# SENSORY PROCESSING DISORDERS AND ADHD SUBTYPES

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A Thesis

Submitted to the

Temple University Graduate Board

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in Partial Fulfillment

of the Requirements for the Degree

Master of Science

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By

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May 2011

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ABSTRACT

Title: Sensory Processing Disorders and ADHD Subtypes

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Degree: Master of Science

Temple University, 2011

The purpose of the study was to explore sensory processing patterns with children ages 5 to 12 years who are diagnosed with two subtypes of ADHD, inattention and hyperactive- impulsive and with children who do not have ADHD. The study delineated children with ADHD from a control group of children without ADHD and how sensory processing issues affect the population with ADHD. The participants were parents or caregivers of children aged 5 to 12 years diagnosed with ADHD and parents or caregivers of children aged 5 to 12 years without a diagnosis of ADHD. The participants totaled 45 with 26 participants in the ADHD group and 19 participants in the non ADHD group. Parents or caregivers completed the SSP Caregiver Questionnaire, the Sensory Processing Measure [SPM], and the Connors Parent Rating Scale–Revised: Short Form. The independent *t*-test was the statistical procedure used to determine whether the means of the ADHD and non-ADHD groups were statistically different from each other. A Pearson correlation was calculated to measure the degree of association between the children with ADHD and non-ADHD with the types of sensory processing patterns. Finding suggested that children who score high on these ADHD scales have more sensory processing difficulties. A sensory pattern unique to the subtype of ADHD is beginning to emerge through this research.

ACKNOWLEDGMENTS

I would like to thank all the parents for their participation in this study. Also, a special word to express my gratitude to my professors, Dr. Beth Pfeiffer and Dr. Moya Kinnealey whose expertise, understanding and patience added to my graduate experience.

I would also like to thank my family for their support and unending encouragement.

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# CHAPTER 1
# INTRODUCTION

## Background

Hyperactivity in children was first documented in 1902. In the beginning, it was named *minimal brain dysfunction*. In the *Diagnostic and Statistical Manual of Mental Disorders*, Second Edition (DSM–II; American Psychiatric Association [APA], 1968), it was named *hyperkinetic reaction of childhood disorder* for the emphasis on the hyperactivity as the key deficit. In 1980, the DSM–III published the name *attention deficit disorder* (ADD; APA, 1980) and provided the first empirical-based set of diagnostic criteria. Within this diagnosis, hyperactivity and inattention were given as primary deficits (Cormier, 2008). The DSM–IV (APA, 1994) classified three types of attention disorders: *combined type,* which carries all symptoms of inattention, impulsivity, and hyperactivity; *predominately inattentive type,* in which attention is the primary issue; and *predominately hyperactive-impulsive type,* in which hyperactive and impulsivity symptoms persist (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009).

According to Schlachter (2008*),* the standard definition of *Attention deficit hyperactivity disorder* (ADHD) in the United States comes from the American Psychiatric Association's (1994) *Diagnostic and Statistical Manual of Mental Disorders (DSM)*, which was published in 1994. ADHD and its treatment have been popular topics in the realm of education and parenting literature over the past 30 years. ADHD is a behavioral disorder that presents itself in a child with varying degrees of inattention, impulsivity, and hyperactive behavior. It is the most frequently diagnosed neurobehavioral disorder during childhood (Schilling, Washington, Billingsley, & Deitz,

2003). Statistically in the United States, 3% to 7% of school-age children are affected (Findling, 2008). Of children diagnosed with ADHD as a school-age child, 37% to 85% will report continued symptoms into their adolescence and adulthood (Findling, 2008). According to Rucklidge (2010), the current estimates indicate that boys are more frequently diagnosed with ADHD than girls; the ratio of diagnosis varies from 2:1 to 9:1. The prevalence rates have been found to not vary by race in the United States. However, African-American and Hispanic children are less likely to report and receive treatment for ADHD without regard to socioeconomic status (Cormier, 2008).

According to Schilling and colleagues (2003), children diagnosed with ADHD have a difficult time in their academic setting because of sensory motor problems such as difficulty sitting and paying attention and failure to complete assignments, which leads to educational underperformance. Children with ADHD experience a wide range of secondary behavioral and emotional problems at school. According to Schilling et al. (2003), students diagnosed with ADHD are thirty-three percent more likely to drop out of school than their counterparts who are not diagnosed with ADHD**.** The diagnosis of ADHD can be co-morbid with other psychiatric disorders. According to Thapar,Van Den Bree, Fowler, Langley, and Whittinger (2006), clinical diagnosis of conduct disorder and oppositional defiant disorder are generally increased in children with ADHD. According to Pliszka et al. (2007), studies have demonstrated that 54% to 84% of children and adolescents with ADHD may also be diagnosed with oppositional defiant disorder, and a marked proportion of these children will develop a conduct disorder. Substance abuse is a concern; 15% to 19% of children diagnosed with ADHD will start to smoke or develop other substance abuse issues. Twenty-five percent to thirty-five percent of children will

have co-existing learning or language difficulty (Pliszka et al., 2007). Symptoms associated with ADHD tend to overlap with symptoms of other disorders. These include reading disabilities, learning disorders, less severe pervasive developmental disorder, and auditory processing disorder (Vlam, 2006).

ADHD accounts for approximately half of the referrals to mental health services in the United States (Mangeot et al., 2001). Children with ADHD have a significantly higher use of healthcare resources and funds compared with children without ADHD. It affects children's academics and parent's work productivity. According to a study completed in Belgium by DeRidder and DeGraeve **(**2006), children with ADHD require additional therapy, have a greater number of general practitioner and specialist appointments, and have more emergency room visits and hospitalizations related to accidents (versus illness). In this research, parents were found to assist the child with homework more than another child without ADHD (DeRidder & DeGraeve**,** 2006). Many parents reduced their working hours to accommodate the extra needed assistance. Further, parents often enlisted the aid of tutors (DeRidder & DeGraeve, 2006).

ADHD is a costly diagnosis because it continues throughout a person's life. These costs include reduced work productivity and loss of earning potential. According to Minkoff (2009), an estimated annual cost to treat children with ADHD ranges from $2 to $11 billion annually, with pharmacotherapy leading this expenditure. The same study by Minkoff (2009) estimates a six-month period for an adult with ADHD that includes medical and drugs cost between two thousand and four thousand dollars.

ADHD has social, academic, and family implications. Its costs affect the mental health and health care systems, education system, and overall economic system. The

child mental health care system cannot handle the high volume of children diagnosed with ADHD. The assessment, diagnosis, and management of ADHD usually begins in the primary care setting. ADHD presents a significant risk factor for difficulties in academics, psychosocial adjustment, and future psychopathology (Mangeot et al., 2001). According to the DSM – IV-TR, the criterion to diagnose ADHD needs the initial symptoms to be present prior to the age of seven and occur in two or more settings (Madaan et al., 2008).

Researchers have suggested that children with ADHD are frequently affected by deficits in sensory processing, especially with sensory modulation dysfunction (Yochmn, Parush, & Ornoy, 2004). Mangeot et al. (2001) suggested that sensory modulation disorder may affect and may be under diagnosed in children with ADHD. Occupational therapy literature has suggested that sensory modulation deficits could be an element of ADHD in children (Schilling et al., 2003). Parush, Sohmer, Steinberg, and Kaitz (2007) explored the relationship between somatasensory function in boys with ADHD and tactile defensiveness. Through cortical and subcortical potentials evoked by a somatosensory stimulus, boys with ADHD showed a marked increase in tactile defensiveness over a control group of boys who did not have ADHD. Cheung and Siu (2009) published findings that children with ADHD demonstrated a significant increase in auditory processing issues. These studies show a link between sensory processing difficulties and children with ADHD. Sensory processing disorder is a concern in many children, because it may not be identified or the children referred for intervention. Identifying specific sensory patterns can help caregivers to understand a child and his or her behavior. With

this knowledge, parents and educators can learn about their child's needs and how to address sensory-related issues.

## Purpose

The purpose of the study was to explore sensory processing patterns (sensation seeking, sensory sensitivity, and sensation avoiding) with children ages 5 to 12years who are diagnosed with ADHD (ADHD primarily inattention and ADHD primarily hyperactive impulsive) and with children who do not have ADHD. The study delineated children with ADHD from a control group of children without ADHD and how sensory processing issues affect the population with ADHD. Relationships were identified between types of ADHD and sensory processing patterns that may provide more information needed for more effective treatment of children with ADHD. This study could help guide appropriate treatment and goals for occupational therapists that treat children with sensory issues and ADHD.

## Research Questions

This study addresses the following questions: What is the relationship between sensory processing patterns and ADHD in children ages 5 to 12 years? Is there a difference in sensory processing patterns between children ages 5 to 12 years with and without ADHD?

## Definitions

*Attention deficit hyperactivity disorder (ADHD):* ADHD is a neurobehavioral disorder that can affect a child's ability to sustain attention and effort, causes deficits in

impulse control and activity regulation, and causes substantial impairment of occupational performance throughout a child's day including home, school, and social settings (APA, 1994). DSM–IV classifies subtypes of this disorder into three categories: ADHD combined type, ADHD predominantly inattention type, and ADHD predominantly hyperactive–impulsive type (APA, 1994).

*Sensory processing:* Sensory processing is a general term that encompasses the information received by the central and peripheral nervous systems and how it is managed (Reynolds &Lane, 2007**).** This includes the reception, modulation, integration, and organization of sensory stimuli.

*Sensory modulation:* Sensory modulation is defined as the ability to regulate and prioritize the degree, intensity, and nature of responses to sensory input in a graded and adaptive manner (Parush et al., 2006). Sensory input includes the tactile, vestibular, auditory, proprioceptive, and olfactory systems. Sensory modulation is more specific than sensory processing.

*Sensory modulation disorder:* Sensory modulation disorder is characterized by an exaggerated avoidant, defensive, sensory seeking, or other inappropriate response to mild sensory input (Parush et al., 2007). According to Reynolds and Lane (2008), this disorder entails over- and underresponsivity and fluctuating responsivity.

# CHAPTER 2
# LITERATURE REVIEW

## Etiology of Attention Deficit/Hyperactivity Disorder

There are a variety of theories about the etiology of ADHD, including genetics. No specific lesions of the brain have been directly related to the origin of this disease (Dunn & Bennett, 2002). ADHD is associated with a combination of several genes with interactions between them and with the environment (Martin, McDougall, & Hay, 2008). Specific neurologic soft signs have been identified with ADHD. These include abnormal muscle tone and balance, decreased coordination in the lower and upper extremities, and abnormal sensory processing compared with children without disabilities (Dunn & Bennett, 2002).

## Types of Attention-Deficit/Hyperactivity Disorder

ADHD is a behavioral disorder characterized by varying degrees of inattention, impulsivity, and hyperactive behavior. DSM–IV-TR classifies three types of attention disorders: combined type, which carries all symptoms of inattention or impulsivity and hyperactivity; predominately inattentive type, in which attention is the primary issue; and predominately hyperactive-impulsive type, in which hyperactive and impulsivity symptoms persist (Madaan et al., 2008). DSM-IV-TR lists 18 core symptoms of ADHD with 9 of these symptoms as inattentive and the other 9 as hyperactive/impulsive. For the inattentive type of ADHD, 6 or more of the following symptoms need to be present and persist for at least 6 months to such a degree that it is considered maladaptive and inconsistent with developmental level for inattention (Madaan et al., 2008):

Often fails to pay close attention to details or makes careless mistakes

Often has difficulty sustaining attention to details or makes careless mistakes

Often does not seem to listen when spoken to directly

Often does not follow through on instructions and does not complete schoolwork or chores

Often has difficulty organizing tasks and activities

Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental activity

Often loses things necessary for tasks

Easily distracted by external stimuli

Often forgetful

For the hyperactivity type of ADHD, six or more of the following symptoms need to be present and persisted for at least 6 months to such a degree that it is considered maladaptive and inconsistent with developmental level for hyperactivity - impulsivity (Kirby et al., 2002):

Often fidgets with hands or feet or squirms in seat

Often leaves seat when remaining seated is expected

Often runs around or climbs excessively in places that it is not appropriate

Difficulty playing quietly

Is often “on the go” and acts as if “driven by a motor”

Talks excessively

Often acts as if “driven by a motor”

Often blurts out answers before questions have been answered

Often has difficulty waiting turn

Often interrupts or intrudes on others

For the impulsivity type of ADHD, the three criteria for the diagnosis include (1) blurts out answers before questions have been completed,(2) has difficulty waiting turn,and (3) interrupts or intrudes on others. The combined type requires six of nine from each category. Initial symptoms of ADHD need to be present before the age of 7 years with impairment in two or more settings (Madaan et al., 2008).

Once a diagnosis is determined, further monitoring of symptoms and response to treatment is essential. Of the three subtypes, ADHD predominately hyperactive-inattentive is the most frequently diagnosis during the preschool years (Riley et al., 2008). McGough and McCracken (2000) showed that hyperactive-impulsive subtype is the least prevalent of the three subtypes. Children diagnosed with hyperactivity-impulsive subtype tend to show symptoms at an earlier age, by age 4, and tend to have more significant symptoms. A diagnosis of hyperactivity-combined type is often seen when academic demands are increased and sustained attention is needed. Hyperactivity-inattention is the most common of the three subtypes, accounting for 40% to 50% of all children diagnosed with ADHD (McGough & McCracken, 2000). According to Riley et al., in 2008, a longitudinal study found that most children with ADHD-hyperactivity are later diagnosed with ADHD-combined type. Current research suggests that ADHD-hyperactivity and ADHD-combined may not be distinct subtypes.

## Evaluation of Attention-Deficit/Hyperactivity Disorder

To meet the criteria set in the DSM–IV, children must exhibit a combination of behaviors that limit them in more than one environment, including home, school, and

social settings. A variety of diagnostic questionnaires are used rather than one defining test. Questionnaire assessments tend to evaluate attention span, activity level, cognition, and behavior. Behavior, social, and child relationships and adaptive function are tested. The questionnaires can be completed by the parent, teacher, or peer or through self-input. Research suggests that sensory processing, specifically tactile, visual, and vestibular differences, are related to attention difficulties (Dunn & Bennett, 2002).

The assessment, diagnosis, and management of ADHD usually begins in the primary care setting. In 2000, the American Academy of Pediatrics Committee on Quality Improvement, Subcommittee on Attention-Deficit/Hyperactivity Disorder provided guidelines to help in the diagnostic decision making for children with ADHD (Vlam, 2006). In their recommendations, children ages 6 to 12 that exhibit inattention, hyperactivity, impulsivity, academic underachievement, or behavior difficulties should be evaluated for ADHD.

The diagnosis of ADHD must meet criteria set by the DSM–IV. Parent's evaluation of primary symptoms of ADHD in a variety of settings, age of onset, duration of symptoms, and degree of functional impairment is included. In addition, the child's teacher often completes an assessment that identifies symptoms of ADHD, duration of symptoms, degree of functional impairment, and associated conditions. Other diagnostic tests are often included for the assessment of coexisting conditions (Vlam, 2006).

Although many tools to assess ADHD are used, according to Rader, Mccauley, and Callen (2009), the Conners' Parent Rating Scale is one of the more commonly used assessments (Conners, 1997). This tool assesses oppositional behavior, cognitive problems, and hyperactivity and has an ADHD index. The Conners' Parent Rating

Scale–Revised: Short Form (Conners, 1997) was chosen for this study. It is a questionnaire completed by the parent. This measure is a standardized rating scale of children's behaviors commonly described as symptomatic of ADHD The parent rating forms include a hyperactivity index, a cognitive/inattention problems index, and a combined type index. The scales are scored, and the results are compared with same-age and same-gender peers in the general population. This scale will help to provide additional diagnostic information about the symptoms and identification of subtypes with ADHD. The Conners' Parent Rating Scale provides a screening for internalizing and externalizing disorders that are common co-morbidities to ADHD. The Conners' Parent Rating Scale has the highest rate of being studied and normed measures. It offers optimal interpretation for the child's symptoms of ADHD (Madaan et al. 2008).

## Sensory Processing and Attention-Deficit/Hyperactivity Disorder

Sensory modulation dysfunction is the most common sensory processing dysfunction (Yochman et al., 2004). Sensory processing is a broad term that refers to the reception, modulation, integration, and organization of sensory input to the central and peripheral nervous systems (Yochman et al., 2004). The three major categories of sensory processing are sensory modulation, sensory discrimination, and sensory-based motor function. *Sensory modulation* is the ability to regulate and organize sensory input to allow for the degree, intensity, and nature of responses to have an optimal outcome that is graded and adaptive. Sensory modulation dysfunction has two distinct behavioral patterns. *Sensation seeking* refers to situations in which a child prefers high intensity or increased duration of sensory stimulation. Some behaviors overlap between sensory

modulation disorder that are associated with sensation seeking and ADHD. Emotional behaviors that overlap between ADHD and sensation seeking are general disregard for others, inability to regulate amount of intensity and length of interactions with others, and mania (Mangeot et al., 2001). The second pattern is *sensation avoiding*. The child reacts with "fight or flight" sympathetic nervous responses to harmless sensory input (Mangeot et al., 2001). Some behaviors that overlap between sensory modulation disorder are associated with sensation avoiding and ADHD such as emotional behaviors including aggressive and hostile behaviors or, when overstimulated, anxious, clingy, or withdrawn behaviors (Mangeot et al., 2001).

Cheung and Siu (2009) documented that children with ADHD have more tactile and visual processing issues than children without ADHD. Their research also shows that sensory information coming in and the processing of this information may not happen properly, which affects the child in environments such as their homes, schools, and communities. Their research showed that children with ADHD have greater vestibular sensory differences that affect their ability with movement and skill attainment (Cheng & Siu, 2009).

Children with ADHD share a common deficit in self-regulation. This deficit affects their abilities in information processing, inhibition of responses, arousal, alertness, planning, executive functioning, metacognition, and self-monitoring. Behavioral inhibitions are the main symptom of ADHD. This deficit has a negative effect on the executive function of self-regulation of affect, motivation, and arousal (Miranda, Presentacion, & Soriano 2002). According to Roberts, King-Thomas, and Boccia (2007), *self-regulation* refers to the ability to measure response to specific stimuli, which

includes physiological, emotional, and behavioral factors. These factors are interdependent. People express their differences through their abilities and behavior. The way a person processes sensory information is a source of variation that accounts for individual differences in self-regulation.

Children with ADHD tend to have deficits in overall sensory processing. Research has been completed using physiological measures. One study by Parush, Sohmer, Steinberg and Kaitz (1997) used a physiological measure; somatosensory evoked potentials showed that children with ADHD recorded larger amplitudes than those of typical children. This finding suggests that children with ADHD show deficits in somatosensory functioning (Parush, Sohmer, Steinberg, & Kaitz, 1997). Another physiological measure, electrodermal reactivity, was used in a study by Mangeot et al. (2001) to measure changes in skin conductance when sensory stimulation was provided. This study showed that children with ADHD have differences in sensory reactivity compared with children without the diagnosis of ADHD.

Other studies have reported a relationship between children with ADHD and increased sensitivity to sensory input of tactile, visual, auditory, and taste. In a study by Dunn (1997), the Sensory Profile, a parent questionnaire, was used to determine parents' perception of their children with ADHD and how they respond to sensory events throughout their day across all sensory domains. This study found that children with ADHD and children with autism scored with higher rates of behavior than children without disabilities. With the children diagnosed with autism and ADHD, each diagnostic group scored at higher rates on different items. In a study by Dunn and Bennett (2002), children with ADHD were reported by their parents to demonstrate

behaviors more frequently related to dysfunctions in auditory, touch, multisensory, emotional/social responses, and behavioral outcomes of sensory processing listed on the Sensory Profile.

The DSM–IV (APA, 1994) provides diagnostic criterion for ADHD. The Sensory Profile has items related to the DSM–IV criteria (Dunn & Bennett, 2002). The Sensory Profile groups individual score items into factors. There are eight items on Factor 1 Sensory Seeking, all six items on Inattention/Distractibility, and two items on Factor 9 Fine Motor/Perceptual that relate to the hyperactivity criteria. It is important to consider the factor scores of the Sensory Profile that relate to the core symptoms or characteristic behaviors related to ADHD to better understand the relationship between the two constructs (Yochman et al., 2004).

In a study by Mangeot et al. (2001), the Short Sensory Profile (SSP) was used to compare the occurrence of sensory modulation dysfunction in children with ADHD with a control group of typically developing children. The SSP showed the children with ADHD had significantly lower scores or higher frequency of behaviors on six of the seven subscales. The variability of the SSP was also scored. For the children with ADHD, scores ranged from 77 to 170, showing greater variability than the control group. Twenty of the 26 children with ADHD scored at least one standard deviation below the mean on the SSP. This large degree of variability in sensory processing suggests that although some children with ADHD may have normal responses to sensory input, another group may be hyper reactive and over responsive**.** In 2004, Yochman and colleagues completed a study using a group comparison to identify possible sensory processing differences between children with and without ADHD. The Sensory Profile

was used. The results demonstrated that children with ADHD have significantly different patterns of sensory processing and modulation compared with children without ADHD. According to Mangeot et al. (2001), children with ADHD do not present as a homogeneous group. An explanation is that their responses to sensory stimulation differ according to their type within ADHD.

In summary, sensory processing issues affect many people in their daily lives. Children with ADHD tend to have more sensory processing difficulties than children without ADHD. Physiological measures have confirmed increased sensitivity to sensory input of tactile, visual, auditory, and taste in children with ADHD. Research using the Sensory Profile as a measurement tool groups factors of more than one system to children with ADHD. The results demonstrated that children with ADHD have significantly different patterns of sensory processing and modulation compared with children without ADHD.

This study identifies the relationship between the various sensory symptoms and the types of ADHD, which may help to explain the variability in sensory processing scores. The study provides further support for the relationship between sensory processing dysfunction and ADHD.

# CHAPTER 3
# METHOD

## Setting

This study took place in the eastern section of the United States. Most parents or caregivers were from either a rural or urban settings in Pennsylvania and New Jersey. One participant was from an urban New York setting and another participant was from a rural Florida setting. Parents or caregivers completed questionnaires in their physician's office, at their homes, or at a local informational ADHD conference.

## Participants

The participants were parents or caregivers of children aged 5 to 12 years diagnosed with ADHD and parents or caregivers of children aged 5 to 12 years without a diagnosis of ADHD. Participants were recruited for this study as a convenience sample. The participants totaled 45 with 26 participants in the ADHD group and 19 participants in the non ADHD group. Participants of varying ethnic backgrounds and economic status were included. The first group of participants had to have children diagnosed with ADHD based on the DSM-IV. The second group consisted of parents of children not diagnosed with ADHD or any other known developmental delay. All children were in good physical health. Informed consent was obtained from the parents before the study. The primary researcher obtained approval from Temple University Institutional Review Board before the study.

Exclusion criteria included non-English-speaking participants who were unable to complete and understand questionnaires about their children and children with developmental disability other than ADHD. Participants were not excluded from the

study if they had additional diagnoses along with ADHD, as co - morbid conditions are common in children diagnosed with ADHD.

See Table 1 for the demographics of the sample.

## Procedure

The primary care pediatrician of a large, urban hospital referred children for participation in the study along with a school-based occupational therapist in a large, rural school district. Further, parents of children with ADHD were solicited at a local ADHD information fair, through flyers posted at physician offices, and on a volunteer Web site. The parents of the children who met the diagnostic criteria of ADHD as defined by the DSM-IV completed the questionnaires of the study. Parents of other children who did not have ADHD were referred and solicited by the primary researchers.

A packet was given to parents or caregivers to complete: an informed consent form, a demographic form, and three questionnaires (the SSP Caregiver Questionnaire, the Sensory Processing Measure [SPM], and the Conners' Parent Rating Scale–Revised: Short Form. Parents were informed of their rights and the costs and benefits of the study in the informed consent. Parents completed a demographic form to provide information about their child (Appendix 1). The SSP Caregiver Questionnaire and the SPM were administered to the participants to determine their child's unique sensory processing pattern. As part of the study, the parents completed the Conners' Parent Rating Scale–Revised: Short Form. This is an assessment used to determine the presence of ADHD in a standardized scale. The forms were returned to the student researcher by mail or by direct collection. All forms were coded with a participant number to maintain confidentiality.

Table 1. Demographic Information for the Attention Deficit Hyperactivity Disorder (ADHD) Group and Non-ADHD Group

| | Number in Each Group | |
|---|---|---|
| | ADHD ($n$ =26) | Non-ADHD ($n$ = 19) |
| Demographic | *N*(%) | *N*(%) |
| Gender | | |
| Male | 22 (84.6) | 12 (63.2) |
| Female | 4 (15.4) | 7 (36.8) |
| Diagnosis | | |
| ADHD/ADD | 20 (76.9) | 0 (0) |
| Additional diagnosis | 6 (23.1) | 3 (15.8) |
| No | 0 (0) | 16 (84.2) |
| Medications | | |
| ADHD | 16 (61.5) | 0 (0) |
| Other | 1 (3.8) | 1 (5.3) |
| None | 7 (26.9) | 18 (94.7) |
| ADHD and psychiatric medication | 2 (7.7) | 0 (0) |
| Ethnicity | | |
| African-American | 2 (7.7) | 0 (0) |
| White | 20 (76.9) | 18 (94.7) |
| Latin American | 2 (7.7) | 0 (0) |
| Hispanic | 0 (0) | 1 (5.3) |
| Other | 2 (7.7) | 0 (0) |
| School placement | | |
| Regular education | 10 (38.5) | 18 (94.7) |
| Special education | 3 (11.5) | 0 (0) |
| Learning support | 2 (7.7) | 0 (0) |
| Combined | 4 (15.4) | 0 (0) |
| Regular education with 504 or IEP | 7 (26.9) | 1 (5.3) |
| Services received | | |
| Psychology or psychiatry | 13 (50) | 0 (0) |
| Behavioral | 2 (7.7) | 0 (0) |
| Physical therapy | 1 (3.8) | 0 (0) |
| Speech–language | 7 (26.9) | 1 (5.3) |
| Occupational therapy | 5 (19.2) | 0 (0) |
| Other | 8 (30.8) | 0 (0) |
| None | 5 (19.2) | 18 (94.7) |
| Mean age (months) | 106.15 | 100.47 |

*Note.* ADD = attention deficit disorder; IEP = individualized education plan.

## Instruments

The parents/caregivers completed three standardized questionnaires (the Short Sensory Profile Caregiver Questionnaire (Dunn, 1999), the Sensory Processing Manual (Parham and Ecker, 2007) and the Conners' Parent Rating Scale–Revised: Short Form (Conners, 1997) and a demographic form). The information provided by the demographic form (Appendix 1) included basic information such as name, gender, date of birth, and ethnic background of child. The parents or guardian listed their own name, relation to child, and contact information, their child's diagnosis and current medications, school placement, and list of special services.

### Short Sensory Profile Caregiver Questionnaire

The Short Sensory Profile (SSP) Caregiver Questionnaire is a 38-question, caregiver-completed profile that is standardized and reports the frequency of the child's response to various sensory experiences (Dunn, 1999). Caregivers complete the form by checking a box that best describes the frequency that their child engages in the listed behaviors. Choices are *never* (5 points), *seldom* (4 points), *occasionally* (3 points), *frequently* (2 points), and *always* (1 point). On this scale, lower scores indicate greater symptoms. The SSP categorizes the child's responsiveness to sensory input into the categories: tactile sensitivity, taste/smell sensitivity, movement sensitivity, under responsive/seeks sensation, auditory filtering, low energy/weak, and visual/auditory sensitivity. Internal consistency for the various sections ranges from 0.47 to 0.91 according to Cronbach's alpha coefficient (Dunn, 1999). This coefficient is widely used to assess internal consistency reliability of a psychometric instrument.

## The Sensory Processing Measure

The Sensory Processing Measure (SPM) is another questionnaire to measure sensory processing patterns. It is designed to be appropriate for children ages 5 to 12 years old. The SPM is a norm-referenced tool that assesses difficulties in the areas of overall sensory processing, praxis, and social participation (Parham and Ecker, 2007). Standard scores are also provided for vision, hearing, touch, body awareness, balance and motion, planning, and ideas. The Home Form was completed by parents or caregivers. This form has 75 items and is formatted in a 4-point Likert scale, ranging from *never* to *always*. On this scale, higher scores indicate greater symptoms. The age range for children is 5 to 12. The Home Form questionnaire is standardized on a demographically representative sample of 1,051 typically developing children in grades kindergarten through 6. The median internal consistency was .85 and the median test–retest reliability was .97 (Parham et al, 2007).

According to the SPM (Parham and Ecker, 2007), it used the SSP as a convergent measure. The SSP and the SPM are significantly related in similar content. The SPM for touch was significantly related with the SSP tactile sensitivity. The SPM for hearing was significantly related with the SSP auditory filtering. The SPM scale was significantly related with the SSP total score. The SPM scores demonstrate a strong significant relationship with the Sensory Profile scores (Parham and Ecker, 2007).

## The Conners' Parent Rating Scale–Revised: Short Form

The Conners' Parent Rating Scale–Revised: Short Form was the third questionnaire completed. This measure is a standardized rating scale of children's

behaviors commonly described as symptomatic of ADHD. The parent rating forms include a hyperactivity index, a cognitive/inattention problems index, and a combined type index. The scales are scored, and the results are compared with same-age and same-gender peers in the general population. On this scale, the higher the score is, the greater the symptoms are. This scale helps to provide additional diagnostic information about the symptoms and identification of subtypes within ADHD. Multiple published studies have shown that the reliability and validity for each subscale is excellent (Conners, 1997).

## Data Analysis

The independent *t*-test was the statistical procedure used to determine whether the means of the ADHD and non-ADHD groups were statistically different from each other. Statistical significance is determined by the difference between group means and not on an individual basis. To test the significance, the alpha level ($a$) was set at .05. If $\alpha > .05$, it is significant. A Pearson correlation was calculated to measure the degree of association between the children with ADHD and non-ADHD with the types of sensory processing patterns. A positive correlation means as the scores increase on one measure or variable they also increase on the other. A negative correlation means as the scores increase on measure or variable they decrease on the other (Portney & Watkins, 2009).

# CHAPTER 4
# RESULTS

## Question

What is the relationship between sensory processing patterns and ADHD in children aged 5 to 12 years? Is there a difference in sensory processing patterns between ADHD and non-ADHD in children aged 5 to 12 years?

## Results

A Pearson correlation coefficient determined the strength of the relationships between the variables of types of ADHD, hyperactivity and inattention, as determined by the Connors Parent Rating Scale-Revised and types of sensory processing disorder as measured by the SSP and the SPM (see Table 2). The Pearson correlation coefficient determines the strength of two variables compared with each other. Higher scores on the Connors Hyperactivity and Inattention Scales indicate greater symptoms of hyperactivity and inattention while higher scores on the SSP indicates less sensory issues. Higher scores on the SPM indicate more sensory issues.

A Pearson correlation coefficient was calculated for the relationship between the scores on the total of the SSP and the Conners' Hyperactivity Scale for the ADHD group. A moderate significant negative correlation was found at ($r = –.418$, $p = .000$). The mean of the ADHD group on the SSP was 134.2 ($SD = 21.9$) and 74.9 ($SD = 20$) on the Conners' Hyperactivity Scale. The lower scores on the Short Sensory Profile indicate more symptoms of sensory processing issues while higher scores on the Conners' Hyperactivity Scale indicate more symptoms of hyperactivity.

A Pearson correlation coefficient was calculated for the relationship between the scores on the total of the SSP and the Conners' Inattention Scale for the ADHD group. A moderate significant negative correlation was found ($r = –.391$, $p = .000$). The mean of the ADHD group on the SSP was 134.2 (*SD*= 21.9) and 78.1 (*SD*= 12.3) on the Conners' Inattention Scale. The lower scores on the Short Sensory Profile indicate more symptoms of sensory processing issues while higher scores on the Conners' Inattention Scale indicate more symptoms of inattention.

A Pearson correlation coefficient was calculated for the relationship between the scores on the total of the SPM and the Connors Hyperactivity Scale for the ADHD group. A moderate significant positive correlation was found at ($r = .285$, $p = .000$). The mean of the ADHD group was 61.6 (*SD*= 7.9) and 74.9 on the Conners' Hyperactivity Scale (*SD*= 20). The higher scores on the SPM indicate more symptoms of sensory processing issues with higher scores on the Conners' Hyperactivity Scale indicate more symptoms of hyperactivity.

A Pearson correlation coefficient was calculated for the relationship between the scores on the total of the SPM and the Conners' Inattention Scale for the ADHD group. A moderate significant positive correlation was found at ($r = .338$, $p = .000$). The mean of the ADHD group was 61.6 (*SD*= 7.9) and 78.1 on the Conners' Inattention Scale (*SD*= 12.3). The higher scores on the SPM indicate more symptoms of sensory processing disorder while higher scores on the Conners' Inattention Scale indicate more symptoms of inattention.

A Pearson correlation coefficient was calculated for the relationship between the scores on the subtests of the SSP and the Conners' Inattentive Scale for the ADHD group.

A moderate significant negative correlation was found at ($r$ = –.394, $p$ = .000) on the auditory subtest. The mean of the ADHD group was 61.6 ($SD$ = 7.9) and 78.1 on the Conners' Inattention Scale ($SD$ = 12.3). The lower scores on the Short Sensory Profile indicate more symptoms of sensory processing issues while higher scores on the Conners' Inattentive Scale indicate more symptoms of inattention.

There were no significant relationships found between the subtests of the SSP (tactile sensitivity, taste/smell sensitivity, movement sensitivity, underresponsive/seeks sensation, low energy/weak, visual/auditory sensitivity) and the Conners' Inattention Scale.

A Pearson correlation coefficient was calculated for the relationship between the scores on the total of the SPM and the Conners' Inattention Scale for the ADHD group. A moderate significant positive correlation was found ($r$ = .401, $p$ = .000) for the touch subtest. The mean of the ADHD group was 61.6 ($SD$ = 7.9) and 74.9 on the Conners' Inattention Scale ($SD$ = 12.3). The lower scores on the SPM indicate more symptoms of sensory processing issues while higher scores on the Conners' Inattention Scale indicate more symptoms of inattention.

There were no significant relationships found between the subtests of the SPM (social participation, vision, hearing, taste and smell, body awareness, balance and motion and planning and ideas) and the Conners' Inattention Scale.

Table 2. Pearson Product Moment Correlation Coefficients Between Types of Attention Deficit Hyperactivity Disorder (ADHD) and the Short Sensory Profile and Sensory Processing Measure ($n$ = 26)

| Measure | | Conners' Inattention | Conners' Hyperactivity |
|---|---|---|---|
| Short Sensory Profile | | | |
| Tactile Sensitivity | r | –2.64 | –0.368 |
| | $p$ (two tailed) | 0.193 | 0.064 |
| Taste and Smell | r | –0.004 | –0.275 |
| | $p$ (two tailed) | 0.984 | 0.174 |
| Movement | r | –0.052 | –0.206 |
| | $p$ (two tailed) | 0.799 | 0.311 |
| Underresponsive | r | –0.693 | –0.404 |
| | $p$ (two tailed) | 0 | 0.041 |
| Auditory | r | –0.394 | –0.362 |
| | $p$ (two tailed) | 0.046 | 0.069 |
| Low energy | r | 0.155 | 0.194 |
| | $p$ (two tailed) | 0.45 | 0.342 |
| Visual | r | –0.151 | –0.252 |
| | $p$ (two tailed) | 0.462 | 0.215 |
| Total | r | –0.391 | –0.418 |
| | $p$ (two tailed) | 0.048 | 0.033 |
| Sensory Processing Measure | | | |
| Social | r | 0.398 | 0.514 |
| | $p$ (two tailed) | 0.044 | 0.007 |
| Visual | r | 0.338 | 0.283 |
| | $p$ (two tailed) | 0.091 | 0.161 |
| Hearing | r | 0.053 | 0.205 |
| | $p$ (two tailed) | 0.798 | 0.314 |
| Touch | r | 0.401 | 0.254 |
| | $p$ (two tailed) | 0.047 | 0.22 |
| Body | r | 0.571 | 0.447 |
| | $p$ (two tailed) | 0.003 | 0.025 |
| Balance | r | 0.162 | 0.144 |
| | $p$ (two tailed) | 0.439 | 0.493 |
| Planning | r | 0.638 | 0.547 |
| | $p$ (two tailed) | 0.001 | 0.005 |
| Total | r | 0.338 | 0.285 |
| | $p$ (two tailed) | 0.098 | 0.168 |

$p < .05$

An individual sample *t*-test was used to compare the mean scores of the ADHD and non-ADHD groups (see Table 3 and 4).

An independent sample *t*-test comparing the mean scores of the ADHD and non-ADHD groups found a significant difference between the means of the two groups on the total score of the SSP ($t(43) = -8.012$, $p < .01$). The mean of the ADHD group was significantly lower ($M = 134.2$, $SD = 21.9$) than the mean of the non-ADHD group ($M = 180.2$, $SD = 14.1$). The mean scores indicate that the children with ADHD generally have more sensory issues than the children in the non-ADHD group, since their scores were remarkably lower.

An independent sample *t*-test comparing the mean scores of the ADHD and non-ADHD groups found a significant difference between the means of the two groups on the SPM total ($t(42) = 5.436$, $p < .01$). The mean of the ADHD group was significantly higher ($M = 61.6$, $SD = 7.9$) than the mean of the non-ADHD group ($M = 48$, $SD = 8.7$). The significant difference in the mean scores is indicative of sensory processing difficulties in the children with ADHD. The ADHD children overall had considerably higher scores.

There was a significant difference in the scores when comparing both types of ADHD separately with the non-ADHD scores. For the Conners' Inattention, an independent sample *t*-test comparing the mean scores of the ADHD and non-ADHD groups found a significant difference between the means of the two groups ($t(40.2) = 11.256$, $p < .01$). The mean of the ADHD group was significantly higher ($M = 78.1$, $SD = 12.3$) than the mean of the non-ADHD group ($M = 45.9$, $SD = 6.7$). For the Conners' Hyperactivity an independent sample t-test comparing the mean scores of the ADHD and non-ADHD groups found a significant difference between the means of the two groups

($t(33.9) = 6.727$, $p < .01$). The mean of the ADHD group was significantly higher ($M$ = 74.9, $SD$ = 20) than the mean of the non-ADHD group ($m$ = 46, $SD$ = 7.6).

Table 3. t-tests Comparisons of Attention Deficit Hyperactivity Disorder(ADHD)Group and Non-ADHD Group

| Test | *t* | *df* | Significant (2-tailed) | Mean Difference | *n* |
|---|---|---|---|---|---|
| Short Sensory Profile | | | | | |
| Tactile Sensitivity | –3.067 | 42.9 | 0.004 | –4.354 | 45 |
| Taste and Smell | –2.86 | 42.334 | 0.007 | –3.575 | 45 |
| Movement | –3.783 | 26.773 | 0.001 | –2.342 | 45 |
| Underresponsiveness | –7.39 | 38.969 | 0 | –12.172 | 45 |
| Auditory | –13.224 | 41.293 | 0 | –14.545 | 45 |
| Low energy | –3.09 | 36.255 | 0.004 | –3.504 | 45 |
| Visual | –4.85 | 26.702 | 0 | –5.526 | 45 |
| Total | –8.012 | 43 | 0 | –45.966 | 45 |
| Sensory Processing Measure | | | | | |
| Social | 6.337 | 43 | 0 | 16.664 | 45 |
| Visual | 4.888 | 36.705 | 0 | 11.901 | 45 |
| Hearing | 6.47 | 36.397 | 0 | 14.48 | 45 |
| Touch | 4.146 | 42 | 0 | 12.655 | 44 |
| Body | 7.382 | 42 | 0 | 16.507 | 44 |
| Balance | 4.568 | 41.71 | 0 | 11.642 | 44 |
| Planning | 6.866 | 42 | 0 | 19.286 | 44 |
| Total | 5.436 | 42 | 0 | 13.6 | 44 |
| Conners' Parent Rating Scale | | | | | |
| Inattention | 11.256 | 40.164 | 0 | 32.182 | 45 |
| Hyperactivity | 5.969 | 43 | 0 | 28.923 | 45 |

$p < .05$

Table 4. Group Means between Attention Deficit Hyperactivity Disorder(ADHD) and Non-ADHD Groups

| | ADHD | Non-ADHD |
|---|---|---|
| Test | Mean (*SD*) | Mean (*SD*) |
| Short Sensory Profile Total | 134.2 (21.9) | 180.2 (14.1) |
| Sensory Processing Measure Total | 61.6 (7.9) | 48 (8.7) |
| Connors Inattention | 78.1 (12.3) | 45.9 (6.7) |
| Connors Hyperactivity | 74.9 (20) | 46 (7.6) |

# CHAPTER 5
# DISCUSSION

## Summary of Results

This study posed the following questions: What is the relationship between sensory processing patterns and ADHD in children aged 5 to 12 years**?** Is there a difference in sensory processing patterns between ADHD and non-ADHD in children aged 5 to 12 years?

A moderate significant negative relationship was found between the SSP and the Conners' Hyperactivity Scale for the ADHD group and the SSP and the Conners' Inattention Scale for the ADHD group. The lower scores on the SSP indicate more sensory issues. A moderate significant positive correlation relationship was found between the scores on the SPM and the Conners' Hyperactivity Scale for the ADHD group and the SSP and the Conners' Inattention Scale for the ADHD group. The higher scores on the SPM indicate more sensory processing issues. These finding suggests that children who score high on these ADHD scales have more sensory processing difficulties.

This further supports that children who score high on these ADHD scales have more sensory processing issues. These scores indicate that the children with ADHD generally have more sensory issues than children in the non-ADHD group.

There was a significant difference between the two groups of children with ADHD and non-ADHD on the SSP and SPM total score. Children with ADHD obtained a significantly higher mean score than non-ADHD children, indicating that the children with ADHD generally have more sensory issues than children in the non-ADHD group.

These findings are suggestive that children with ADHD, hyperactive or inattentive type, have more sensory processing difficulties than non-ADHD children.

There was a significant difference between the two groups of children with ADHD on the SSP under responsive subtest. Children with hyperactivity ADHD scored a significantly higher mean score than children with inattention ADHD, which indicates a unique sensory processing pattern for each diagnosis.

There was a significant difference between the two groups of children with ADHD on the SSP auditory subtest. Children with inattention ADHD scored a significantly higher mean score than children with hyperactivity ADHD, which indicates a unique sensory processing pattern for each diagnosis.

Along with this, there was a significant difference between the two groups of children with ADHD on the SSP touch subtest. Children with inattention ADHD scored a significantly higher mean score than children with hyperactivity ADHD, which indicates a unique sensory processing pattern for each diagnosis.

These findings are suggestive that children with ADHD, hyperactive type and children with ADHD, inattentive type have different sensory processing patterns from each other. Results suggest that children with ADHD have significantly more patterns of sensory processing dysfunction.

## Supporting Literature

Results from this study are supported in a study by Cheung and Siu (2009), which concluded that children with ADHD demonstrate sensory processing issues more often than do children without the diagnosis. According to Mangeot et al. (2001), children with

ADHD demonstrated significantly more sensory processing issues than a sample of typically developing children when measured using the SSP. According to Dunn (2007), children with sensory processing issues are more likely to have intense sensory response patterns. Dunn proposed a model in which there are 4 sensory patterns including poor registration, sensitivity to stimuli, sensation seeking and sensation avoiding. Children in the *under responsiveness/seeks sensation* category have poor sensory registration (Reynolds & Lane, 2008). Low energy levels and disinterest in surroundings are characteristics of under responsiveness. Sensory seeking behaviors, which include a high level of activity, can be explained as children attempt to alter their level of arousal. In sensory seekers, inattention, decreased impulse control, and hyperactivity are also described in the ADHD phenotype (Mangeot et al., 2001). Mangeot et al. showed variability in sensory processing scores occurs with children who are diagnosed with ADHD. Mangeot et al (2001) used the SSP and found that children with ADHD had sensory problems in the areas of sensory seeking, auditory filtering, tactile sensitivity, visual/auditory sensitivity, and taste and smell sensitivity. This study concurred with the current findings of the SSP in the subtests of under responsive for Connors inattention and Connors hyperactivity. Sensory issues may affect children with ADHD inattention differently than ADHD with hyperactivity (Mangeot et al., 2001). The study results identified a significant relationship between the SPM subtest for touch and the Conners' Inattention subtest but not a significant relationship with the Conners' Hyperactivity scale. In addition, the SSP subtest of auditory filtering is significantly related to the Conners' Inattention scale but not to the Conners' Hyperactivity scale. This is the beginning of research on a sensory pattern specific for the differing types of ADHD.

The Dunn and Bennett (2002) study used the Sensory Profile, a parent-reporting questionnaire. The purpose of the study was to compare children with a primary diagnosis of ADHD and children without ADHD to determine whether there was a homogeneous pattern of sensory issues for children with ADHD. The Short Sensory Profile consists of 38 items providing scores for 7 sections and 1 total score. The sections include Tactile Sensitivity, Taste/Smell Sensitivity, Movement Sensitivity, Underresponsiveness/Seeks Sensation, Auditory Filtering, Low Energy/Weak, and Visual/Auditory Sensitivity. The findings of this study support the previous findings of the Dunn and Bennett (2002) as the children with ADHD had significantly lower scores on the auditory Sensory Profile subtests. Lower scores on the Sensory Profile mean more frequent behaviors. The study completed by Dunn and Bennett (2002) concluded the subtests of touch, multisensory, emotional/social responses and behavioral outcomes of sensory processing also had significantly lower scores. According to Davies and Tucker (2010), the Dunn and Bennett study in 2002 demonstrated that the items on the Sensory Profile were significant in four of the nine factors, which included sensory seeking, emotionally reactive, inattention/distractibility, and fine motor/perceptual skills.

## Limitations

The study may be limited secondary to factors that contribute to research bias. The first limitation of this study included the use of a convenience sample. Parents were self-selected and may have interest in the research topic in their desire to be included in the study. Another factor was that the effect of medication on sensory processing was not accounted for in data analysis: Nineteen of the 26 children in the ADHD group were on

medication. Children with ADHD may present differently when they are not on medication resulting in possible changes on the scores of the sensory questionnaires. Research has identified that it is likely that medications affecting the nervous system will be related to sensory processing issues (Dunn & Bennett, 2002). The small sample size was represented in one geographical area. Parents of children with ADHD and additional diagnosis were included in the study. ADHD tends to have other related diagnoses, which may influence scores on the measures. For beginning research, specific sensory patterns may be easier to identify in children with ADHD only. Along with this the questionnaires used were based on an individual response as opposed to objective observation of a professional trained in ADHD.

## Further Research

For sensory modulation dysfunction, clear definitions of overresponsivity, underresponsivity, and sensory seeking are needed in order to maintain validity of research. Because sensory integration and sensory processing theories continue to evolve, a single or multiple sensory characteristics or the integration of multiple sensory modalities needs to examined (Davies & Tucker, 2010). Along with this, it would be important to know the relevance of sensory integration as an effective intervention to target sensory issues in children with ADHD.

## Implications

The findings from this study provide evidence that assessments measuring sensory processing are beneficial and necessary in evaluating children with ADHD. Children with ADHD demonstrate a sensory processing difference from children without

ADHD. In addition, children with ADHD may not present as a homogeneous group. From a sensory perspective, a child with ADHD hyperactivity may present differently from a child with ADHD inattention. A caregiver questionnaire can help parents by providing more information about their child's sensory processing needs. This information would be useful for intervention planning.

## Conclusion/Summary

The results of this study demonstrate that children with ADHD present with significantly more sensory processing difficulties than do children without the diagnosis of ADHD. When children are diagnosed with ADHD, a sensory processing evaluation tool should be added to the assessment battery**.** Another key point this study found was that different types of ADHD may have different sensory patterns. Education about sensory processing and how it manifests is important for individuals interacting and working with ADHD considering: caregivers, educators, and therapists.

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# APPENDIX A

**Demographic Form**

**Today's Date:** _____

**Name of Child:** _____

**Gender:** _____

**Date of Birth:** _____

**Parents or Guardians:** _____

**Person completing this form:** _____

**Contact Information (address and phone contact):**

**Ethnic Background of your child:**
**____African American**
**_____Asian**
**_____ Caucasian**
**_____Latino/Latina**
**_____Native American**
**_____ Other (Please describe _____)**

**Diagnoses of your child (please include all diagnoses):**

**Medications:**

**School Placement (i.e. regular education with or without supports, resource room, special education):**

**Please list all special services (i.e. psychological supports, occupational, physical, and/or speech therapy, behavior support services, etc.) that the child has received and provide dates and places of where the child receives or received these services.**