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An Overview of Sensory Processing Disorder:

Use of Sensory Integration Theory

Heather Lonkar

Western Michigan University

Overview:

“Sensory processing, (sometimes referred to as “sensory integration” or SI) is a term that describes the way the nervous system receives messages from the senses, and turns them into appropriate motor and behavioral responses,” (“Sensory processing disorder foundation,” 2014). No matter the task you are performing: eating dinner, going to a new class, or walking down the street, there is some type of sensation involved. Whether it be the flavor of our food, the sound of cars passing by, or the bright lights of a lecture hall, we are surrounded by sensory stimulation. “Sensory Processing Disorder, (SPD) is a condition that exists when sensory signals do not get organized into appropriate responses,” (“Sensory processing disorder foundation,” 2014). Occupational therapist and developmental psychologist, Dr. Anna Jean Ayres (1920-1989), Ph.D., OTR, was the first to use the term sensory integration dysfunction in 1963 and described it as, “The neurological process that organizes sensation from one’s own body and from the environment and makes it possible to use the body effectively within the environment,” (Ayres, 1972). It is sometimes referred to as a neurological “traffic jam” preventing specific parts of the brain from receiving the sufficient information they need to respond to stimulus in the environment.

Someone who experiences SPD has difficulty completing everyday tasks or activities of daily living, (ADLs) such as: bathing, dressing, feeding, toileting, and leisure activities. These tasks involve both gross motor and fine motor skills. Gross motor skills are those tasks we perform using our large muscle groups, such as arms and legs. Fine motor skills are more intricate skills that require smaller muscle groups such as the use of hands and eyes. This thesis

will include a detailed analysis of: the definitions, diagnosis, symptoms, and treatment of SPD, along with the common co-morbid conditions and causes. The first step is understanding the diagnosis of Sensory Processing Disorder.

Sensory Processing Disorder: The Diagnosis:

Sensory Processing Disorder can occur in typically developing children and has a high co-morbidity with autism and other developmental disorders such as: premature birth weight, brain injury, learning disorders, and other conditions. Obtaining an appropriate diagnosis, based on clinical observations and parent report of symptoms, can be the catalyst for effective treatment. The Sensory Processing Disorder nosology, which explains the subtypes of Sensory Processing Disorder, and their relationship to each other, can assist with accurate diagnosis. Discussed below, are the diagnoses of each subtype of Sensory Processing Disorder.

Sensory Processing Disorder can occur due to a dysfunction in processing information from the environment through our senses. Although we are typically taught about the five senses, we much consider seven senses and their contributions to SPD. The seven senses that occupational therapist's, (OT's) will observe when evaluating and treating a client with SPD are: vision, auditory, gustatory, tactile, olfactory, proprioception, and vestibular. The first vision/sight, is the sense we use to perceive things such as color, luminosity, shape, and the size of an object. Auditory/hearing aides in responding to the environment based on the sounds around us such as a fire alarm or a school bell, which prompt us on how to react in certain situations. Gustatory/taste is associated with eating and this can also pertain to textures that we feel while eating that elicit certain responses in our bodies. Tactile or our sense of touch can help us further analyze objects within our environment and help us create the appropriate response to them.

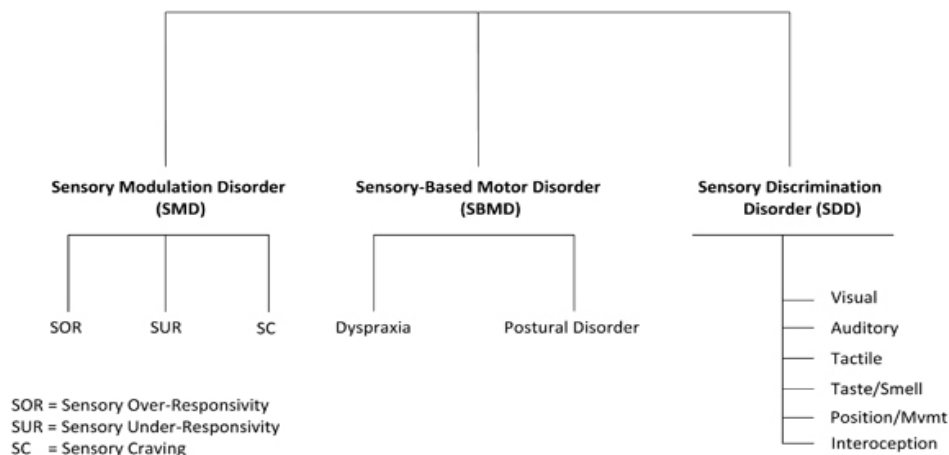
Olfactory, also known as our sense of smell, can assist us in reacting to our environment even before we can see or hear something around us. Proprioception is information that we receive from our muscles and joints that tells us where our body is in space. Our vestibular sense refers to the information that we receive through our inner ear that tells us where our body is in relation to the ground. Each of these, although unique to each client, can be greatly affected in a child with SPD.

Familiarizing oneself with the common red flags and warning signs of SPD can be helpful in the diagnosis of a child. However, because it is the parents who are most likely to have concern for their child’s development when they do not reach certain motor milestones, their observations are often discounted because they are “just the parents,” (Miller, 2006, p. 20). Lucy Miller, Ph.D., OTR, acknowledges that if these concerns are brought up to their child’s doctor or primary care physician, it is most likely, because of the lack of evidence of SPD, that the parents concerns will be dismissed, overlooked, or misinterpreted (2006). When this happens, children often go misdiagnosed, and do not receive the help that they truly need to reach those motor milestones. It is important to know what to look for in your child if you suspect that they are having sensory issues, or if they are not reaching milestones at the times

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Sensory Processing Disorder (SPD)



Sensory Modulation Disorder (SMD):

The first form we will discuss is Sensory Modulation Disorder (SMD), “a chronic and severe problem turning sensory information into behaviors that match the nature and intensity of the message,” (Miller, 2006, p. 21). As Miller explains, children with SMD may over-respond, or under-respond to stimuli in the environment, (2006). However, some do neither and instead, resort to seeking sensation with a single minded determination, (2006, p. 21). For each of the subtypes of SMD, Miller has constructed a list of red flags and behaviors that are commonly seen within each.

Sensory Over-Responsivity (SOR):

The first subtype identified is sensory over-responsivity (SOR) (sometimes called “sensory defensiveness”). This refers to when a child “responds to sensory messages more intensely, more quickly, and/or for a longer time than a child with normal sensory responsivity would,” (Miller, 2006, p. 22). Some of the common symptoms in a child with SOR are covering their ears, eyes, or nose, difficulty with playground toys, and they have a low threshold for sensation. Children who experience sensory over-responsivity, often set off the biggest alarm with parents, because their actions cannot be easily ignored (Miller, 2006, p. 23). An example, used by Miller, is when a child is sitting on the couch next to a hot lamp, they may start to get nervous, or experience some anxiety and discomfort, which is not a typical response.

A child with over-responsivity may experience symptoms in one of the senses or in a combination of two or three in some cases. The sense of touch may be affected if a child gets fussy in certain clothes, such as when their tag is itching the back of their neck. A child, whose sight is affected, may cover their eyes when the lights in a room are turned on. A child's sense of smell can also be affected in the same ways. An example would be if someone with perfume walked past them they would cover their nose, even after the person was out of sight. The over-responsive child may have difficulty transitioning from the indoors to the outdoors, or have trouble seeing two foods that have different textures on their plate at one time. Below is a list of some red flags and common behaviors of over-responsivity according to Miller (2006):

- Intolerance of fuzzy or furry textures (wool clothing, animal fur, textured blankets)
- Intolerance of mud or glue on hands
- Food textures
- Playing on swings
- Bright lights or sunshine
- Irritable, fussy, moody
- Unsociable; avoids group activities and has trouble forming relationships
- Upset by transitions and unexpected changes

Sensory Under-Responsivity (SUR):

In an example from Sensational Kids, a mother submitted a story about her son who grabbed a hot light bulb, and held it long enough in his hand to get second degree burns (Miller, 2006, p. 24). This is an example of the second subtype of Sensory Modulation Disorder known as sensory under-responsivity (SUR). "Children with sensory under-responsivity exhibit less of

a response to sensory information than the situation demands, taking longer to react and/or requiring relatively intense or long-lasting sensory messages before they are moved to action,” (Miller, 2006, p. 25). Common symptoms seen in a child with SUR are: they appear lethargic, they have low energy, do not react to bright lights or loud noises, and they have a high threshold for sensation. A child with SUR, will not notice when they bump into something and get a bruise, or, if they fall and scrape their knee they will continue playing as if nothing happened. According to Miller (2006), “Children with under-responsivity are usually socially withdrawn, preferring solitary games to playmates or not playing at all,” (p 25). These symptoms are often overlooked, as the child is simply seen as being quiet and self-contained. “In infancy, under-responsivity is often seen simply as the sign of a quiet personality and may even be viewed by parents and caregiver as a plus-the mark of a “good baby,” (Miller, 2006, p. 26). Below is a list of red flags and common behaviors of sensory under-responsivity according to Miller (2006):

- Doesn't cry when seriously hurt and isn't bothered by minor injuries
- Doesn't seem to notice when someone touches them
- Is or was unaware of the need to use the toilet
- Does not notice noxious smells
- Passive, quiet, withdrawn
- Easily lost in his own fantasy world
- Apathetic and easily exhausted
- Excessively slow to respond to directions or complete assignments

Sensory Craving (SC):

Sensory craving (SC), is the last subtype of sensory modulation disorder. Sensory craving refers to when a child cannot get enough sensation in their environment. Children who are sensory craving, “have a nearly unsatisfiable craving for sensory experiences and actively seek sensation, often in ways that are socially unacceptable,” (Miller 2006, p. 28). Although, Miller explains, that some degree of sensory craving is normal in all children as they learn, grow, and are challenged with new tasks, children who are sensory seekers take this seeking to a new degree. “At school, they clown around by throwing themselves against a wall and falling to the floor with such violence, that supervising adults worry they’ll hurt themselves,” (Miller 2006, p. 28). This example is used to explain how children who are sensory craving tend to be explosive or aggressive. Miller says that these children are often labeled as, “troublemaker,” “bad,” and even “dangerous,” and their symptoms are easily confused with better-known, Attention Deficit Hyperactivity Disorder (ADHD). Miller describes that kids who are sensory craving may prefer foods with spices, they may find that no noise is ever “too loud,” and their social interactions tend to be invasive-they crowd people and touch them, or knock other kids over. Below is a list of red flags and common behaviors of sensory craving according to Miller (2006):

- Likes crashing, bashing, bumping, jumping, and rough-housing
- Takes excessive risks during play; climbs high into trees, jumps off tall furniture
- Loves to play music and television at extremely high volume
- Often licks, sucks, or chews on non-food items such as hair, pencils, clothing
- Angry or even explosive when they are required to sit still or stop what their doing
- Intense, demanding, hard to calm
- Prone to create situations others perceive as “bad” or “dangerous”

- Excessively affectionate physically

Sensory-Based Motor Disorder (SBMD):

“Sensory-Based Motor Disorder (SBMD), the second classic pattern of SPD, describes the dysfunction that occurs when the “hidden” proprioceptive and vestibular senses that allow our bodies to move and sense our body position, are impaired,” (Miller, 2006, p. 30). As discussed earlier the proprioceptive system is, “the sense that tells us where our body parts are in relation each other, and signals how much we have to contract our muscles in order to move,” (Miller, 2006, p. 31). Our vestibular sense is what we use to figure out where we are in space, we use this sense to tell if we are standing upright, even when we get out of bed in the dark. In Sensational Kids, children with SBMD are described as “having trouble with stabilizing, moving, or performing movement sequences, such as opening the car door and getting into the car seat,” (Miller, 2006, p. 31). SBMD is categorized under two subtypes, Dyspraxia and Postural Disorder.

Dyspraxia:

“Children with dyspraxia have difficulty translating sensory information into physical movement, unfamiliar movements, or movements with multiple steps, such as planning how to move through a crowded classroom in order to put an assignment into the teacher’s tray,” (Miller, 2006, p. 32). Symptoms of dyspraxia can appear in a child’s gross-motor skills (large movements), fine-motor skills (small movements of the fingers and hands), or oral-motor skills (movements of the mouth), or a combination of these things.

Large movements such as learning to ride a bike or participating in gym class would be difficult for a dyspraxic child who struggles with gross-motor movements. Miller (2006)

explains these children appear awkward and clumsy and are often slow to reach milestones such as crawling, walking, and running. A child with fine-motor dyspraxia, begins to show symptoms at around twelve months of age. Signs of this could be, difficulty reaching for a toy, or holding onto/letting go of small objects. Fine-motor dyspraxia affects a child's ability to color inside the lines at a young age, learning to write, and getting dressed, often looking disheveled if they dress themselves, as Miller describes. The last form of dyspraxia is oral-motor, this "creates challenges involving use of the mouth, tongue, and lips," (Miller, 2006, p. 32). Sucking, swallowing, or breathing deeply, are common issues these children face. However, oral-motor dyspraxia, may also affect a child's speech later in life. "Children with dyspraxia often have a low tolerance for frustration and may suffer low self-esteem because of their chronic failure to perform basic motor activities," (Miller, 2006, p. 33). Because of their inability to perform these basic motor activities, their social lives are also affected. Withdrawing themselves from situations in which they are required to perform these tasks can lead to rejection from peers. "Some dyspraxic children develop dazzling verbal creativity to compensate, becoming 'bossy' and telling playmates what to do because they can conceptualize a game but lack the physical ability to play an active part," (Miller, 2006, p. 33). Listed below are symptoms and common behaviors of dyspraxia according to Miller (2006):

- Was slow to sit up, roll, crawl, walk, and/or run
- Has difficulty learning new motor skills, such as riding a bicycle, tricycle, or big wheels
- Frequently breaks toys and other objects unintentionally
- Has trouble with self-care activities that require multiple steps, such as getting dressed
- Frustration when unable to complete tasks due to poor motor skills

- Preference for sedentary activities rather than active play
- Preference for fantasy games or talking to actually “doing” things

Postural Disorder:

The second subtype of SBMD is postural disorder, which is a child’s inability to maintain the needed flexion/extension muscle balance required for a particular activity, inappropriate muscle tone, decreased core strength and stability, and/or lack or strong orientation to midline. Although a dyspraxic child’s handwriting may be messy because of poor planning skills, a child with postural disorder has “messy handwriting because they lack the muscle tone in their shoulders and upper bodies to stabilize themselves in an upright position while their fingers keep a just-right grip on a pencil,” (Miller, 2006, p. 35). Miller (2006) points out that postural disorder is frequently seen in conjunction with other subtypes of Sensory Processing Disorder, (p. 35). Common symptoms and behaviors of postural disorder are listed below according to Miller (2006):

- Poor muscle tone and/or seems weak compared to other children
- Has poor balance and falls over easily, sometimes even when seated
- Has difficulty climbing a jungle gym or dangling from a bar with his arms
- Appearing unmotivated or indifferent
- Tiring easily or appearing tired most of the time
- Difficulty holding his own in games like tug-of-war

Sensory Discrimination Disorder (SDD):

The final form of SPD is Sensory Discrimination Disorder (SDD). “Sensory discrimination is the ability to interpret and distinguish messages within sensory

systems,” (Miller, 2006, p. 37). For example, tactile sensory discrimination makes it difficult for a child to zip a zipper without looking at their fingers. Auditory sensory discrimination is the inability to hear the difference between spoken sounds within a word. Visual sensory discrimination can make it difficult for a child to locate specific objects. Miller (2006) explains that the ability to distinguish between similar sensations in one or more of several systems: touch, vision, hearing, taste, smell, or perception of body movement. “Children with SDD often need extra time to process sensory information because they have trouble figuring out what they are perceiving as quickly and naturally as other children do,” (Miller, 2006, p. 37). Due to these difficulties, children with SDD may appear cognitively delayed and be subject to stereotyping which can result in self-esteem issues. Miller (2006) gives a list of red flags and common behaviors:

- Distinguishing exactly what is touching them and/or where on their body
- Identifying and distinguishing between different sounds
- Judging how much force is required for a task, such as how firmly to hold a pencil
- Seating self in chair; may overshoot or sit too hard
- Difficulty following directions; gets lost easily
- A need for more directions to be repeated or for more time than other children to perform assigned tasks

It is important to remember that simply because you have recognized some of the red flags, a symptom, or common behaviors in your child, does not mean that your child has Sensory Processing Disorder. “It’s possible that a medical condition or a non-sensory disorder is present,” (Miller, 2006, p. 39). Only if the symptoms persist and begin to interfere with “the

child's ability to develop and enjoy a normal active childhood," should you begin to ask questions, as early diagnosis is the key to effective intervention in children with SPD, (Miller, 2006, p. 39-40).

Below is an example of a Sensory Profile Checklist from The National Strategies Primary and Secondary Inclusion Development Program which is often filled out by parents to determine their child's preference to sensations in their environment.

Table 1. Sensory checklist for staff to complete on a pupil

- Tick which apply and then consider which teaching staff need to know this information.
- Where possible, complete this in discussion with the parents or carers and the pupil.

No.	Item	Yes	No	Don't know	Action required
1	Resists changes to familiar routines				
2	Does not recognise familiar people in unfamiliar clothes				
3	Dislikes bright lights				
4	Dislikes fluorescent lights				
5	Is frightened by flashes of light				
6	Puts hands over eyes or closes eyes in bright light				
7	Is attracted to lights				
8	Is fascinated by shiny objects and bright colours				
9	Touches the walls of rooms				
10	Enjoys certain patterns (e.g. brickwork, stripes)				
11	Gets lost easily				
12	Has a fear of heights, lifts, escalators				

13	Has difficulty catching balls				
14	Is startled when approached by others				
15	Smells, licks, taps objects and people				
16	Appears not to see certain colours				
17	Uses peripheral vision when doing a task				
18	Finds it easier to listen when not looking at person				
19	Remembers routes and places extremely well				
20	Can memorise large amounts of information on certain topics				
21	Finds crowded areas very difficult				
22	Prefers to sit at back of group or front of group				
23	Covers ears when hears certain sounds				
24	Can hear sounds which others do not hear				
25	Is very distressed by certain sounds				
26	Bangs objects and doors				
27	Is attracted by sounds and noises				
28	Does not like shaking hands or being hugged				
29	Likes a hug if chosen to do this				
30	Only seems to hear the first words of a sentence				
31	Repeats exactly what others have said				
32	Very good auditory memory for songs and rhymes				
33	Dislikes the feel of certain fabrics and substances				
34	Seems unaware of pain and temperature				

35	Dislikes certain foods and drinks				
36	Seeks pressure by crawling under heavy objects				
37	Hugs very tightly				
38	Enjoys feeling certain materials				
39	Dislikes certain everyday smells				
40	Eats materials which are not edible				
41	Likes to have food presented in a certain way on the plate				
42	Dislikes crunchy or chewy food				
43	Quite clumsy and bumps into objects and people				
44	Finds fine motor movements hard				
45	Has difficulty running and climbing				
46	Finds it hard to ride a bike				
47	Does not seem to know where body is in space				
48	Has poor balance				
49	Afraid of everyday movement activities such as swings, slides, trampoline				
50	Has extremely good balance				

(Based on the sensory profile checklist from Bogdashina, 2003)

Co-morbid Conditions of Sensory Processing Disorder:

Any of the above forms of SPD can occur co-morbidly within a child. According to the medical-dictionary comorbidity is two or more coexisting medical conditions, or diseases, in addition to an initial diagnosis. It is important to have a physician who listens to your concerns and helps you in find the right treatment/intervention for your child. Not only can the above

patterns and subtypes of Sensory Processing Disorder overlap with each other in a child, but it is common to see the following overlap with SPD as well: Attention Deficit Hyperactivity Disorder (ADHD), Autism, Fragile X, Fetal Alcohol Syndrome, Obsessive Compulsive Disorder (OCD), and Tourette's syndrome. It is imperative that each of the child's diagnoses be addressed in order to find the intervention that is most likely to improve their functioning. In the next few sections, we are going to examine further these additional disorders, their relationship to SPD, and the common symptoms, or signs, a child with these co-morbid conditions may exhibit.

Attention Deficit Hyperactivity Disorder (ADHD):

The first co-morbid condition being discussed is the Sensory Processing Disorder (SPD) and Attention Deficit Hyperactivity Disorder (ADHD) Connection. Below are four of the possible relationships that occur between ADHD and SPD:

Figure 2: Four scenarios for the association of SPD and ADHD

- They are different and do not overlap.
- They are different but do overlap, with some children having both disorders.
- One disorder is actually a variation or subset of the other.
- The disorders are identical.

Each of these is a possible occurrence that can be seen within any child diagnosed with ADHD or SPD. Accurate diagnosis is important for every child, especially in the case of co-morbid conditions, so that doctors, and therapists, can give the child treatment that is suitable for them.

Miller (2006) explains that a nationwide study was done in an effort to find out which of these relationships most accurately describes the connection between SPD and ADHD, (p. 275).

“In the study, parents of 2,410 typically developing children participating in the development of

a standardized IQ test, were surveyed with a questionnaire that screens for both the attentional symptoms of ADHD, and the sensory symptoms of SPD,” (Miller, 2006, p. 275). Within the survey, parents were asked to respond to specific statements, and children who scored in the lowest 5 percent on the Impulsivity, Activity Level, and Attention subtests were classified as having ADHD symptoms, (Miller, 2006, p. 275). Those who scored in the lowest 5 percent on the Sensitivity and Regulation subtest were classified as having SPD symptoms, these scores were then compared to each other, (Miller, 2006, p. 275). The study found that 7.5 percent of the children in the general population had symptoms of either SPD or ADHD, or a combination of both disorders. “Notably, 40 percent of the children with distinct symptoms of one disorder had symptoms of the other disorder as well,” (Miller, 2006, p. 275). Researchers found an overlap in symptoms of ADHD and SPD in 60 percent of children who had already been diagnosed with either disorder (Miller, 2006, p. 275). The way in which children with ADHD and SPD process information differs greatly, which means that the intervention that is appropriate for those specific disorders will differ as well. The standard treatment for ADHD is medication, and for SPD is occupational therapy, however, the misdiagnosis may result in a child receiving inappropriate intervention. “Much further study into the underlying neurological mechanisms of SPD and ADHD is needed to understand these matters,” (Miller, 2006, p. 279).

In addition to studying the SPD-ADHD connection, researchers are looking into the connection between Sensory Processing Disorder and autism, Fragile X, Fetal Alcohol Syndrome (FAS), Obsessive Compulsive Disorder (OCD), and Tourette’s Syndrome, (Miller, 2006, p. 279).

Autism:

Another common condition that is often co-morbid with SPD is autism. Children with autism often show difficulty with social interaction, verbal, and nonverbal communication, and repetitive behaviors, (Autism Speaks, 2013). Many of these symptoms are commonly found in varying forms of SPD. This overlap of symptoms, is already a sign that the two may be closely related. 78% of children who are diagnosed with autism, also show symptoms of SPD, however, not all children who are diagnosed with SPD are diagnosed with autism, (Miller, 2006, p. 280). Out of all the children referred for SPD, none of them were diagnosed with autism. Despite these results, research suggests that each of these conditions are distinct disorder. It is essential to get accurate diagnosis of these disorders in order for your child to receive appropriate treatment. The relationship between SPD and high-functioning autism is of great interest to scientists and researchers. “Studies to date suggest that children with autism divide into two groups: children with high arousal and children with low arousal,” (Miller, 2006, p. 280). The children who fall into the low arousal group, can require a great deal of stimulation before they are aware of it and active. The high arousal group on the other hand, may be overly sensitive to stimulation. The following section will discuss the possible relationship between SPD and Fragile X.

Fragile X:

Fragile X is another co-morbid condition that can occur in children with any of the above types of SPD. According to the National Fragile X Foundation (2014), Fragile X is a genetic condition involving the X chromosome, it is an inherited intellectual disability, and the most common cause of autism or autism spectrum disorders, (“National fragile x foundation,”

1998-2014). The co-morbid condition that almost invariably occurs in children with Fragile X is sensory over-responsivity, (Miller, 2006, p. 258). In some studies, children with Fragile X had dramatically larger responses to sensory messages than typically developing children had, (Miller, 2006, p. 258). The data collected from the studies suggest there are two possible causes for the high reactions to stimulus in children with Fragile X and over-responsivity; either too much sympathetic activity (speeds up reactions) or too little parasympathetic activity (slows down reactions), (Miller, 2006, p. 258-259). The next section will be examine the co-morbid possible co-morbid condition between SPD and Fetal Alcohol Syndrome (FAS).

Fetal Alcohol Syndrome (FAS):

Fetal Alcohol Syndrome (FAS), is another common co-morbid condition with SPD. “FAS is a permanent birth defect syndrome caused by maternal consumption of alcohol during pregnancy,” (Franklin, Deitz Jirikowic, & Astley, 2008, p 265). In a study conducted by Franklin, Deitz, Jirikowic, and Astley (May/June 2008), it has been found that children who have been diagnosed with Fetal Alcohol Syndrome (FAS), display similar symptoms as a child with SPD. However, “findings have been considered preliminary due to limitations with instrumentation, sample size, and the depth of concurrent problem behaviors,” (Franklin, et al., 2008). This study supports previous findings from a study done in 1995 that indicated that Sensory Processing Disorder and problem behaviors co-occur in children with FAS, (Franklin, et al., 2008). Studies have shown significant patterns of sensory-processing problems in children with FAS, compared to typically developing children. More information is needed to understand the relationship between FAS and Sensory Processing Disorder. Investigations into these co-morbid conditions may lead to more effective intervention for this population. The next section

will consider the possible co-morbid relationship between SPD and Obsessive Compulsive Disorder (OCD).

Obsessive Compulsive Disorder (OCD):

In addition to ADHD, Autism, Fragile X, and FAS, Obsessive Compulsive Disorder is another co-morbid condition seen alongside SPD. Obsessive Compulsive Disorder (OCD) is diagnosed when obsessions, intrusive thoughts, or images impact daily functioning (NIMH, 2013). The thoughts and images that come from these obsessions are: “unwanted, inappropriate, and disturbing, unrelated to actual event of concerns, come from their own mind and not someone’s suggestion, are not realistic responses to actual event, and are done to avoid a feared outcome, (Mauro, 2006). This may be shown through a daily routine, such as: clinging to a piece of clothing or baby blanket or eating only one type of food. The compulsions take up much of the child’s time and attention, can result in the incompleteness of daily living tasks, and result in lack of normal social relationships, (Mauro, 2006). In relation to SPD, if a child is hypersensitive to information coming in through their senses, such as finding a touch or sight as threatening that others would find harmless, they may set up routines or defenses that could be mistaken for OCD, (Mauro, 2006). However, the hypersensitivity may be due to SPD under the subtype of sensory over-responsivity (SOR), when a child is highly sensitive to things such as, loud noises, and bright lights (Miller, 2006, p. 22-24). Children with OCD are obsessed with things that do not actually exist, and a child with SPD is bothered by real things in their environment. Therefore, if you are able to change the things that are real, you may be able to change their behaviors in response to those things that are not real. The last co-morbid condition being reviewed is SPD and Tourette’s syndrome.

Tourette's Syndrome:

The final co-morbid condition related to SPD that will be discussed, is Tourette's syndrome. Tourette's syndrome is characterized by multiple motor and vocal tics that a child displays, (Jewers, 2009). Some children, who are diagnosed with Tourette's syndrome, will perform their tics when they are experiencing sensory stimulation, either if they are seeking or avoiding it, (Jewers, 2009). The child must display at least two motor tics and at least one vocal tic, occurring before they are 18, and have lasted for at least one year, (Jewers, 2009). Just as SPD overlaps with ADHD, OCD, and Learning Disorders, so does Tourette's syndrome. This relationship could help us understand the co-morbid conditions, and lead us to more accurate diagnosis, and intervention. Although there are not many studies done on the connection between Tourette's syndrome and SPD, researchers are interested to know more about the overlap in diagnoses. The next topic being discussed, are the suspected causes of SPD.

Causes of Sensory Processing Disorder:

It has been estimated that 5 to 15 percent of all children have some form of Sensory Processing Disorder and that 40 to 85 percent of these children have already been diagnosed with another disability as discussed earlier, (Miller, 2006, p. 283). Miller describes a survey done on parents in Colorado, that, of the 703 returned, showed 14 percent of the children had symptoms of SPD significant enough to warrant a full evaluation for SPD, (2006, p. 284). This survey led to more findings, such as, slightly more than 5 percent, one in twenty children, of all the kindergartners warranted evaluation based on the screening, (Miller, 2006, p. 284). If these findings were based on the United States population of children, it would suggest that at least fifteen million children, and adults, would have symptoms of SPD, with about 220,000 of them

being kindergarteners, (Miller, 2006, p. 284). However, if the rate of occurrence is closer to the survey done in Colorado, with nearly 14 percent showing signs that number would more than double. Needless to say, parents of children with SPD are not alone, (Miller, 2006, p. 284).

Although the exact cause of SPD, like so many other neurodevelopmental disorders, has not been identified, preliminary studies and research suggest some leading contenders. Much of the research gathered suggests that SPD is often inherited, (Miller, 2006, p. 285). If this is true, then the causes of SPD are coded into the child's genes. Prenatal and birth complications have also been implicated, along with environmental factors. The causes of SPD, as with any developmental and/or behavioral disorder, are more than likely due to both genetic and environmental factors. More research needs to be done to be sure of the causes, to ensure that children with SPD can get appropriate treatment. In the next few sections we will take a look at different causes of SPD including: heredity, prenatal conditions/birth trauma, and environmental factors.

Heredity:

Of any of the proposed causes of SPD, heredity appears to be the largest suspect. Many parents start to notice similarities between their child's behavior and their own at a young age. This demonstrates how strong heredity is, and, how without even realizing it, we shape our child's lives. A small pilot study* ¹ looked at the family similarities between twenty-seven children, (eighteen boys and nine girls) with SPD and their biological parents. Many heredity studies go back through many generations to discover evidence of a profound trace of a specific disorder. However, researchers found a correlation so sound, which was unnecessary. The

¹ A pilot study is one in which the researchers are trying to establish whether there is enough evidence to conduct a large-scale project. Pilot studies often have limited sample sizes.

study found that ninety-two percent of the children in the study had at least one parent with symptoms of SPD, and that the association between the mothers was only slightly higher (40 percent) than with the father (37 percent), (Miller, 2006, p. 285).

Despite that the studies were not large or complete enough to establish a definitive link between SPD and heredity, the evidence suggests a strong link. Similar studies have been done, such as a study that looked at twins, half identical and half fraternal, raised in the same home, (Miller, 2006, p. 285). Parents were surveyed about behaviors in their toddlers, and identical twins were more likely to exhibit more similar sensory symptoms than fraternal twins, which again suggests that the traits seen are genetic, (Miller, 2006, p. 285). It is important to keep in mind that, solely based on these studies, we cannot assume that every child with SPD inherited it from a parent. However, taking the time to record traits that appear in close family members is an imperative first step to establishing the causes of SPD. Larger studies have already been funded and begun, (Miller, 2006, p. 286).

Prenatal Condition/Birth Trauma:

Not only are the genes they inherit from their parents being considered as a possible cause, prenatal conditions and birth trauma are a suspected cause of Sensory Processing Disorder. A study done in a large occupational therapy practice in Massachusetts, evaluated three hundred children up to the age of sixteen who were receiving treatment, (Miller, 2006, p. 286). The data collected from the study was investigated to find out how many children endured birth complications such as: prolonged labor, breech birth, prematurity, or fetal distress, (Miller, 2006, p. 286). With birth complications occurring in less than 10 percent of all live births, exceptions to those being cesarean section and induced labor, it was revealed that the children

involved in the study who had sensory symptoms, had had some complication during birth, (Miller, 2006, p. 287-288).

Although they have not been completed, researchers intend to do further studies about the connection between birth complications and SPD. An example is, those children who are receiving treatment for SPD were of low birth weight or exposed to alcohol or drugs prior to birth, (Miller, 2006, p. 287). Determining whether or not sensory issues within a child are caused by premature birth, hospitalization following birth, or other outside factors is the challenge. Of the findings we have thus far, none of them have been able to link the birth trauma to a child developing sensory difficulties. However, it is believed that they do indicate that prenatal and birth risk factors occur in children with SPD far more than in typical developing children, (Miller, 2006, p. 287). As researchers progress towards finding the causes of SPD, birth complications will continue to be a good place to explore.

Environmental Factors:

The final possible cause of SPD being considered by experts is the environment. “Studies of children living in Romanian orphanages find strong associations between later sensory problems and the low levels of sensory stimulation, environmental complexity, and interaction with people and the environment prevalent in these institutions,”*(Miller, 2006, p. 287 & 289). Adoptive parents reported sensory issues in the children, and it was noted that the longer the child was institutionalized, the more sensory issues they showed, thus indicating that the environment of the institution is a factor, (Miller, 2006, p. 289). Most of the reports showed over-responsivity symptoms followed later by sensory-seeking habits.

A second environmental factor being discussed is a child who has experienced physical or sexual trauma in the home. Many of these children who experience Post-Traumatic Stress Disorder, also, have difficulty with loud noises or become defensive when someone tries to touch them, even if in an appropriate manner. This is another potentially useful cause to consider. Other environmental factors that researchers are looking into are: poverty-related risks, lead poisoning, and newborn hospitalization for medical conditions, (Miller, 2006, p. 289). Although they may not be direct causes of SPD, children who appear “colicky,” “fussy,” or have difficulty with feeding or sleeping, could soon become the red flags that lead to earlier evaluation, diagnosis, and treatment, (Miller, 2006, p. 289).

Researchers are off to a good start, but, they will need to do many more studies on the different suspected causes of SPD before they can come to a conclusion. It is imperative to remember as a parent that poor parenting is not a cause of SPD, (Miller, 2006, p. 289).

Treatment:

Although sensory integration theory has been discussed since the 1960's, effective treatment protocols are still evolving. “Sensory integration refers to skills and performance in developing and coordinating sensory input, motor control and sensory feedback in a smooth and controlled process, for use in behavioral responses,” (Wright, 2010). Sensory integration allows us to better organize our senses that we are taking in, and turn them into appropriate responses. Being able to accurately organize the sensory input from the environment is where children with sensory issues struggle, not with the information itself. The goal of sensory integration is to improve the accuracy of how children process sensory information, and, most importantly how they understand and respond to it. As discussed above, the senses that can be affected are visual

(sight), auditory (hearing), olfactory (smell), gustatory (taste), tactile (touch), vestibular (movement sense), and proprioceptive (body position sense). “Intervention based on sensory integration theory (Ayres, 1972) is widely used among occupational therapists working with various children with developmental, learning, and behavioral problems, “(Parham, Cohn, Spitzer, Koomar, Miller, & Burke, et al, p. 216). When sensory integration is put to work, it allows our brains parts to work accurately together to allow us to interact with the environment and participate in daily activities. This therapy provides people with ways to better control sensory input, and, its ultimate goal is to aide in the development of more adaptive behaviors, and responses to sensations from the environment. With the use of sensory integration, children are able to perform higher levels of gross motor and fine motor skills, while also boosting their confidence, better managing self-control, and increasing their attention span, (Wright, 2010).

Since the discussion of sensory integration theory has started, three theoretical constructs that occupational therapists hold to be true, have been collected.

Table 2. Theoretical Constructs

Postulate One	Learning is dependent on the ability to process sensation from movement and the environment; use it to plan and organize behavior.
Postulate Two	Individuals who have decreased ability to process sensation may have difficulty producing appropriate actions which may interfere with learning and behavior
Postulate Three	Enhanced sensation, as a part of meaningful activity that yields an adaptive interaction, improves the ability to process sensation, thereby enhancing learning and behavior.

These three postulates, are something that many occupational therapists hold to be true about sensory processing, and sensory integration intervention. Through them, they hope to create meaningful activities, that will then lead to meaningful responses. To be able to analyze them more closely, occupational therapists must first create a list of core elements, that explains

what sensory integration intervention hopes to achieve, and to test the fidelity of sensory integration intervention. The theoretical constructs stated above, guide sensory integration intervention, more specifically when talking about fidelity.

Fidelity and Sensory Integration:

“Fidelity is generally defined as faithfulness, loyalty, accuracy, and exact correspondence to the original,” (Oxford Encyclopedic English Dictionary, 1996). In the case of sensory integration, it is the loyalty to the intended underlying theoretical and clinical guidelines that it hopes to prove, (Parham, et al., 2007, p. 217). By using fidelity tools, clinicians are able to provide treatment that is in line with theory and clinical guidelines and researchers are able to decide whether the findings follow from treatment that is faithful to a set of principles. In examining the fidelity of the research being done, we may be able to strengthen the assumptions that can be drawn about the effectiveness of occupational therapy using a sensory integration approach (OT-SI), (Parham, et al., 2007, p. 216). It is important to establish fidelity in your research to ensure that any researchers after you trying to replicate your study, can get similar findings, and establish that the treatment is distinct from others types of intervention. Ways in which researchers establish fidelity are: to thoroughly describe the intervention, identify specific features that make it distinguishable from other types of intervention, all while creating a procedure that fidelity of intervention can be evaluated for effectiveness, (Parham, et al., 2007, p. 217). Raters will score the fidelity of the intervention based on observations, or interview with recipients of the intervention or therapists providing the intervention, (Parham, et al., 2007, p. 218).

The use of fidelity in sensory integration, (SI) has recently become an interest to researchers evaluating the effectiveness of SI intervention. Through the research done, it was found that elements of the physical environment such as space, safety, and exploration, are key parts to SI intervention, (Parham, et al., 2007, p. 219). Another important principle to SI intervention, is the competency of the therapist; we must take into consideration if the therapist has sufficient qualifications and training to provide intervention, (Parham, et al., 2007, p. 219). By distinguishing these two principles, researchers were able to, “organize the structural features of SI intervention into two main categories: (a) environmental design, which includes room setup and types of equipment, and (b) therapist qualifications, which include professional background, formal education, clinical experience, post-professional training, supervision, and certification in sensory integration or in sensory integration clinical assessment,” (Parham, et al., 2007, p. 219).

Each of the elements that were identified by the researchers was organized into ten core intervention process elements, (Parham, et al., 2007, p. 219).

Table 3. Core Elements of Sensory Integration Intervention Process

Core Process Elements	Description of Therapist’s Behavior and Attitude
Provide sensory opportunities	Presents the child with opportunities for various sensory experiences, which include, tactile, vestibular, and/or proprioceptive experiences; intervention involves more than one sensory modality.
Provide just-right challenges	Tailors activities so as to present challenges to the child that are neither too difficult nor too easy, to evoke the child’s adaptive responses to sensory and praxis challenges.
Collaborate on activity choice	Treats the child as an active collaborator in the therapy process, allowing the child to actively exert some control over activity choice; does not predetermine a schedule of activities independently of the child.
Guide self-organization	Supports and guides the child’s self-organization of behavior to make choices and plan own behavior to the extent the child is capable; encourages the child to initiate and develop ideas and plans for activities.

Core Process Elements	Description of Therapist's Behavior and Attitude
Support optimal arousal	Ensures that the therapy situation is conducive to attaining or sustaining the child's optimal level of arousal by making changes to the environment or activity to support the child's attention, engagement, and comfort.
Create play context	Creates a context of play by building on the child's intrinsic motivation and enjoyment of activities; facilitates or expands on social, motor, imaginative, or object play.
Maximize child's success	Presents or modifies activities so that the child can experience success in doing part or all of an activity that involves a response to a challenge.
Ensure physical safety	Ensures that the child is physically safe either through placement of protective and therapeutic equipment or through the therapist's physical proximity and actions.
Arrange room to engage child	Arranges the room and equipment in the room to motivate the child to choose and engage in an activity
Foster therapeutic alliance	Respects the child's emotions, conveys positive regard toward the child, seems to connect with the child, and creates a climate of trust and emotional safety.

(Parham, et al., 2007, p. 219)

After constructing these ten core elements, researchers then sought out to test if intervention fidelity was being put to work in sensory integration, (SI) intervention. Their findings indicated that descriptions of the interventions did not fully address these ten elements; in fact, some of the intervention went against them, (Parham, et al., 2007, p. 222). Second, they found that, before this research was done, there is little documentation of fidelity in sensory integration intervention, (Parham, et al., 2007, p. 222). Finally, addressing the influence that fidelity has on intervention, has rarely been considered, (Parham, et al., 2007, p. 222). Although there were limitations in the research done on fidelity and sensory integration intervention, it is apparent from their findings, that fidelity needs to be examined more closely by the therapist's providing sensory integration intervention when they provide treatment and discuss the outcomes and effectiveness. By not taking note of the fidelity within sensory integration intervention, we are, "compromising the extent to which conclusions can be drawn regarding the effectiveness of OT-SI," (Parham, et al., 2007, p. 223).

Controversy with Sensory Integration:

The argument on whether sensory integration (SI) is effective or ineffective still goes on today. Although there have been many more studies done in the past 30 years, the evidence remains deficient. This is especially frustrating for the therapists, who observe that the intervention has helped improve the quality of life among children, and their families, but lack conclusive research to support this practice, (Parham, et al., 2007, p. 216). Things begin to get more difficult when families request SI, and there is no funding that will be provided for the service without evidence of its effectiveness, (Parham, et al., 2007, p. 216).

One challenge being closely examined is the challenge of inadequately selecting and describing participants involved in the intervention, size of the study, the study design, including alternative interventions, operationalization of the intervention, so that it is congruent with the assumptions, and theoretical principles, (Parham, et al., 2007, p. 217). Being able to accurately document the findings from the study and show that they are congruent with the principles of the intervention, is the focus of many researchers studying sensory integration, (Parham, et al., 2007, p. 217). Once we have established that fidelity has been considered in our intervention plans, we must set goals for our clients to reach throughout their treatment.

Goals of SI Treatment:

The overall goal of occupational therapy is to help clients, “improve their occupational roles and functional performance,” (Bundy, Lane, & Murray, 2002, p. 439). More specifically, goals related to Sensory Processing Disorder may be more unique to the child, and their sensory or motor issues. However, the overall goals must always revert back to the different occupations of the client, target the family’s specific needs for change, and always present the just-right

challenge. The just-right challenge refers to creating an activity that provides the person with a challenge that is just above what they currently can do with ease, (Harrison, 2010). Parents of child who are diagnosed with Sensory Modulation Disorder, value socialization, the ability to self-regulate, confidence levels, and some may even have a specific skill set they would like their child to work on, (Bundy, et al., 2002, p. 439). Prior to beginning treatment, occupational therapists will set goals for their clients to reach, so they know what they are working towards, and are able to track their progress throughout treatment.

The four areas that occupational therapists address, as mentioned above, are: occupational performance, self-regulation, social participation, and self-esteem, (Bundy, et al., 2002, p. 439). Bundy, Lane, & Murray (2002), explain that occupational performance refers to those activities of daily living, such as, dressing, bathing, toileting, and eating. It also, includes our leisure skills, and our performance at either our job or at school, more specifically, our gross and fine motor skills. Self-regulation is our ability to adapt to changes, or difficulties in our daily routines. This can involve our ability to focus on more than one task at any given time, completion of those tasks, and our ability to monitor our behavior and emotions before they become a problem, (Bundy, et al., 2002, p. 439). Social participation is important for children to be able to form relationships, and understand how to appropriately interact with others. This consists of not only making friends, but keeping friends. The last goal that occupational therapists must consider in treatment, is self-esteem. It is important for a child to have a good perception of themselves, and know that they can achieve the goals that have been set for them. It is an occupational therapists job to give positive, constructive feedback throughout treatment, to ensure that the client knows they are doing well, or what could be done differently. The most

important thing to remember, are the needs of not only the child, but the family, (Bundy, et al., 2002, p. 440).

Conclusion:

Sensory Processing Disorder affects many facets of life. Aside from being able to transfer sensations from the environment into appropriate actions and reactions, it affects a child's ability to socialize with others; it can diminish their self-esteem, and disables them from being able to perform activities of daily living (ADLs). There are many subtypes of Sensory Processing Disorder to consider as a possible diagnosis for each child, with red flags of each that parents can report to an occupational therapist, to ensure that they receive the correct intervention. Accurate diagnosis is important to getting the child treated correctly. Keeping in mind the core principles, or fidelity, of sensory integration intervention, occupational therapists can then move towards creating a treatment plan that is unique to each individual child. Once the concerns of the parents have been voiced, the child has been observed in a stimulating environment, and the child's daily occupations are considered, the therapist can then form goals, at a just-right challenge, for the child to achieve throughout therapy.

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