**SENSORY PROCESSING DISORDERS IN INFANTS AND CHILDREN**

**(2 CE HOURS)**

**Learning objectives**
- Define sensory integration.
- Define sensory integration dysfunction.
- Define sensory processing disorder (SPD).
- Explain why sensory integration is vital to development.
- Identify infants and children who may be at higher risk for sensory issues.
- Identify diagnostic criteria for sensory processing disorder in infants and children.
- Distinguish between SPD and other disorders.
- List complications of SPD and co-morbidity.
- Describe assessment tools for parents and providers.
- List available interventions.

**Introduction**

Sensory integration refers to people’s ability to use their senses (sight, touch, taste, sound, proprioceptive and vestibular) to interpret sensory input received from the environment and internal cues, and then react in a way to have meaningful and purposeful interactions with the world around them. The development of sensory integration skills begins at birth and continues throughout a lifetime. Sensory integration is a neurological activity that occurs in the brain centers responsible for processing a particular type of sensory information. For most, this activity occurs without much thought, but it is not unconscious. For some, it is a challenge that can begin in infancy and pervade every aspect of daily living, making even the simplest task of combing one’s hair a challenge.

Sensory problems occur when sensory input does not flow in the regular pattern when the nervous system processes it. Somewhere in the process, the signals are jammed or misrouted, and the outcome is a system that is out of sync and confused. The manifestation of this issue is very dependent on the sense or senses that are affected. The individual’s behavioral responses and feelings also play a strong role in the manifestation of this issue. An individual with sensory problems can exhibit clumsiness, motor and speech difficulties, behavioral problems, depression, anxiety, failure in school, the appearance of being “lazy” or “detached,” and other issues that can have a major impact on participating in everyday life in a meaningful way.

Why should mental health professionals be knowledgeable about sensory processing disorder (SPD)? It is currently estimated that one in 20 children will be affected by SPD significantly enough to impair their everyday functioning (Sensory Processing Disorder, 2010). As we are able to gain more knowledge about sensory integration processes through research, we are able to provide more effective assistance to families and gain more effective interventions for neuro-developmental problems like SPD.

The cause of SPD is currently unknown, but what we do know is that there may be a genetic link; that it may be an effect of birth or pregnancy complications; and that environmental factors can also play a role (Sensory Processing Disorder, 2010). It is crucial for clinicians to be aware of this complicated and often misunderstood diagnosis and its enormous impact on those diagnosed and their families.

**Sensory integration defined**

Sensory integration refers to an individual’s ability to organize, integrate and process sensory information received from inside the body and from the external environment to produce purposeful and goal-directed responses (Reed, 2001). Sensory integration is a neurological process that utilizes the five basic senses of taste, touch, smell, hearing and vision to tell the body how to function in the environment. There are other recognized senses such as vestibular sense, which refers to balance and the sense of movement, as well as proprioception, which refers to the sense of knowing one’s position in space (Eide, 2003) (Reed, 2001).

Inputs from the different sensory organs are believed to be processed in different areas of the brain. The communication that occurs within and between these specialized areas is called functional integration. Different parts of the brain are responsible for processing specific sensory input. For example, the temporal lobe is responsible for the senses of smell and sound. More recent research is showing that it may be even more complex than that, with different areas of the brain responsible for more than one type of sensory input, working together and in an integrative way rather than working independently with static functions (Wheble and Hong, 2006) (Mauer, 1999).

The environment and an individual's senses are constantly interacting to answer questions such as, Who am I? What is happening around me? Where am I? What am I doing? What do I want? How will or should I react? When one reacts to answer all these questions, it is not done individually, but in an integrative fashion.

For most individuals, sensory integration is an unconscious activity that occurs without much effort or conscious thought. We are able to quickly take in sensory input from multiple modalities, then process and assign meaning to the input and respond appropriately. An example of this may be a mother washing dishes, and while doing so listening to her child recount the events of her day at school. This mother is able to hear, understand and respond to her child, all the while doing dishes, and may even find herself finished with all of the dishes done and not realizing she had completed the whole task while talking with her child. This mother did not have to think about how to apply dish soap to the sponge or the correct pressure to apply depending on what type of dish she was washing or how dirty it was. If a dish fell from her grip or her child gasped while recounting her school day story, this mother might have stopped and focused attention on this unexpected event, but otherwise, she would go on with her normal activity. This is an example of normal sensory modulation. This is the ability of the nervous system to regulate its own activity and to generate responses graded in an appropriate way to the sensory stimuli coming in, rather than under- or overreacting to them (Reed, 2001).

**Sensory integrative dysfunction**

Sensory integrative dysfunction (SID) occurs when there is a problem encoding the information received from the senses. This term was coined by Dr. A. Jean Ayers in the 1970s. Dr. Ayers was an occupational therapist and psychologist who was the first to describe sensory integration issues in the clinical sense. She devoted her career to the study after her work with and observations of children with learning disabilities. She noticed these children displayed perceptual, sensory and motor difficulties (Schaaf and Miller, 2005). These types of dysfunctions disrupted the children’s day-to-day functions at home, in school and during play and affected attention and arousal (by way of hyperactivity or hypoactivity), movement, speech, balance, and auditory and visual perception (Eide, 2003).

Dr. Ayer’s theory stands on the basic premise that there is plasticity in the central nervous system. There are five additional assumptions of sensory integration theory that have been used as the foundation for much of the research and resulting practice and interventions used today (Paul, et al., 2003).

1. Through the provision of controlled tactile, vestibular and proprioceptive sensory inputs the ability of the brain can be modified.
2. Sensory integrative process occurs in a developmental sequence.
3. The brain functions as an integrated whole, but is comprised of systems that are hierarchically organized. Higher-level brain functions evolved, formed and are dependent upon the lower level sensorimotor experience.
4. Evincing an adaptive behavior promotes sensory integration. An adaptive behavior is one that is purposeful and goal-directed, and it enables the individual to successfully meet the “just right” challenge and learn something new.
5. People have an inner drive to develop sensory integration through participation in sensory activities.

**Sensory processing disorder**

Today the term sensory processing disorders (SPD) has replaced “sensory integration dysfunction,” and since the pioneering work of Dr. Ayers, has been expanded upon as more research about how the brain and senses function together became available. Sensory processing disorder is a neurological diagnosis. Unlike individuals with a physiological disorder...
such as blindness, SPD individuals receive sensory information, but the information is processed by the brain in an atypical way that can cause distress or confusion (Mauer, 1999). Sensory processing disorders form a continuum from hyper-responsivity on one end to hypo-responsivity at the other (Reed, 2001).

SPD is characterized by three primary diagnostic groups:

**Type I:** Sensory modulation disorder (SMD) – Over- or under-responding to sensory input or seeking sensory stimuli.

**Type II:** Sensory-based motor disorder (SBMD) – Motor output that is disorganized as a result of incorrect sensory processing of information.

**Type III:** Sensory discrimination disorder (SDD) – Challenges of postural control or sensory discrimination, and/or dyspraxia.

Sensory modulation refers to the central nervous system’s ability to regulate its own activity in a way that is appropriately graded to incoming sensory stimuli (Reed, 2001). Therefore, a disorder of sensory modulation refers to the system’s over- or under-responses to sensory stimuli because of an inability to regulate its own activity.

Sensory defensiveness is a reaction of hypersensitivity. An individual with this issue would likely be overwhelmed by an ordinary sensory stimulus and act defensively with a fight-or-flight response or a negative emotional reaction. While any sensory system can be involved in these types of problems, the most information known about this type of response is in tactile defensiveness and gravitational insecurity (Reed, 2001).

Sensory registration problems are a reaction of hyposensitivity. An individual with this issue would likely fail to attend to an ordinary sensory stimulus, have poor attentional focus and overfocus on an irrelevant stimulus (Reed, 2001).

Unfortunately, there is still not a full understanding of how the mechanism of sensory modulation works, making it difficult to pinpoint the cause of these types of issues. What we believe is that the limbic system is involved in processing sensory stimuli, and sensory issues arise when the central nervous system fails to properly modulate incoming stimuli to an acceptable level for the individual (Reed, 2001).

Below is a list of fundamental facts about SPD that may help in both understanding SPD and differentiating between other diagnoses (SPD Foundation, 2010):

**Ten fundamental facts about SPD**

1. Sensory processing disorder is a complex disorder of the brain that affects developing children and adults.
2. Parent surveys, clinical assessments and laboratory protocols exist to identify children with SPD.
3. At least 1 in 20 people in the general population are affected by sensory processing disorder.
4. In children who are gifted and those with ADHD, autism, and fragile X syndrome, the prevalence of SPD is much higher than in the general population.
5. Studies have found a significant difference between the physiology of children with SPD and children who are typically developing.
6. Studies have found a significant difference between the physiology of children with SPD and children with ADHD.
7. Sensory processing disorder has unique sensory symptoms that are not explained by other known disorders.
8. Heredity may be one cause of the disorder.
9. Laboratory studies suggest that the sympathetic and parasympathetic nervous systems are not functioning typically in children with SPD.
10. Preliminary research data support decades of anecdotal evidence that occupational therapy is an effective intervention for treating the symptoms of SPD.

**Sensory integration and development**

The senses are the building blocks for learning. Sight, smell, touch, taste, sound, body awareness and gravitational awareness all contribute to the human learning process from birth throughout the lifespan. The development of sensory integration skills is vital at every stage and type of development. Sensory integration theory states that when an infant is able to successfully meet the challenges of his or her environment, the brain increases its ability to organize sensations for the production of more complex adaptive responses (Paul, et al., 2003). In essence, as the infant demonstrates mastery responses to the internal and external stimuli presented, the brain gets ready for the next, more complex adaptive response that will be needed to be successful in normal sensory development. Sensory integration is responsible for the proper development of perceptions, sensations, behavior organization, understanding the individual’s relationship between gravity and the environment, and learning from external stimuli (Paul, et al., 2003).

One of the first things we should expect to see in an infant’s sensory development is the understanding of body position and movement in space. When this occurs successfully, the result might be seen as an infant feeling comforted when cuddled or snuggled by her mother. Another example would be an infant understanding the feeling of having her head tilted backwards during feeding time. These are normal adaptive responses that infants display as they are learning about the environment around them and their own responses to it. A baby may show increased environmental sensitivity when she is ill or may cry after being awake for a certain amount of time or when her diaper is wet. An infant learns about the environment first through the primary caregiver, then as she is able to use internal and external cues more independently, is able to interact, learn and self-regulate with less dependence on the caregiver.

Dr. Winnie Dunn is a leading researcher in sensory processing and one of the first to teach sensory integration theory, testing administration and interpretation (Kentucky Occupational Therapy Association, 2010). Dunn’s theory of sensory processing helps explain how this process occurs during development. According to this theory, there are four areas involved in processing: neurological thresholds, which can be low or high; and self-regulation, which can be passive or active.

Neurological thresholds are a construct of the nervous system and are on a continuum. Stimulation will activate a threshold somewhere along the continuum depending on the individual’s threshold range. Someone with a low threshold will notice and respond to a stimulus often, whereas someone with a high threshold may actually miss the stimulus altogether because it takes longer for that stimulus to activate the threshold. One person may have a high threshold to sounds but have lower thresholds for touch. This means the person may not pick up on the same noises as most others would hear, but would be very sensitive to touch. Dunn and her colleagues further tested this theory and found that these processing patterns occur in every age group, and that those with disabilities such as autism, attention deficit/hyperactivity disorder, schizophrenia, Asperger’s syndrome, and developmental and learning disabilities have not only distinctive, but also more intense sensory processing patterns as compared with those without disabilities (Dunn, 2007).

Self-regulation is a behavioral construct that is also on a continuum. An individual uses passive behavioral strategies on one end, and on the other, more active behavioral strategies. Someone with a passive self-regulation response may stay in a noisy environment that he or she finds unpleasant. Someone with an active self-regulation response would get up and move from the area of discomfort until he or she was in a comfortable sensory environment.

Four basic patterns of sensory processing emerge when the two continua explained above intersect. These are the extreme of the relationships between the two ends (Dunn, 2007).

These patterns are:

- **Sensation seeking** – High thresholds and an active self-regulation response.
- **Sensation avoiding** – Low thresholds and an active self-regulation response.
- **Sensory sensitivity** – Low thresholds and a passive self-regulation response.
- **Low registration** – High thresholds and a passive self-regulation response.

Most children and adults use more than one pattern, depending on the sensory system involved. Most can also adapt their responses in a way to be able to perform daily tasks and interact in the environment. Those who are on
the extreme of the continuum of thresholds and self-regulation responses are at risk for individual processing patterns to interfere with daily living. Being knowledgeable about how sensory processing occurs, and even more specifically, being able to identify how an individual processes sensory stimuli can help professionals and caregivers meet a child’s specific needs and allow opportunities for success (Dunn, 2007).

Infants and children at risk for sensory issues
Below is a quick snapshot of the prevalence of SPD in the population and who might be at higher risk for the disorder (May-Benson, Koomar, and Teasdale, 2006):

■ Prevalence:
  □ 73 percent are males.
  □ 5-13 percent of children entering school.  
  □ 40-88 percent of children with autism.

■ A study conducted by May-Benson, Koomar, and Teasdale (2006) of 1,000 children with SPD conservatively estimated prenatal and birth problems:
  □ 42 percent complications during labor or delivery.
  □ 32 percent delivered by assisted delivery methods.
  □ 25 percent mothers had infections or illnesses during pregnancy.
  □ 13 percent were pre-term, less than 37 weeks.
  □ 5 percent had cord wrap/prolapse at birth.

■ Estimated early childhood health problems:
  □ 62 percent chronic ear infections.
  □ 40 percent allergies or asthma.
  □ 27 percent experienced serious injuries or illnesses.
  □ 25 percent jaundice at birth.
  □ 20 percent colic as infants.

■ Developmental findings:
  □ 47 percent went through the “terrible two’s” late or not at all.
  □ 33 percent had strong positioning preferences as infants.
  □ 32 percent had feeding problems.
  □ 31 percent had sleeping problems.

Diagnostic criteria for sensory processing disorder (SPD) in infants and children
Diagnosis of SPD is increasing among pediatricians, neurologists and child psychologists. There are a variety of terms used for SPD, which may lead to some confusion, but they all in essence refer to the same disorder. Other terms used to describe the disorder may be sensory-regulatory dysfunction, sensory-integrative disorder or dysfunction, or sensory-integration disorder or dysfunction. Sensory processing disorder is not at this time recognized by the DSM-IV; however, the meaning falls under the criteria for Asperger’s syndrome. An important point to note is that sensory processing disorder has made the final list for new disorders being considered for recognition in the 2013 revision of the Diagnostic and Statistical Manual (SPD Foundation, 2010).

Regulatory-sensory processing disorder (RSPD) is now an accepted diagnosis in the Diagnostic Manual for Infancy and Early Childhood. Below is the diagnostic information according to the Diagnostic Manual of the Interdisciplinary Council on Developmental and Learning Disorders (ICDL) (ICDL Work Groups, 2005):

■ 200. Regulatory-sensory processing disorder:
  □ Sensory modulation challenges (Type I):
    201. Over-responsive, fearful, anxious pattern.
    202. Over-responsive, negative and stubborn pattern.
  □ Sensory discrimination challenges (Type II) and sensory-based motor challenges (Type III):
    205. Inattentive, disorganized pattern.
    206.2 With sensory discrimination challenges.
    206.3 With dyspraxia.
    206.4 With combinations of 206.1-206.3.
  206. Compromised school and/or academic performance pattern.
    206.1 With sensory discrimination challenges.
    206.2 With postural control challenges.
    206.3 With dyspraxia.
    206.4 With combinations of 206.1-206.3 contributing sensory discrimination and sensorn-based motor challenges.
  207. Mixed regulatory-sensory processing patterns.
    207.1 Attentional problems.
    207.2 Disruptive behavioral problems.
    207.3 Sleep problems.
    207.4 Eating problems.
    207.5 Elimination problems.
    207.6 Elective mutism.
    207.7 Mood dysregulation, including bipolar patterns.
    207.8 Other emotional and behavioral problems related to mixed regulatory-sensory processing difficulties.
    207.9 Mixed regulatory-sensory processing difficulties where behavioral or emotional problems are not yet in evidence.

A regulatory disorder of sensory processing is an accepted diagnosis of the Zero to Three Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood: Revised Edition (DC: 0-3R). According to the DC: 0-3R, this diagnosis refers to an infant or child’s difficulties in regulating emotions, behaviors and motor abilities in response sensory stimulation. These difficulties lead to impairment in development and functioning. The characteristic patterns of behaviors related to this disorder manifest across settings and within multiple relationships. There are three features that must be present in order to diagnose regulation disorders of sensory processing:
  1. Sensory processing difficulties.
  2. Motor difficulties.
  3. A specified behavior pattern.

It is important that the clinician ensure all three characteristics are present because some of these may be present in other classifications. This and other disorders may co-occur with and overlap to a certain degree.

Below is the diagnostic information for regulatory disorders of sensory processing as outlined in the DC: 0-3R (Zero to Three, 2005):
  400. Regulation disorders of sensory processing.
    410. Hypersensitive.
    411. Type A: Fearful/cautious.
    412. Type B: Negative/defiant.
    420. Hyposensitive/under-responsive.
    430: Sensory stimulation seeking/impulsive.

Differentiating SPD from other disorders and dealing with co-morbidity
Sensory processing disorder by nature is complex. It has been shown to be a unique disorder and can be diagnosed without any co-morbid conditions, although symptoms can be very easily confused with those of other childhood disorders. SPD sometimes is overlooked or “lumped in” with other disorders of childhood. For example, children with symptoms of SPD can easily be misdiagnosed as having an attentional disorder. The same can occur with a child displaying symptoms that may look like SPD but are in fact that of an attentional disorder. A child may have simple attention problems due to boredom or being distracted, but be referred for a sensory processing disorder evaluation. Symptoms of SPD and other disorders often do overlap, and in addition, co-morbidity often does occur between this and other medical and emotional and attentional diagnoses (SPD Foundation, 2010). The mental health professional will need to have a clear understanding and take the time needed to review SPD, compare and contrast with any other possible disorders using differential diagnosis and provide an accurate diagnosis.

Sensory processing disorder has been linked to many other conditions, some of which are autism spectrum disorders, attention deficit disorder, dyslexia, Tourette syndrome, speech delays, Asperger’s and Fragile X syndromes, learning...
disabilities, language disorders, anxiety disorder, depression and post-traumatic stress disorder. It is easy to see where confusion may arise among professionals with so many associated disorders. There are a few disorders that are very closely associated with SPD, and this is where clinicians may need to focus to make a proper diagnosis. Studies have shown that co-morbidity of this disorder in children diagnosed with autism is very high; more than three quarters of the children diagnosed with autism will also have SPD. The converse however, is not true. It has also been shown that 40-60 percent of children with either SPD or attention deficit disorder will also have the alternate diagnosis (SPD Foundation, 2010).

Another group that has been a very recent focus area within the realm of associations with SPD is gifted children. One study showed that significant SPD symptoms were prevalent in 35 percent of the gifted children who were tested. In addition, it was found that these children also may have had other co-existing disorders, such as a learning disability (Jarrard, 2008).

Assessment tools for families and professionals
The assessment of sensory issues primarily occurs through observation and primary caregiver report. There are many formal and informal tools available to assist families and professionals in assessing sensory processing issues. In many cases, the professional conducting the standardized testing will be an occupational or physical therapist. However, assessment would be most beneficial using a multidisciplinary approach pooling information from multiple resources. Assessment and evaluation should include medical and developmental history; observation and interview with primary caregiver, including the school environment if applicable (to determine whether the child’s ability to organize and interpret sensory information is interfering with daily life); and the utilization of standardized testing (Mauer, 1999). The clinician should be sure to get a clear understanding of symptoms to gear testing to the areas of concern. Quality of life is an important factor when gathering information. The clinician should understand how the presenting problems affect psychosocial functioning, learning difficulties, communication problems and daily living issues (Kinnealey & Miller, 1993).

Historic or current developmental information is also vital to a thorough assessment. The clinician should be sure to understand not only birth information including any complications, but also pregnancy information and any related issues. In addition, family relational issues will need to be evaluated to include risk as well as protective factors. Developmental milestones in motor, communication, cognitive and socio-emotional functioning should be assessed as well as behavior and functioning. Clinical skills and observations are key components in assessments because there are certain areas of sensory integration functioning that are observed, not derived from standardized tests. Clinicians should have a general understanding of these areas. For example, muscle tone, reflex integration, co-contracting skills, crossing the mid-line, tactile defensiveness and anti-gravity reactions are all areas that require clinical observation skills and are not specifically measured by any testing method. These observations should occur across settings and over time (Miller, Robinson, and Moulton, 2008).

In addition to observation, there are a number of standardized tests used as part of the assessment process. One commonly used psychometric scale available, named the Sensory Profile, was created by Dunn, a leading sensory processing researcher (Kentucky Occupational Therapy Association, 2010). This tool consists of 125 items that are divided into eight areas of sensory processing: auditory, visual, taste/smell, movement, touch, activity level, body position and emotional/social. There are subscales for each area with anywhere from three to 21 items where parents are asked to rate the frequency the behavior is displayed. A 5-point Likert-type scale is used for rating the behavior (Zeenah, 2005). The behavior question is presented as a statement such as, “can’t work when there is background noise” (Atchinson, 2007). Parents rate children as:

1. Always engaging in the behavior.
2. Frequently engaging in the behavior.
3. Occasionally exhibiting the behavior.
4. Seldom exhibiting the behavior or exhibiting 25 percent of the time.
5. Never exhibiting the behavior (Zeenah, 2005).

The scores of each category are converted to a classification of the behavior as “typical,” “probable difference,” or “definite difference.” The “typical” classification denotes a child without sensory processing difficulties. The “probable difference” classification denotes some level of difficulty with sensory processing tasks. The “definite difference” classification denotes a significant level of sensory processing difficulties. The tool is intended to be utilized in addition to observations by a professional in multiple natural contexts and in discussion with the caregiver. One drawback of this tool is that it was tested and designed with children without disabilities.

A standardized test often used is called the Sensory Integration and Praxis Test (SIPT). This test has been shown over time to be both reliable and valid. Those who administer this exam require specialized training and extensive experience in pediatrics as well as some experience in statistics and measurement (Kinnealey and Miller, 1993).

The SIPT is a battery of 17 subtests that provide the examiner with detailed information on the sensory integrative status of children age 4 years through age 8 years, 11 months. It takes about 90-120 minutes for administration, depending on the child’s age and the examiner’s experience level (Kinnealey and Miller, 1993). The exam’s publisher, Western Psychological Services, scores the exam. All of the subtests require performance by the child; none are rated by verbal report.

The test was created by Dr. A. Jean Ayers, the individual who created sensory integration theory. The tests she created primarily focused on the ability to detect position and movement in space (vestibular processing), ability to sense body position (proprioceptive processing), tactile perception, praxis (motor planning skills), visual perception (hand-eye coordination and visual discrimination), and other abilities (Kinnealey & Miller, 1993).

The subtests are categorized into four groups as follows:

- Measures of tactile and vestibular-proprioceptive processing:
  - Kinesthesia (KIN)
  - Finger identification (FI)
  - Graphesthesia (Gra).
  - Localization of tactile stimuli (LTS).
  - Postrotary nystagmus (PRN).
  - Standing and walking balance (SWB).

- Measures of form and space perception and visual-motor coordination:
  - Space visualization (SV).
  - Figure-ground perception (FG).
  - Motor accuracy (MA.)
  - Design copying (DC).
  - Constructional praxis (CPR).

- Measures of praxis:
  - Design copying (DC).
  - Constructional praxis (CP).
  - Postural praxis (PPR.).
  - Praxis on verbal command (PVC).
  - Oral praxis (OPR).

Those of the above that test non-motor visual perception abilities are SV and FG, and can be compared with visual motor coordination on MA and DC. Tactile components of form and space are measured by MFP. Abilities of visual construction, including elements of form and space perception, are measured by DC and CP.

- Measures of bilateral integration and sequencing:
  - Design copying (DC).
  - Constructional praxis (CP).
  - Postural praxis (PPR.).
  - Praxis on verbal command (PVC).
  - Oral praxis (OPR).

- Measures of bilateral integration and sequencing:
- Oral praxis (OPR) – the ability to organize sequenced movements in the area of the mouth.
- Sequencing praxis (SPR) – the ability to complete tasks in a specific order.
- Graphesthesia (Gra) – the ability to recognize writing on the skin purely by the sensation of touch.
- Standing and walking balance (SWB).
- Bilateral motor coordination (BMC).
- Space visualization contralateral use (SVCU).
- Space visualization preferred hand use (PHU).

All of the above test the ability to integrate functioning on both sides of the body. This is either in gross motor movements with SWB and BMC, oral motor movements with OPR and tactile perception with graphesthesia. The ability to cross the midline of the body is measured by SVCU. The demonstration of dominant or preferred handwriting is measured by PHU.

The Miller Assessment for Preschoolers (MAP) (Kinnealey and Miller, 1993) was developed with the intention of being a screening test to predict which children are at risk for later developmental delays and learning disabilities. The test can be administered to those aged 2 years, 9 months to 5 years, 8 months.

There are five indices of the assessment:
1. Foundation index-neurological function.
2. Coordination index-coordination of gross, fine and oral movements.
3. Verbal index-verbal skills.
4. Non-verbal index-visual-perception skills.
5. Complex tasks – an indicator of the child’s ability to integrate information.

Test scores are in percentiles and normal ranges from 16 percent to 84 percent (Stagnitti, Raison, and Ryan, 1999).

Other standardized tests that may be used for measuring sensory integrative abilities of children aged 3 years through adulthood are the McCarron Assessment of Neuromuscular development (MAND) and the Haptic Visual Discrimination Test (HPVT). A test designed to measure motor functioning in children aged 4 years, 6 months through 14 years, 6 months is the Bruininks-Oseretsky Test of Motor Proficiency (Kinnealey and Miller, 1993).

Differential diagnosis of visual-motor integration versus motor-free visual perceptual dysfunction is an important factor in testing. Some tests that can be used together and then compared for performance are the Test of Visual-Perceptual Skills and the Motor-Free Test of Visual Perception, then adding the Developmental Test of Visual-Motor Integration to test the integration of visual and motor skills (Kinnealey and Miller, 1993).

The area of sensory integration and infants is still developing, along with tools to assess issues at early onset. Typically sensory issues in infants present as difficulties with sleeping and eating, difficulty in organized play, and strong emotional outbursts after sensory input (Miller, Robinson, and Moulton, 2008). Some of the current standardized tests utilized for assessing infants and young children are The Sensory Rating Scale for Infants and Young Children, Test of Sensory Functions in Infants (TSFI), the Toddler and Infant Motor Evaluation (TIME), and the Bayley Scales of Infant Development-II (BSID-II) (Kinnealey and Miller, 1993).

Primary caregiver information plays an essential role in the assessment process. Below is an excerpt from an informal tool that can be used by primary caregivers to record signs and symptoms they observe. Most checklists such as this are quite extensive, but the sample below highlights some sample behaviors to illustrate those that may be of concern and in what area of function the behavior is categorized. Before a primary caregiver completes a checklist such as this, it is important that they and the clinician understand the function of the tool as part of the assessment process and not as a complete diagnostic tool. Every individual has his/her own way of processing sensory information and may even display some of the symptoms outlined. A true sensory processing disorder will maintain over time and is not associated to a certain stage of development. The symptoms will pervade across settings, and interfere with the individual’s ability to function normally and adapt to his or her surroundings.

**Sensory processing disorder checklist:**

**Signs and symptoms of dysfunction** (SPD Foundation, 2010)

**Signs of tactile dysfunction:**

1. Hypersensitivity to touch (tactile defensiveness):
   - As an infant, did/does not like to be held or cuddled; may arch back, cry and pull away.
   - Distressed when diaper is being, or needs to be, changed.
   - A raindrop, water from the shower or wind blowing on the skin may feel like torture and produce adverse and avoidance reactions.
   - May overreact to minor cuts, scrapes or bug bites.
   - Avoids/dislikes/aversive to “messy play,” i.e., sand, mud, water, glue, glitter, Play-Doh, slime, shaving cream/funny foam and so on.
   - Distressed by clothes rubbing on skin; may want to wear shorts and short sleeves year round. Toddlers may prefer to be naked and pull diapers and clothes off constantly.
   - May want to wear long-sleeve shirts and long pants year round to avoid having skin exposed.
   - Resists brushing teeth and is extremely fearful of the dentist.
   - Is a picky eater, only eating certain tastes and textures; mixed textures tend to be avoided as well as hot or cold foods; resists trying new foods.
   - May walk on toes only.

2. Hypo-sensitivity to touch (under-responsive):
   - Is not bothered by injuries, like cuts and bruises, and shows no distress with shots (may even say they love getting shots).
   - May not be aware that hands or face are dirty or feel his/her nose running.
   - May be self-abusive; pinching, biting or banging his own head.
   - Mouths objects excessively.
   - Frequently hurts other children or pets while playing.
   - Repeatedly touches surfaces or objects that are soothing (i.e., blanket).
   - Seeks out surfaces and textures that provide strong tactile feedback.
   - Craves vibrating or strong sensory input.

3. Poor tactile perception and discrimination:
   - Has difficulty with fine motor tasks such as buttoning, zipping and fastening clothes.
   - May not be able to identify which part of own body was touched if he or she was not looking.
   - May be a messy dresser; looks disheveled, does not notice pants are twisted, shirt is half untucked, shoes are untied, one pant leg is up and one is down and so on.
   - Continues to mouth objects to explore them even after age 2.
   - May not be able to identify objects by feel, uses vision to help, such as reaching into backpack or desk to retrieve an item.

**Signs of vestibular dysfunction:**

4. Hypersensitivity to movement (over-responsive):
   - Avoids/dislikes playground equipment; i.e., swings, ladders, slides or merry-go-rounds.
   - Prefers sedentary tasks, moves slowly and cautiously, avoids taking risks and may appear “wimpy.”
   - May appear terrified of falling even when there is no real risk of it.
   - Fearful of feet leaving the ground.
   - Afraid of being tipped upside down, sideways or backwards; will strongly resist getting hair washed over the sink.
   - As an infant, may never have liked baby swings or jumpers.
   - May have disliked being placed on stomach as an infant.

5. Hypo-sensitivity to movement (under-responsive):
   - In constant motion, can’t seem to sit still.
   - Craves fast, spinning and/or intense movement experiences.
   - Loves being tossed in the air.
   - Loves to swing as high as possible and for long periods of time.
   - Is a “thrill-seeker”; dangerous at times.
6. Poor muscle tone and/or coordination:
- Has a limp, “floppy” body.
- Frequently slumps, lies down or leans head on hand or arm while working at his/her desk.
- Difficulty simultaneously lifting head, arms and legs off the floor while lying on stomach (“Superman” position).
- Often sits in a “W sit” position on the floor to stabilize body.
- Fatigues easily.
- Compensates for “looseness” by grasping objects tightly.
- May have never crawled as a baby.
- Poor gross motor skills; difficulty jumping, catching a ball, jumping jacks, climbing a ladder and so on.
- Poor fine motor skills; difficulty using “tools,” such as pencils, silverware, combs, scissors and so on.
- May appear ambidextrous, frequently switching hands for coloring, cutting, writing and other actions; does not have an established hand preference/dominance by 4 or 5 years old.
- Has difficulty licking an ice cream cone.
- Rocks body, shakes a leg or head while sitting.
- Likes sudden or quick movements, such as going over a big bump in the car or on a bike.

**Signs of proprioceptive dysfunction:**
7. Sensory seeking behaviors:
- Stomps feet when walking.
- Loves to be tightly wrapped in many or weighted blankets, especially at bedtime.
- Prefers clothes (and belts, hoods, shoelaces) to be as tight as possible.
- Loves “roughhousing” and tackling/wrestling games.
- Frequently falls on floor intentionally.
- Grinds his/her teeth throughout the day.
- Loves pushing/pulling/dragging objects.
- Loves jumping off furniture or from high places.
- Frequently hits, bumps or pushes other children.

8. Difficulty with grading of movement:
- Difficulty regulating pressure when writing/drawing; may be too light to see or so hard the tip of writing utensil breaks.
- Written work is messy and he/she often rips the paper when erasing.
- Misjudges the weight of an object, such as a glass of juice, picking it up with too much force sending it flying or spilling, or with too little force and complaining about objects being too heavy.
- Seems to do everything with too much force, i.e., walking, slamming doors, pressing things too hard, slamming objects down.
- Plays with animals with too much force, often hurting them.

**Signs of auditory dysfunction: (with diagnosed hearing problems ruled out)**
9. Hypersensitivity to sounds (auditory defensiveness):
- Distracted by sounds not normally noticed by others; i.e., humming of lights or refrigerators, fans, heaters or clocks ticking.
- Startled with or distracted by loud or unexpected sounds.
- Bothered/distracted by background environmental sounds; i.e., lawn mowing or outside construction.
- Runs away, cries and/or covers ears with loud or unexpected sounds.
- May decide whether he/she likes certain people by the sound of their voice.

**Signs of oral input dysfunction:**
11. Hypersensitivity to oral input (oral defensiveness):
- Picky eater, often with extreme food preferences; i.e., limited repertoire of foods, picky about brands, resistive to trying new foods or restaurants, and may not eat at other people’s houses.
- May only eat “soft” or pureed foods past 24 months of age.
- May gag with textured foods.
- Avoids seasoned, spicy, sweet, sour or salty foods; prefers bland foods.

12. Hyposensitivity to oral input (under-registers)
- Excessive drooling past the teething stage.
- Frequently chews on hair, shirt or fingers.
- Constantly putting objects in mouth past the toddler years.
- Acts as if all foods taste the same.
- Can never get enough condiments or seasonings on his/her food.
- Loves vibrating toothbrushes and even trips to the dentist.

13. Hypersensitivity to smells (over-responsive):
- Reacts negatively to or dislikes smells that do not usually bother other people, who might not even notice them.
- Tells other people (or talks about) how bad or funny they smell.
- Bothered/irritated by smell of perfume or cologne.
- Bothered by household or cooking smells.

14. Hyposensitivity to smells (under-responsive):
- May drink or eat things that are poisonous because they do not notice the noxious smell.
- Unable to identify smells from scratch-and-smell stickers.
- Does not notice odors that others usually complain about.
- Makes excessive use of smelling when introduced to objects, people or places.

**Signs of visual input dysfunction (no diagnosed visual deficit):**
15. Hypersensitivity to visual input (over-responsive):
- Sensitive to bright lights; will squint, cover eyes, cry or get headaches from the light.
- Easily distracted by other visual stimuli in the room; i.e., movement, decorations, toys, windows, doorways and so on.
- Enjoys playing in the dark.
- Engages in visual悬崖的tactics of hiding, blocking, coloring, and so on.

16. Hyposensitivity to visual input (under-responsive or difficulty with tracking, discrimination or perception):
- Has difficulty locating items among other items; i.e., papers on a desk, clothes in a drawer, items on a grocery shelf or toys in a bin/toy box.
- Often loses place when copying from a book or the chalkboard.
- Difficulty controlling eye movement to track and follow moving objects.
- Has difficulty telling the difference between different colors, shapes and sizes.
- Compares about “seeing double.”
- Difficulty finding differences in pictures, words, symbols or objects.
- Confuses left and right.
- Difficulty judging spatial relationships in the environment; i.e., bumps into objects/people or missteps on curbs and stairs.

**Auditory-language processing dysfunction:**
- Unable to locate the source of a sound.
- Difficulty identifying people’s voices.
- Difficulty filtering out other sounds while trying to pay attention to one person talking.
- Bothered by loud, sudden, metallic or high-pitched sounds.
- Often talks out of turn or “off topic.”
- Difficulty articulating and speaking clearly.
- Ability to speak often improves after intense movement.

**Social, emotional, play and self-regulation dysfunction:**
Social:
- Difficulty getting along with peers.
- May refuse to play at someone’s house because of the way it smells.
Self-regulation:
- Difficulty accepting changes in routine (to the point of tantrums).
- Often explosive or impulsive.
- Functions best in small group or individually.
- Variable and quickly changing moods; prone to outbursts and tantrums.
- Prefers to play on the outside, away from groups, or just be an observer.
- Avoids eye contact.

Emotional:
- Difficulty with potty training; does not know when it is necessary.
- Difficulty with imitative play (over 10 months).
- Needs adult guidance to play, difficulty playing independently (over 18 months).
- Participates in repetitive play for hours; i.e., lining up toys, cars, blocks, watching one movie over and over, and so on.

Play:
- Difficulty with imitative play (over 10 months).
- Wanders aimlessly without purposeful play or exploration (over 15 months).
- Needs adult guidance to play, difficulty playing independently (over 18 months).
- Participates in repetitive play for hours; i.e., lining up toys, cars, blocks, watching one movie over and over, and so on.

Self-regulation:
- Excessive irritability, fussiness or colic as an infant.
- Can’t calm or soothe self through pacifier, comfort object or caregiver.
- Can’t go from sleeping to awake without distress.
- Requires excessive help from caregiver to fall asleep; i.e., rubbing back or head, rocking, long walks or car rides.

Internal regulation (the interoceptive sense):
- Becoming too hot or too cold sooner than others in the same environments; may not appear to ever get cold/hot, may not be able to maintain body temperature effectively.
- Respiration that is too fast, too slow, or cannot switch from one to the other easily as the body demands an appropriate respiratory response.
- Respiration and heart rate that take longer than what is expected to slow down during or after exertion or fear.
- Unpredictable state of arousal or inability to control arousal level (hyper to lethargic quickly, vacillating between the two; overstimulated to understimulated within hours or days, depending on activity and setting and so on).
- Difficulty with potty training; does not seem to know when he/she has to go (i.e., cannot feel the necessary sensation that bowel or bladder are full).
- Unable to regulate appetite; has little to no appetite or will be “starving” one minute then full two bites later, then back to hungry again (prone to eating disorders and/or failure to thrive).

Interventions

There are some challenges that arise when discussing treatment options for those affected by sensory processing disorder. While there are many treatment modalities available and being used by professionals, few have empirical data to support their efficacy. Sensory issues cross many disciplines including neurology, cognitive neuroscience, education, psychology and occupational and physical therapy. In addition, the individuals who suffer from this disorder are very heterogeneous, making it easy to have several confounding variables. All of this makes research design in this area difficult. However, there is a growing body of knowledge in this area, and it will grow as technology allows us a deeper understanding of the sensory systems and how they function.

Another challenge in treatment is the fluctuation of symptoms from day to day. These fluctuations are a result of the influence of environment on sensory systems, the complexity of the systems themselves and how they are regulated. What the individual perceives depends on the functioning of the neural pathways and sensory systems, and the pathways are also affected by the information received such as emotions, attentional factors and environmental stimuli (Eide, 2003). These fluctuations require patience and an inventive mind on the part of the clinician, primary caregiver and other entities that play a major role in the individual’s daily life. In short, what worked today may not work again tomorrow. Most times, the therapy for this disorder will be planned and guided by an occupational or physical therapist unless the clinician has advanced training in the area of sensory integration treatment strategies. The clinician and primary caregiver need to take an active role during treatment to reinforce the therapy.

The main form of treatment for sensory related issues is called sensory integration therapy. This treatment modality is complex and difficult to concisely describe because it must be flexible and variable based on the individual receiving therapy and the responses to therapy. But there are set and recognizable components, and they are (Miller, Robinson, and Moulton, 2008):

- Active participation by the person being treated, making activities interesting and fun.
- Client-directed activity using the individual’s preferences.
- Individualized treatment based on the individual’s age, disorder, developmental status and response.
- Purposeful activities that require an adaptive response (often referred to as the “just-right challenge”).
- Sensory stimulation must be a part of the activities.
- Improving underlying neurologic processing and organization instead of focusing on the development of splinter skills.

- Treatment by a therapist with advanced training in specific sensory integration treatment techniques.

There are three postulates held as the foundation for sensory integration treatment planning (Miller, Robinson, and Moulton, 2008):

1. There is a continuum between hypo-responsiveness and hyper-responsiveness in each sensory system, and this affects the individual’s ability to interact effectively and efficiently in the environment.
2. The symmetry or asymmetry of function between the two sides of the body and the two hemispheres affects efficiency and function.
3. The brain functions as a whole; however, a hierarchy within the central nervous system affects neurologic functioning and therefore affects behavioral manifestations of nervous system integrity.

Other treatment modalities that are used in conjunction with sensory integration therapy include (Success in Motion Therapy, 2010):

- Therapeutic massage – This type of “touch” therapy can be used for relaxation and stress reduction, helping establish the body-mind connection and rehabilitate certain medical conditions that may be associated with SPD (such as headache, chronic pain, chronic fatigue).
- Interactive Metronome – A computer-based program to help improve timing skills and rhythmic physical response.
- Craniosacral therapy – A light-touch, hands-on modality that relieves restrictions in the fascia, the connective tissue surrounding the brain and spinal cord. This allows more efficient function of the nervous system.

In general, the therapy plan will include a clear identification of the individual’s sensory processing registration, modulation and emotional/behavioral response. There will also be a component of awareness training for the primary caregiver, educational staff and other members of the multidisciplinary team. The individual will be introduced to a “sensory diet,” most often used to provide proprioceptive feedback and to promote sensory integration. This can be created at home and in other environments.

A sensory diet is basically a purposeful input of sensory activities that are tailored to the individual’s sensory needs. There may actually be a room specifically created to challenge and stimulate all of the senses. The sensory diet may include a list of activities to use for calming or ALERTING the sensory system. Environmental modifications may be made, such as use of equipment to enhance the therapeutic plan. These are almost endless possibilities in the use of equipment to assist and enhance the therapeutic plan, ranging from the use of earplugs to help block out loud and unpleasant noise to specifically designed commercial sensory equipment such as the “Sensory Trolley.”
Parents and clinicians who play an active role in treatment will benefit from using guidelines as they work through therapy:

- Be aware of, allow for and accept individual needs.
- Tune into timing, frequency and duration of difficult times. Use a chart to see patterns.
- Be patient, validate and communicate that you understand their frustrations.

Treatment guidelines for hypersensitive children: (over-reacts to sensory input)

- Slow/gradual introduction to sensory stimuli.
- Do not force child to move, taste, touch things that cause a significant fearful response.
- Prepare the child and let him/her know what you are doing ahead of time and while engaged in activity/treatment.
- Allow the child to experience sensations when he is ready. You can encourage it and creatively find a way to get him to do it.
- Let the child know you understand and accept what he/she is feeling.
- Be patient, allow extra time, ask the child what is making him or her feel anxious, sad, angry and so on. Give the child words to use to express feelings and emotions.

Common diagnoses associated with hypersensitivity include:

- DC: 0-3 – Regulation Disorder of Sensory Processing (400), Hypersensitive/under-responsive (420), Sensory-Stimulation Seeking/Impulsive (430)

Treatment challenges in hypersensitive/under-responsive diagnosis:

- Infants and children with this diagnosis may seem unresponsive to their environment and unceptive to others. These children require significant persistence and effort to achieve engagement. They may appear sad and uninterested in their surroundings, but this only reflects their failure to reach the threshold for arousal that would be a motivating factor to act and interact.

Common diagnoses associated with hypersensitivity:

- Type A: Fearful/Cautious (411) or Type B: Negative/Defiant (412)

Treatement guidelines for hyposensitive children: (under-reacts to sensory input)

- Make child aware of body parts through heavy work/input and sensory play.
- Remind child to do what her body needs to do, but safely. Help her understand her own sensory needs.
- Use as much deep pressure and heavy work as needed and tolerated.
- Allow child more movement experiences and movement breaks.
- Have child do activities in a variety of positions; sitting, kneeling, lying on stomach propped on elbows, sitting on a therapy ball and so on.

Common diagnoses associated with hyposensitivity include:

- DC: 0-3 – Regulation Disorder of Sensory Processing (400), Hypersensitive/under-responsive (420), Sensory-Stimulation Seeking/Impulsive (430)

Treatment challenges in hyposensitive/under-responsive diagnosis:

- Infants and children with this diagnosis are similar to those with the hyposensitive/under-responsive diagnosis in that they require high-intensity, frequent and/or long duration of sensory input before they are able to respond. Unlike the hyperactive child, these children actively seek out satisfying their need for high levels of sensory input.

The family and the practitioner role are equally important in the success of the individual during treatment. It is difficult to provide a “cookie-cutter” treatment plan for sensory processing disorder, so it will be vital to create an individual treatment plan based on the research and tools available, keeping in mind the need for creative and “outside of the box” thinking. While there is no cure for SPD, there are treatment modalities that can be established to make life more enriching and meaningful for those affected by this diagnosis.

Conclusion

Sensory processing disorder is a complex diagnosis and requires a deep understanding of the disorder and the individual who is diagnosed to provide effective treatment strategies. SPD manifests as early as infancy and continues throughout adulthood. This diagnosis is often co-morbid with other disorders, and by nature, symptoms can vary from day to day, making treatment a challenging process. With knowledgeable and patient caregivers and clinicians, individuals who are diagnosed with SPD can learn to interact with the world around them in a meaningful and productive way.

Bibliography

1. A neurological process that utilizes the five basic senses of taste, touch, smell, hearing and vision to tell the body how to function in the environment is?
   a. Vestibular sense.
   b. Sensory integration.
   c. Dyspraxia.
   d. Autism.

2. There are four basic patterns of sensory processing. Sensation seeking is the pattern that is described as?
   a. Low thresholds and an active self-regulation response.
   b. Low thresholds and a passive self-regulation response.
   c. High thresholds and a passive self-regulation response.
   d. High thresholds and an active self-regulation response.

3. There are three features that must be present in order to diagnose regulation disorders of sensory processing, including?
   a. Sensory processing difficulties.
   b. Motor difficulties.
   c. A specified behavior pattern.
   d. All of the above.

4. One study showed that significant sensory processing disorders (SPDs):
   a. Were prevalent in 15 percent of tested gifted children.
   b. Were prevalent in 25 percent of tested gifted children.
   c. Were prevalent in 35 percent of tested gifted children.
   d. Were prevalent in 45 percent of tested gifted children.

5. The ability to plan and execute oral motor movement patterns is measured by?
   a. Postural praxis (PPR).
   b. Constructional praxis (CPR).
   c. Graphesthesia.
   d. Oral praxis (OPR).