Sensory Integration Dysfunction

"The Misunderstood, Misdiagnosed and Unseen Disability"

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Introduction

Our mind and body are superbly interwoven to meet the demands of today's world. The feelings, thoughts and actions we experience occur through the complex actions of our brain. How we process environmental and internal information has a major impact on our feelings, thoughts and actions. The slightest change in our brain processes can influence how we manage daily living skills, academic progress and social interaction. Sensory integration dysfunction is one example of what can go wrong in the processes of the brain. This paper will explain sensory integration dysfunction to the point of understanding the nature of this unseen (and often misdiagnosed) disability, as well as its psychological, emotional, learning and social effects on the individual.

Sensory Integration Dysfunction (SID) is a neurological disorder pioneered 40 years ago by A. Jean Ayres, Ph.D., OTR. Dr. Ayres developed the sensory integration theory to explain the relationship between behavior and brain functioning. As described in Williams & Shellenberger's work entitled, *How Does Your Engine Run? A Leader's Guide to The Alert Program for Self-Regulation*, "Countless bits of sensory information enter our brain at every moment, not only from our eyes and ears, but also from every place in our bodies" (1-2). The brain must organize and integrate all of these sensations if a person is to move and learn normally.

The Senses

We are all familiar with the five basic sensory systems: sight, sound, taste, smell and touch. These basic senses or far senses" respond to external stimuli from the environment. However, less familiar sensory systems exist within our bodies called interoceptive, tactile, vestibular and proprioceptive senses. These body-centered sensory systems or "near senses" operate without conscious thought and we cannot observe them (Kranowitz, 41).

- Interoceptive: "Sensory system of the internal organs (e.g., heart rate, hunger, digestion, state of arousal, mood, etc.),
- Tactile Sense: Processing information about touch received primarily through the skin,
- Vestibular Sense: Processing information about movement, gravity and balance, primarily received through the inner ear, and

- Proprioceptive: Processing information about body position received through the muscles, ligaments and joints" (Kranowitz, 41-42).

The brain "locates, sorts and orders sensations--somewhat like a traffic policeman directs moving cars" (qtd. in Williams & Shellenberger, 1-3). Tactile, Vestibular and proprioceptive processing is at the core of sensory systems, leading to the five basic sensory systems.

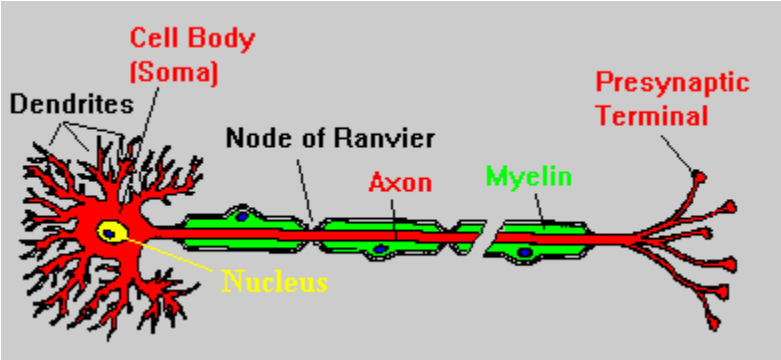
The Brain

In *The Developing Child, 8th Edition* (1997), Helen Bee provides a description of the nervous system. Three layers of the brain have developed through evolution [see Fig. 1]:

- Reptilian Brain: This is the inner most layer of the brain (also called the "primitive brain") and has the responsibility of instinctive behavior.
- Limbic System: The next layer is the limbic system (also know as the "smell brain"). The "smell brain" enables emotions and processes smell and taste. This layer adds emotions to otherwise instinctive behavior.
- Cerebrum: The cerebrum is the third layer (also known as the "thinking brain"). This layer has the responsibility of processing and organizing complex sensory information so we can think, remember, plan and execute actions.

The five main structures of the brain are the spinal cord, medulla, midbrain, cerebellum and cortex [see Fig. 2]. The midbrain and medulla (completely developed at birth) are located in the "primitive" and "smell" portions of the brain. The least developed part of the brain is the cortex, the "thinking" portion of the brain. All five of these structures are composed of neuron cells and glial cells (Bee, 44) [see Fig. 3].

Virtually all neuron cells are present at birth. As shown in Fig. 3, neuron cells are composed of dendrites, axons and terminals. Billions of neurons in the human body connect to form the nervous system. The dendrites of a neuron cell receive stimuli from other nerves or a receptor organ (such as a sense organ). The impulse passes through the nucleus to the axon. The axon conducts impulses through the terminal to the dendrites of another neuron cell or to an effector organ (such as a muscle cell) called synapses [see Fig. 4]. For an impulse to pass from one neuron to another (or from a neuron to a receptor or effector organ) it must pass across a synapse.[1]



A child's developmental process is essentially the creation of synapses by the growth of dendrites, axons and terminals. This growth process begins in the midbrain and the medulla (the "primitive" brain) and expands to the cortex (the "thinking" brain). Sensory stimulation and experiences create more dendrites and synapses. The more dendrites and synapses, the better the integration process works. Michael Jordan (the famous basketball player) is an example of an individual whose integration system is exceptional.

The brain also possesses the remarkable ability to regulate the sensory information to the demands of the environment and its current needs. An individual needs the following mechanisms in order to self-regulate (Kranowitz, 42-44):

- *Modulation*: The brain will turn neural switches on or off to regulate its activity and subsequently, our activity level. It bases the regulation process on the task or activity we are doing. We need neural switches turned on to play a game of volleyball and turned off to focus on reading a book.
- *Inhibition*: The brain will reduce connections between sensory intake and behavioral output when certain sensory information is not needed to perform a particular task. While sitting in a classroom, the sensory intake needs to inhibit the sounds coming from the humming fan so we can pay attention to the teacher. Our sensory system may become overstimulated if we do not block out unnecessary information.
- *Habituation*: When we become accustomed to familiar sensory messages, our brain automatically tunes them out. The tautness of a seatbelt initially occupied our attention but eventually we may not even notice the seatbelt.
- *Facilitation*: The brain will promote connections between sensory intake and behavioral output by sending messages of displeasure (e.g., motion sickness) or pleasure (e.g., the calming feeling of a rocking chair). Facilitation lets us know when we need to stop activities or will give us the "go ahead" signal for pleasurable activities.

Sensory Integration

Carol Stock Kranowitz, MA, who has a degree in Education & Human Development, has been teaching music, movement and drama to preschool children since 1976. As the author of *The Out-of-Sync Child, Recognizing and Coping with Sensory Integration Dysfunction*, 1998, Kranowitz clearly describes sensory integration and sensory integration dysfunction. She indicates that sensory integration is the neurological process of organizing information we get from the "far" and the "near" senses. "When the brain processes sensory information properly, we respond appropriately and automatically [Kranowitz, 39-40].

The task of safely crossing the street is an example of proper sensory integration. You are standing at the curb paying close attention to the traffic. The "far" senses remain tuned to the task at hand. As you step off the curb, a horn suddenly blows. You automatically step back on to the curb because the auditory (hearing) sense interpreted the sound as a danger signal and your brain told your body what action needed to take place.

Sensory Integration Dysfunction

Sensory integration dysfunction is the inability to process certain information received through the senses. When an individual has sensory integration dysfunction, he or she may be unable to respond to certain sensory information to plan and organize what he or she needs to do in an appropriate and automatic manner. This may cause the individual to resort to the primitive survival techniques of fright, flight and fight located in the "primitive" brain. This fright, flight and fight response can appear extreme and inappropriate for a particular situation.

Using the example of crossing the street, an individual with sensory integration dysfunction may be unable to process the sound of the blowing horn, causing him or her to freeze (a fright response--as a deer caught in a spotlight). "Any nervous system will respond to protect the body if the brain's perception is that of danger" (Williams & Shellenberger, 10). However, the dendrites and synapses of the neuron cells effecting auditory response did not fully expand to the cortex (the "thinking" portion) causing the individual to act instinctively, rather than appropriately.

Sensory integration dysfunction is a disruption in the process of intake, organization and output of sensory information. Inefficient sensory intake is taking in too much or too little information. With too much information, the brain is on overload and causes an individual to avoid sensory stimuli. With too little information, the brain seeks more sensory stimuli. Neurological disorganization can occur in three different manners. One way is when the brain does not receive messages because of a disconnection in the neuron cells. A second manner is sensory messages are received inconsistently. The third way is sensory messages are received consistently but not connect properly with other sensory messages. Inefficient motor, language or emotional output occurs when the brain poorly processes sensory messages, which deprives us of a motor response in order to behave in a purposeful way (Kranowitz, 55).

Characteristics of Sensory Integration Dysfunction

Everyone shows signs of sensory integration problems from time to time because no one is well regulated all the time. Try to imagine a time you went without sleep. The lack of proper sleep may have affected your motor reflexes and your ability to concentrate. It is impossible to supply a concrete list of symptoms because the dysfunction can affect each person in different ways and to varying degrees. Table 1 is a basic list of symptoms broken down into categories.

Table 1. Symptoms of Sensory Integration Dysfunction. (Reproduced with permission from the Apraxia-Kids Web page)

Sensory	Symptoms
Auditory	• Responds negatively to unexpected or loud noises • Holds hands over ears

	• Cannot walk with background noise • Seems oblivious within an active environment
Visual	• Prefers to be in the dark • Hesitates going up and down steps • Avoids bright lights • Stares intensely at people or objects • Avoids eye contact
Taste/Smell	• Avoids certain tastes/smells that are typically part of children's diets • Routinely smells nonfood objects • Seeks out certain tastes or smells • Does not seem to smell strong odors
Body Position	• Continually seeks out all kinds of movement activities • Hangs on other people, furniture, objects, even in familiar situations • Seems to have weak muscles, tires easily, has poor endurance • Walks on toes
Movement	• Becomes anxious or distressed when feet leave the ground • Avoids climbing or jumping • Avoids playground equipment • Seeks all kinds of movement and this interferes with daily life • Takes excessive risks while playing, has no safety awareness
Touch	• Avoids getting messy in glue, sand, finger paint, tape • Is sensitive to certain fabrics (clothing, bedding) • Touches people and objects at an irritating level • Avoids going barefoot, especially in grass or sand • Has decreased awareness of pain or temperature
Attention, Behavior And Social	• Jumps from one activity to another frequently and it interferes with play • Has difficulty paying attention • Is overly affectionate with others • Seems anxious • Is accident prone • Has difficulty making friends, does not express emotions

When one sensory system does not adequately expand the neuron cell's dendrites and synapses, the inadequacies may limit the connecting neuron cell, and so on and so on. The following are brief examples of problems that may develop:

- *Attention and Regulatory Problems.* Linda C. Stephens, MS, OTR, in an article entitled "Sensory Integrative Dysfunction in Young Children" stated, "The ability to attend to a task depends on the ability to screen out, or inhibit, nonessential sensory information, background noises, or visual information." An individual with sensory integration dysfunction may respond to sensory input without this screening ability. This can produce distractibility, hyperactive, or uninhibited output. They may be unable to calm or console themselves and may overreact or be unresponsive to "far" sense stimuli. Attention and regulatory problems occur in the modulation, inhibition, habitation or facilitation brain processes.
- *Sensory Defensiveness.* This is the fright, flight and fight response mentioned in the crossing the street example given earlier. An individual with sensory defensiveness typically has a "highly aroused nervous system which prepares the body for survival, but does not recognize that the input is non-threatening" (Stephens). The behavior exhibited by an individual in this category may be aggression, avoidance, withdrawal and intolerance of daily routines. Sensory defensiveness can occur in the auditory, visual, vestibular or tactile senses.
- *Activity Levels.* Children with sensory integration dysfunction may show problems in their activity level. "The child may appear disorganized or lacking purpose in his or her activity. The child does not explore the environment or lacks variety in play activities. He or she may appear clumsy and has poor balance. The child may have difficulty calming down after physical activity or seeks excessive amounts of sensory input" (Stephens). These characteristics can come from improper functioning in any of the sensory systems or a combination of them.
- *Behaviors.* A child may exhibit negative behaviors that have an underlying cause. The child may "lack flexibility, be explosive, or have difficulty with transitions" (Stephens). The child may show unexplainable irritability or crying until the discovery of the underlying cause. Underlying causes could be that the child is fearful of certain sounds or visual stimuli or intolerant to the wrinkles in his or her socks.

In light of the problems that may develop due to sensory integration dysfunction, it is no wonder a child may lack emotional stability and social skills. The way a child behaves or interacts influences how individuals will interact with them. A child with sensory integration dysfunction may feel insecure in completing daily tasks because of their uncertainty of the environment. The fact that sensory integration dysfunction is generally not a visible disability, the child may be treated unfairly or the disability not be given consideration. All of us depend on adequate sensory integration to carry out daily tasks in work, play and self-maintenance. "Disorders in the sensory integration domain greatly influence our ability to function, but also can be so subtle that they easily go unrecognized" (Stephens).

As Gething points out in "Person to Person, A Guide for Professionals Working with People with Disabilities," people with hidden disabilities can experience different reactions from those with visible disabilities. "Having a hidden disability means that it is possible to mix with others without them being aware of the disability. This can create conflicts for the person with the disability about self-disclosure, identity confusion and fear of being found out" (Gething, 7). The feeling of living a "false life" can lead to anxiety and low self-esteem.

Dr. Temple Grandin, in her book entitled "Thinking in Pictures, and Other Reports from My Life with Autism," described the difficulties she encountered with tactile defensiveness. She stated, "When I got accustomed to pants, I couldn't bear the feeling of bare legs when I wore a skirt. After I became accustomed to wearing shorts in the summer, I couldn't tolerate long pants" (66). Dr. Grandin invented the "squeeze machine." This machine is a device an individual with sensory integration dysfunction will lay in and they can place self-controlled pressure over their entire body. Researchers found that children who were using this machine for more than five minutes a day were calmer and had a greater ability to inhibit a motor response (Grandin, 81).

Sensory Integration Dysfunction and Learning

No one part of the central nervous system works alone. Messages must go back and forth from one part to another. "Touch aids vision, vision aids balance, balance aids body awareness, body awareness aids movement and movement aids learning" (Kranowitz, 45). Robert J. Doman, Jr., M.D., Clinical Director of the United Cerebral Palsy of Delaware County, Pennsylvania, expressed the need for stimulation in his article entitled "Sensory Stimulation." Dr. Doman states, "Stimulation 'excites' the brain. What does excitement of the brain produce? Functional activity. What is functional activity? Breathing, metabolizing food, walking, talking, reading, etc." Proper stimulation leads to the growth of more and more connections between brain cells creating efficient pathways of brain function.

The pyramid of learning begins in the central nervous system [as shown in Fig. 5]. Each level must properly integrate with the previous level or levels in order to move on to the next level. The ultimate goal is to reach the cognitive level of functioning in order to attend to the tasks of daily living and learning. An individual on the SID listserv eloquently stated the impact of sensory integration dysfunction on learning. She stated:

> I cannot imagine a case of untreated SI that does not interfere with a child's education. If the child is distracted and annoyed by sounds, sights, movement (or lack of), touch, smells and tastes (among other sensations), how could these irritants not interfere with his or her education? Is this possible?
>
> Try this: Turn on the radio, but do not tune it. Leave it on static and fuzz. Turn it up. Ask someone to turn the lights on and off. Strap yourself into a broken chair that is missing a leg and use a table that is off balance--you

> know the ones in restaurants that makes us all so mad. Now put on some scratchy lace in place of a comfortable T-shirt, put your pants on backwards and wear shoes one size too small. Pour a bowl of grated Parmesan cheese, open a can of sardines and bring the cat box to the table. Now snack on your least favorite food, the one you never eat because it comes with a gag reflex. With all this in place, pick up a new book and learn something new! (Permission given from Listserv member of SID@onelist.com)

Parent & Child magazine published an article written by Ellen Booth Church entitled "Think! How your child learns to problem-solve." The article discusses how children figure out what things are and how they work. Church says, "Every time she experiments with and investigates things in her world, such as how far water will squirt from a sprayer and what's inside a seedpod, for example, she is building her ability to solve problems (33). This also develops a "...longer attention span, an ability to focus, and, finally, a great sense of self-esteem!" (Church, 36). If a child avoids interaction with the environment, they are limited in their ability to learn. Proper integration is the key to learning.

Sensory Integration Dysfunction and Misdiagnoses

Numerous psychological, psychiatric and neurological disorders appear the same as sensory integration dysfunction. These can include schizophrenia, conduct disorder, depression, attention deficit/hyperactivity disorder (ADHD), attention deficit disorder (ADD), autism (or disorders on the autism spectrum), pervasive development disorder (PDD), and Tourette syndrome.[2] Many symptoms of sensory integration dysfunction look like symptoms of other common disabilities making it difficult to differentiate one difficulty from another. "Unfortunately, symptoms of SI Dysfunction are often misinterpreted as psychological problems" (Kranowitz, 19). Studies show that deprivation of sensory stimulation through the five senses can lead to dramatic changes in the efficiency of the brain. These changes can cause partial loss of memory, a lowering of I.Q., personality changes including withdrawal and hallucinations (Doman). As Dr. Doman suggests in his article "Sensory Deprivation," lack of sensory stimulation can produce a "picture not unlike what is seen in the mentally ill patient who becomes withdrawn and hallucinates."

A college instructor from the SID listserv expressed her frustrations with professionals who do not acknowledge sensory integration dysfunction. She indicated, "No professional I've every dealt with in any field ever heard of SID or recognized or even acknowledged its existence. This includes the pediatrician, family physician, preschool staff, pediatric ophthalmologist, pediatric audiologist, child psychologist, school psychologist, school principal, assistant principal, special education coordinator, kindergarten teacher, speech teacher, resource teacher, and graduate faculty in special education." As Larry B. Silver, M.D. states in Kranowitz, "...even more frequently, educational, health and mental health professionals focus on the emotional, social, and

family problems as if they were the primary issue..." (Forward, xiii). The underlying problem needs addressed before emotional, social and family problems can improve.

A child may show only a few of the characteristics of sensory integration dysfunction. Some of the characteristics may be something other than sensory integration dysfunction. Parents and professionals need to look at the "pattern of behaviors" on how the problems interfere with the child's physical and emotional development (Stephens). Doctors are understandably cautious in the diagnostic process and would rather go slowly and "wait and see," not wanting to err in such a serious matter. Proper treatment certainly depends on accurate diagnosis (Naseef, 179). However, as Grandin pointed out, sensory integration therapy will have the greatest effect on young children, while their brains are still developing (80). Consequently, the "wait and see" approach may be detrimental to the child with sensory integration dysfunction.

The Balanced Sensory Diet

All children need sensory input and experiences to grow and learn, but this is even more crucial for the child with sensory integration dysfunction. A sensory diet is a planned and scheduled activity program implemented by an occupational therapist. They are designed and developed specific to meet the needs of the child's nervous system. "Just as the five main food groups provide daily nutritional requirements, a daily sensory diet fulfills physical and emotional needs" (Kranowitz, 187). As explained earlier, stimulation of the "near" senses (tactile, vestibular and proprioceptive) leads to the growth of the neuron cell's dendrites and synapses. A sensory diet includes a combination of alerting, organizing and calming techniques that lead directly to the "near" senses.

Many parents fear the stigma attached to sensory integration dysfunction and do not want their child to be labeled as a special needs child. That fear is normal, but it does not help the child. We must consider the identification of sensory integration dysfunction as a benefit because a child can get help before the problem turns into a serious learning disability. The psychological, emotional, learning and social effects of sensory integration dysfunction on an individual may be reduced with proper sensory integration treatment and an understanding from the medical and professional fields.

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[1]The information gathered to describe the brain and a neuron cell came from a combination of sources. "Neurophysiology." Encarta Encyclopedia 99; "Nervous System." The World Book Encyclopedia, 1967; Bee, Helen. The Developing Child. 8th ed. New York: Longman, 1997; and Kranowitz, Carol Stock. The Out-of-Sync Child: Recognizing and Coping with Sensory Integration Dysfunction, New York, NY: The Berkley Publishing Group, 1998.

[2]The Diagnostic and Statistical Manual, Volume 4 (DSM-IV) provides a detail list of the symptoms for the disorders listed.