

Latest Physiological Research Validating Sensory Processing Difficulties in Children

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Sensory Processing involves the brain's ability to take in, organize and make sense of different kinds of sensation received by the brain in order to participate successfully in daily activities. Sensory Processing Disorder (SPD) is a developmental disorder historically referred to as Sensory Integration Dysfunction. Originally conceptualized by Dr. A. Jean Ayres,¹ occupational therapist and neuroscientist, the theory of sensory integration hypothesizes that a relationship exists between deficits in processing sensation from the body and from the environment resulting in difficulties in motor, learning, and/or functional patterns of behavior.² Children with sensory processing difficulties often suffer from impaired self-esteem, anxiety, depression, or aggression, that affect social participation.²⁻⁴ Ayres' intervention model, also called sensory integration, is based on theories of neural plasticity and environmental enrichment as well as evolving research in neuroscience, motor control and motor learning.^{2,5} Occupational therapy intervention uses enhanced sensory experiences within a playful, goal-directed context to produce successful responses to environmental challenges. The intended outcome is improvement in social participation, self-esteem, self-regulation, and sensorimotor abilities needed for daily life tasks.^{2-3,6}

SPD has recently become the proposed terminology for this condition in order to distinguish the disorder from the theory and from the intervention.⁷ Although not yet accepted in the Diagnostic and Statistical Manual (DSM), SPD is recognized by and included in the *Diagnostic Manual for Infancy and Early Childhood of the Interdisciplinary Council on Developmental and Learning Disorders*⁸ and the *Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood, Revised* (know as the DC: 0-3R).⁹ Three primary diagnostic groups are categorized within this global umbrella term in order to facilitate communication amongst parents and professionals as well as ensure homogeneity of samples for research.⁷

1. Sensory modulation disorder (SMD): refers to difficulty regulating and organizing responses to sensory input. The three subtypes of SMD are listed below. Responses may vary depending upon the type of sensory input and context.
 - Sensory Overresponsivity: is a tendency to respond to sensory input faster, more intensely and for a longer duration
 - Sensory Underresponsivity: is a tendency to not respond to sensory input
 - Sensory Seeking/Craving: is a tendency to crave intense and an unusual amount of sensory input.⁷
2. Sensory Discrimination Disorder (SDD): refers to difficulty interpreting the qualities of sensory information
3. Sensory-based Motor Disorder (SBMD), which has two subsets:
 - Postural disorder is a problem with posture and postural control as a result of sensory problems.
 - Dyspraxia is a problem in planning, sequencing, and executing novel motor actions as a result of sensory problems.

SPD is considered a disorder when it impacts a child's ability to perform daily routines or roles.⁷

Current research efforts are directed toward inclusion of SPD in the upcoming revision of the DSM scheduled for publication in 2012. The focus is on the following areas: 1. Identifying biological markers of SPD, 2. Developing a 'gold standard' for evaluating SPD- Sensory Over-Responsivity and Sensory Under-Responsivity, 3. Differentiating SPD from ADHD, Anxiety disorder, Autism Spectrum Disorder or other disorders that present with similar symptoms, and 4. Identifying the prevalence of sensory symptoms from both prospective community samples and retrospective twin studies. Additional efforts are directed toward study of the effectiveness of occupational therapy using a sensory integration approach.¹⁰

A preliminary study of prevalence reports atypical behavioral responses to sensory input using the Short Sensory Profile, a functional parent-report measure of sensory modulation.¹¹ Based on survey data using this measure, the prevalence of children with SPD exhibiting atypical sensory responsivity is conservatively estimated to be 5%.¹² The literature reports atypical responsivity to sensory stimuli¹³⁻¹⁶ may be as high as 95% in individuals with autism.¹⁷ Atypical responses to sensory input are also reported in children with Fragile X syndrome and ADHD¹⁸⁻²⁰ and are reported in children with SPD without co-morbid diagnoses.^{11, 21} Abnormal sensory reactivity is found to have a significant relationship with overall problems in adaptive behavior.¹⁵

Psychophysiological research suggests that children with SPD have difficulty regulating responses to sensory information as reflected by functions of the Autonomic Nervous System. The Autonomic Nervous System (ANS) plays a major role in the regulation of behavior to maintain a steady internal environment in response to changing external conditions. Electrodermal activity (EDA), a marker for sympathetic nervous system functioning, and cardiac vagal tone index (VT), a marker for parasympathetic nervous system, are used to reflect sensory reactivity. Electrodermal activity (EDA) is measured by recording the sweating response and Vagal tone (VT) is measured by recording heart rate variability. In a laboratory paradigm called the Sensory Challenge Protocol, EDA and VT are measured in response to various sensory experiences including tone, strobe light (visual), siren (auditory), wintergreen smell feather (touch) and chair tipping (movement) stimuli. Children with sensory processing difficulties show atypical electrodermal activity (EDA) across these sensory domains that are significantly different from the EDA of typically developing children after the same sensory experiences.¹¹ High parasympathetic activity is associated with self-regulation and homeostasis and the ability to adapt to changing stimuli.²² Children with sensory processing impairments have decreased vagal tone (low parasympathetic activity) when presented with sensory stimuli.²²⁻²³ According to Miller,²⁴ this is consistent with previous research that shows a relationship between impaired parasympathetic functioning and developmental delays or emotional and behavioral over reactivity.

A measure of brain activation during the processing of sensory information also shows differences between children with SPD and typically developing children. Electroencephalography (EEG) and event-related potentials (ERP), measures of electrical activity in cortical regions of the brain, are used in a sensory gating paradigm to differentiate children with SPD from typically developing controls. Sensory gating refers to the brain's ability to suppress repeated, irrelevant sensory stimuli. The children with SPD are either hypersensitive or hyposensitive to this auditory stimuli, suggesting that children with SPD cannot filter out irrelevant auditory input like typically developing children. Children with SPD do not show a significant relationship between sensory gating and age which was seen in the age-matched control group. In addition, brain responses from the children with SPD were less organized and showed considerable variability compared to the responses of the control group. Such research suggests that sensory processing difficulties in children with SPD are related to central nervous system dysfunction and provides empirical data to support the validity of SPD.²⁵

Although there are many treatment effectiveness studies on sensory integration, most of these studies lack scientific rigorous methodology. A pilot randomized clinical trial examining the effectiveness of occupational therapy using a sensory integrative approach, compared to an active placebo, shows significant improvement in a group of 24 children with sensory modulation disorder.²⁶ Findings show the group receiving occupational therapy had higher scores on the Attention subtest and the Cognitive/Social composite of the Leiter International Performance Scale-Revised and on Goal Attainment Scaling, compared to the wait list or placebo groups. Improvement trends on the Short Sensory Profile, the Child Behavior Checklist, and electrodermal reactivity in the hypothesized direction are also reported.²⁶

Rigorous research is underway to replicate such studies with a larger sample size and to further explore the underlying mechanisms of the disorder, to identify the phenotype(s), and to discriminate this disorder from other developmental disorders.¹⁰

A scientific workgroup spearheaded by Lucy Miller, PhD, OTR, comprised of not only occupational therapists but psychologists, basic scientists, and physicians from prestigious institutes, is contributing to this body of research. The American Psychiatric Association committee is seriously considering an application to include Sensory Processing Disorder (SPD) in the 2012 revision of the Diagnostic and Statistical Manual (DSM-V). The following members of the scientific workgroup, in collaboration with the SPD Foundation, are focusing on the current agenda:

1). Identifying Biological Markers of SPD

Barbara Brett Green, PhD, Director of the Psychophysiology Lab at the SPD Foundation, is studying the neural responses to multisensory audio-tactile stimuli in children with SPD and comparing these responses to typically developing children of the same age-range. The primary goal of this project is to identify biological markers specific to SPD as well as compare the neurobiology of SPD from other groups (e.g. typical, ADHD, autism, etc) to differentiate the neurobiology of SPD from other disorders.

2. Development of the Sensory Processing Scales

Sarah A. Schoen, PhD, OTR, Director of Applied Research at the SPD Foundation, is leading efforts to develop a "gold standard" measure of SMD subtypes. The measure includes a Performance Assessment administered directly to the child and an Inventory Checklist that is completed by the caregiver. Reliability and Validity studies are underway.

3) Differentiating SPD from other childhood diagnoses such as ADHD, Autism, Anxiety Disorder, etc.

H. Hill Goldsmith, PhD, at the University of Wisconsin-Madison has a large sample of twins who were screened for sensory symptoms over the past 4 years. Within this community sample of twins, the prevalence of SPD will be compared to those with other diagnoses (ADHD, Autism, Anxiety).

Alice S. Carter, PhD, at the University of Massachusetts has a birth cohort in New Haven. She will be using the Sensory Processing Scale Checklists to also study the incidence of SPD compared to other diagnoses (ADHD, Autism, Anxiety) based on a prospective community sample.

4) Case Studies Project

Ed Goldson, MD, at the University of Colorado Health Sciences Center and The Children's Hospital will be identifying children with SPD and then conducting a thorough evaluation by a

pediatrician, a psychiatrist and a psychologist to rule in/out other diagnoses. The goal is to identify 'pure' cases of children with SPD who do not have other co-morbid diagnoses.

This research is essential toward better understanding of the underlying mechanisms of sensory processing problems and will contribute to best practice related to diagnosis and treatment. The goal is to improve the quality of life for families and their children. For more information on research in this area to help children with sensory processing deficits, please visit:

<http://www.spdfoundation.net>.

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