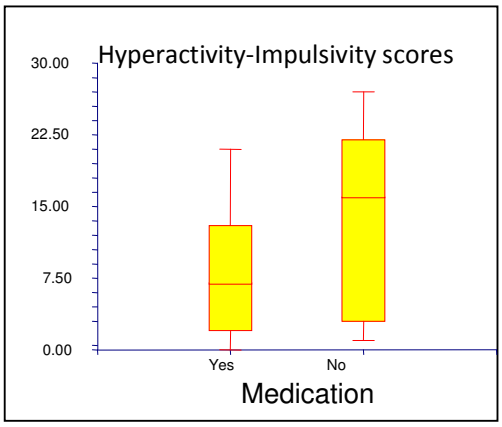

Figure 4.16: *HI* scores on ADHD Rating Scale-IV and medication

The results for the *Total score* (combined *IA and HI scores*) indicate significant skewness in both groups **on** and **not** on medication (see Table 4.12 and Figure 4.17). Learners **on medication** were negatively skewed (= -4.0), indicating concentrated scores in the quartile below the median which indicates a lower frequency of ADHD behaviours.

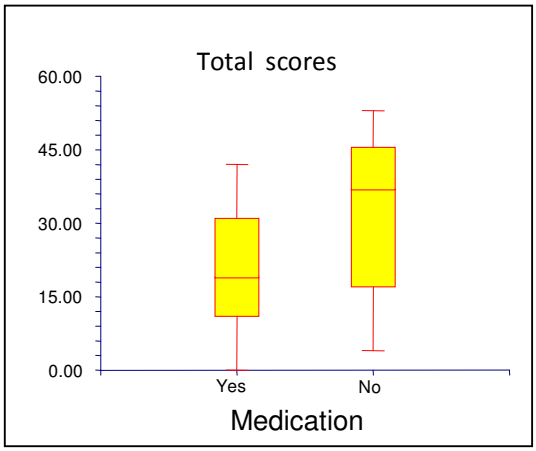

Figure 4.17 *Total* scores on ADHD Rating Scale-IV and medication

The learners **not** on medication were positively skewed (= 10.0), indicating concentrated scores in the quartile above the median which depicts less variance in the frequency of ADHD behaviours that are problematic. There was a difference of 6 between the interquartile range of Medication – Yes (20) and Medication – No (26), showing that the range of the behaviours of the learners **not** on medication was greater for the *Total scores*.

The educators reported more variance in the behaviours of learners not on medication for ADHD.

4.2.2.3 Summary of performance of learners in the Western Cape on the ADHD Rating Scale-IV

It was not possible to differentiate all the learners in terms of the ADHD subtypes on the ADHD Rating Scale-IV.

However, the results showed that there was a significant difference in ADHD WC learners who were on medication and those who were not for the *IA, HI* and *Total scores* of the ADHD Rating Scale-IV. The learners **not** on medication presented with a higher frequency of ADHD behaviours. There was interquartile skewness, both negative (*IA* not on medication and *Total* on medication) and positive (*HI* on medication and *Total* not on medication). This indicates a variance in reporting of ADHD behaviours of ADHD WC both on and not on medication.

Clinically, when medication is prescribed for a learner, the paediatrician and therapists use rating scales to determine the effectiveness of various medications on the learner's behaviour. This enables the specialist medical practitioner to prescribe the most appropriate medication and dosage. From the above findings it is evident that medication may have an influence on the behaviours of ADHD and these findings could thus be used clinically to determine the effectiveness of prescribed medication.

Considering that most researchers are not accounting for medication when doing research in sensory processing and ADHD learners, a future study is this area is recommended.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This section concludes with putting together the most important findings of this research and follows it up with recommendations for future studies and recommendations for occupational therapy services and educators who work with learners with ADHD.

5.1 Conclusion

In answer to the first objective (to ascertain how learners with ADHD in the Western Cape perform on Dunn's SPSC), the results showed that there were significant differences for all 13 group scores of the SPSC. ADHD WC learners showed significantly more behaviours indicating poorer sensory processing than Dunn's normal sample. The performance of learners with ADHD in the Western Cape, compared to those of ADHD Dunn, did not differ for 11 of the 13 group scores. It can therefore be accepted that ADHD WC learners performed similarly to the ADHD learners in Dunn's study. *Avoiding* and *SF 4* showed significant differences between ADHD WC and ADHD Dunn with the ADHD WC group showing more extreme behaviours related to sensory input. This can be seen in the lower mean score, which is indicative of more sensory processing problems. Further investigation is needed to establish the reasons for this difference.

The second objective (to ascertain which school factors will emerge from Dunn's SPSC in the Western Cape that may impact upon classroom function), could not be achieved. The factor analysis was not done on the recommendation of the statistician employed, as it is an extensive exercise to determine possible new factors that may impact on classroom function and it is beyond the scope of this master's degree.

As discussed in Chapter 4 it was not possible to use the ADHD Rating Scale-IV to differentiate between the two types of ADHD (objective 3), because the ADHD Rating Scale-IV was standardised on learners prior to them taking medication[84]. The fact that some of the learners were on medication may have played a role in the difficulty differentiating between the two types of ADHD. In spite of this, the performance of ADHD WC learners on the ADHD Rating Scale-IV was discussed with regard to the performance of learners on prescribed medication and not on the ADHD-IV Rating Scale. There was a

significant difference in all three scores (*IA, HI* and *Total*) with learners not on medication showing a higher frequency of ADHD behaviours. This topic needs further investigation.

The fourth objective (to establish the association correlation between Dunn's SPSC and the ADHD Rating Scale-IV) could not be investigated. This was due to the fact that the ADHD Rating Scale-IV could not differentiate sufficiently between the subtypes of ADHD, namely the inattentive subtype and combined subtype.

The results indicated that learners with ADHD in the Western Cape showed problems with sensory processing, and by using the SPSC the specific type of sensory problem for each learner can be identified. This information would be helpful in the intervention plan for the learner with ADHD. Based on these results, the researcher extrapolated and postulated the impact of the ADHD on classroom behaviour of learners in the Western Cape. This was discussed in Chapter four. The recommendations for occupational therapy services delivery follows in section 5.4.

5.2 Limitations

The study was confined to the Western Cape to limit the geographic coverage since it was a research assignment and a wider sampling would have been more costly in terms of time and money. It should also be noted that only 202 of the 308 learners identified by the LSEN educators and researcher could be included, due to several reasons such as no parent/legal guardian consent, forms not returned or exclusion criteria. Considering that the relatively small sample comprising 108 learners were recruited from a convenience sample in the Western Cape, the results cannot be generalised to the whole population of learners between ages of 5 and 10 years in South Africa.

Due to time constraints and levels of complexity involved in statistical analysis, three of the objectives stated at the outset of this research, could not be achieved. Based on these limitations, several recommendations to counter them, are put forward in the next section.

5.3 Recommendations for further research

The rigour of the results should be further investigated by:

- Recruitment of learners from all the provinces and socio-economic backgrounds by means of randomised sampling.
- A matched sample of age and gender for the group with ADHD and another group without ADHD would be required.
- Normative data of the SPSC needs to be obtained by standardising the SPSC on the South African population.

A study in which learners are recruited at the time of diagnosis, and before medication has been prescribed, will enable the researcher to employ the ADHD Rating Scale-IV and address objective three (to ascertain whether the ADHD Rating Scale-IV will differentiate between the two types of ADHD). This will enable the learners to be classified into one of the two main subtypes of ADHD, namely the inattentive subtype and one for the *Combined* subtype (*Inattention* and *Hyperactivity-Impulsivity*).

Researchers are not accounting for medication when doing research in sensory processing and ADHD learners[7]. A comparative study of the effect of medication and no medication on the results of the SPSC and the ADHD Rating Scale-IV would be useful.

A factor analysis study investigating all the variables (age, gender, medication and occupational therapy and sensory integration therapy) may uncover more in-depth understanding of gender differences and the impact of medication and or OT/SI therapy.

A study to compare how parents and educators rate the sensory and ADHD behaviours of learners would be critical in investigating the presentation of ADHD in different environments.

5.4 Recommendations for Occupational Therapy services

It is essential that occupational therapists treating learners with ADHD should be made aware of the findings that learners diagnosed with ADHD have a very strong possibility of having sensory processing problems. A sensory history needs to be completed by the caregiver and educator, in addition to an in-depth assessment by the occupational therapist to ascertain the extent of the sensory processing problem. This information will

enable the therapist to plan an appropriate therapy programme and to give advice and support to the caregiver and educator on management and to provide intervention techniques for the learners in the classroom. There is an enormous need to inform educators on the effect of poor sensory processing on the learners' behaviour and availability to learn in the classroom situation. Educators also need to be made aware of the coping behaviours which the learners have developed to manage their problems.

The effect of ADHD compounded by inefficient sensory processing needs to be taught to all those in the education system and to medical professionals involved with these learners. Educators and medical professionals also need to know that there is much that can be done to assist these learners to learn more effectively. It would be highly beneficial for professionals and parents involved with these learners to gain insight into how the learners experience having a diagnosis of ADHD and how they experience their sensory worlds. This will enable educators to help these learners reach their full potential and enjoy school. The link between ADHD, sensory over-responsivity and anxiety needs to be considered in treating the learner with ADHD holistically. When a learner is suspected of having an attention problem the SPSC and the Sensory Profile Caregiver Questionnaire or a similar measure, such as the SPM, should be used to investigate the underlying sensory processing differences they may be experiencing.

It would be important to differentiate which learner has only ADHD or only sensory processing problems and which learner has a combination of ADHD and sensory processing problems so that the intervention can be individualised for each learner.

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Diagnostic Criteria for Attention-Deficit/Hyperactivity Disorder

Taken from: Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV)

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

(a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
(b) often has difficulty sustaining attention in task or play activities
(c) often does not seem to listen when spoken to directly
(d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
(e) often has difficulty in organizing tasks and activities
(f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
(g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
(h) is often easily distracted by extraneous stimuli
(i) is often forgetful in daily activities

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

Hyperactivity

(a) often fidgets with hands or feet or squirms in seat
(b) often leaves seat in classroom or in other situations in which remaining seated is expected
(c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
(d) often has difficulty playing or engaging in leisure activities quietly
(e) is often "on the go" or often acts as if "driven by a motor"
(f) often talks excessively

Impulsivity

(g) often blurts out answers before questions have been completed
(h) often has difficulty awaiting turn
(i) 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 the age 7 years.
C. Some impairment from the symptoms is present in two or more settings (e/g., at school [or work] and at home).
D. There must be a clear evidence of clinical significant impairment in socal, 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 mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a 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

Behavioural similarities and differences between ADHD and Sensory Processing Disorder subtypes.

Sensory Seeking versus Hyperactive/Impulsive ADHD

Common behaviour in both disorders	**SPD Behaviour: Sensory-seeking subtype**	**ADHD behaviour: Hyperactive/Impulsive**
Acts impulsively	Can stop impulsive behaviour if sensory input is sufficient	Cannot stop impulsive behaviour irrespective of sensory input
Extraordinarily Active	Craves activity that is specifically related to sensation (usually vestibular and sometimes proprioceptive)	Craves novelty and activity that is not necessarily related to specific sensations
Seems disorganized	Looks more organized after receiving intense sensory input	Does not become more organised after receiving intense sensory input
Impatient and demanding	More patient if given appropriate frequency, intensity and duration of sensory input while waiting	Has difficulty waiting or taking turns better with cognitive input than with sensory input
Lacks self-control	Touches, pulls and/or pokes people or objects; frequently seems to need more tactile input than most children	Tends to talk all of the time, impulsively interrupting, has trouble waiting turn in conversation

Sensory Under-Responsivity versus Inattentive/ADHD

Common behaviour in both disorders	**SPD Behaviour: Under-responsive subtype**	**ADHD behaviour: Inattentive**
Does not follow through and finish up activities	Does not want to initiate activities but can stick with activities when prompted	Can start activities but not stick with them
Has difficulty with focussing attention	Often in a daze; seems not interested in material enough to focus on it	Interested but makes careless mistakes, focus gets diverted easily
Appears disinterested and uncooperative	Often fatigued and appears lazy, bored and unmotivated	Often daydreams and seems far away
Does not follow directions well	Unaware of directions being given; has trouble discriminating sounds or has difficulty with motor planning ad thus appears not to be following directions	Gets started but has difficulty remembering or following through on a long list of verbal directions; no motor component contributes to difficulty with directions
Does not perform daily routines in a timely manner	Knows the routines but is impossibly slow	Often forgets or gets lost in the middle of a routine but completes a normal pace when forced

Source: Miller L, Fuller D. Sensational Kids. 1st ed. New York: Penguin Group 2006, p181-182.

Navrae
Enquiries
IMibuzo

Telefoon
Telephone
IFoni

Faks
Fax
IFeksi

Verwysing
Reference
ISalathiso

Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Mrs Ray Cook

Dear Mrs R. Cook

RESEARCH PROPOSAL: TO ASCERTAIN WHETHER DUNN'S SENSORY PROFILE SCHOOL COMPANION CAN DISCRIMINATE BETWEEN THE SENSORY PROCESSING OF TWO TYPES OF ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (INATTENTION AND HYPERACTIVITY-IMPULSIVITY).

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **1st April 2009 to 30th September 2009**.
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Signed: Ronald S. Cornelissen
for: **HEAD: EDUCATION**
DATE: 26th March 2009

APPENDIX D

Date:

The Principal,

.....

.....

Dear Sir/Madam

I am a Master in Occupational Therapy student at Stellenbosch University and would appreciate it if your school could assist by participating in a research project.

Please take some time to read the information presented here, which will explain the details of this project. If there is any part of the research project that you do not fully understand, you are welcome to contact the researcher.

This study has been approved by the **Committee for Human Research at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

Permission for this study was also obtained from the Western Cape Department of Education.

What is this research study all about?

This study will entail two questionnaires to be completed by the educator of the learners (aged between 5 and 10 years) identified by the researcher in collaboration with the LSEN educator at your school. Only learners who have been diagnosed with ADHD will be included in this study. The ADHD questionnaire aims to distinguish between the two major subtypes of ADHD. The other questionnaire (Dunn's Sensory Profile School Companion) is about observations of the learner's sensory processing and behaviour in the classroom situation.

The learner will not be required to actively participate in the study. The information required by the questionnaires does not need observation or participation by the learner, but can be answered by the educator, using prior knowledge of the child gained over a period of time.

The school will not benefit directly from this research, but answers to the questions in this research will help the occupational therapist in the future to better assess children and enable the occupational therapist to provide more optimal interventions.

There are no risks involved in this research. No treatment will be provided, or withheld from any learner. There will be no costs involved on the part of your school.

Who will have access to the questionnaires?
Although the educator completes the questionnaires, she cannot draw any conclusions from it. The researcher will analyze the questionnaires and then group the learners according to the responses into categories, which will then be analyzed by a statistician. To ensure anonymity, no names of learners will be given to the statistician (only numbers) or be made public, and all results will be kept securely. Only the researcher will have access to the individual's performance.

Is there anything else that you should know or do?
You can contact the Committee for Human Research at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your child's study researcher.

Should you require any information or want to see the informed consent forms, please contact the researcher.

Ray Anne Cook
Student

N E Smit
Supervisor

ray anne cook
occupational therapist/ arbeidsterapeut

INFORMATION PACKAGE AND PROCESS

Attached, please find the following documents to be used in the research.

Permission for research from Western Cape Education Department

Appendix A: ADHD Rating Scale-IV

Appendix B: Dunn's Sensory Profile School Companion

Appendix C.1: Informed Consent from parent for access to learners files Appendix C.2: Informed Consent form (parent and child) (English) and questions for parents to answer

Appendix C.3: Informed Consent form (parent and child) (Afrikaans) and questions for parents to answer

Appendix D: Letter to Principal of selected schools

Appendix E.1 : Informed consent from educator

Appendix E.2 : Informed consent from educator

PROCEDURE FOR RESEARCH

1. Head master and LSEN educator need to decide on the method to obtain permission from the parents or refusal to participate in the research. This is for the LSEN educator to have access to the learners files to find the participants. See App1 or example for newsletter
2. LSEN teacher goes through learners files for participants in research. Inclusion criteria are learners aged 5 – 10 years who have been diagnosed with ADHD by a medical practitioner and informed by the parent hereof. Exclusion criteria are learners diagnosed with cerebral palsy, autism or any other physical or psychiatric disability. LSEN teacher to please make a list of learners by the date set for the next appointment with Mrs Cook.
3. At the 2nd appointment Mrs. Cook will go through the list with the LSEN educator to confirm the criteria for the participants.
4. LSEN educator send forms out to educators and parents for permission
5. Educator fills out the questionnaires
6. Educator returns all the questionnaires and consent forms to the LSEN educator
7. Mrs Cook collect forms at a convenient time for LSEN teacher
8. Continue this process until Mrs. Cook gets 29 children in each area.