Uncovering the Hidden Senses:

An Introduction to Sensory Integration

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We are born with a sensory system that helps us survive by interpreting information from our internal and external environment, integrating that information into a whole picture, and developing an appropriate response. What is this sensory process and how does it develop? We have our five familiar senses: visual (seeing), auditory (hearing), gustatory (tasting), olfactory (smelling), and tactile (touching) systems. There are two other senses, often called the hidden senses, which may not be as familiar to us. These are the proprioceptive (body awareness) and vestibular (movement) systems. The visual, auditory, and olfactory systems are often considered to be distal senses, meaning that information comes to them from a distance and is then interpreted by the brain in a series of increasingly integrative neural firings. The gustatory and tactile systems, on the other hand, are a combination of distal and proximal because, even though the stimulus is outside the body, the object must come into contact with the body to be known. Because awareness is contained in the body itself, the proprioceptive and vestibular systems are considered to be proximal senses (meaning nearer the center of the body). The proximal senses, particularly the vestibular system, are considered key to one's ability to integrate sensory information accurately. In humans, sensory development and capabilities start in the fifth week of gestation, beginning with touch. The perception of pain appears in the brain and spinal column at 12 to 16 weeks gestation (Foster & Verny, 2007).

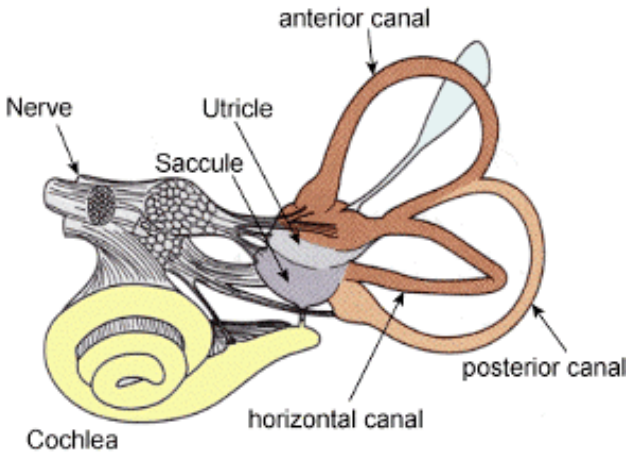
To better understand how our sensory system gives us a picture of the world, let's consider one of the five senses in detail. Our tactile system has two major purposes: to provide protection (by telling us when a stimulus is potentially dangerous and activating the fight/flight system) and discrimination of input (by telling us where we are being touched and what is touching us). This sense is the first to receive information about the world in utero and is central in an infant's bonding process.

When there is tactile over-responsivity, the receptors perceive normally non-noxious stimuli as noxious or harmful, with the result being a fight or flight response. Children may scream, yell, and possibly run from parents who are trying to appropriately wash their faces. They may feel easily upset by the textures of clothing and food. At the other end of the spectrum, children who are under-responsive may need stronger tactile input, including extra touch stimulation or deep pressure, both passive and active, in order for them to feel calm (Kranowitz, 2005). Such children may have difficulty getting dressed because they cannot feel the buttons, or where the clothes are on their bodies. In addition to these differences, children may experience difficulties with attachment because of their altered way of

experiencing caring touch. As with all of our senses, touch is an important link in allowing us to integrate and respond to our experience of the world, and so is part of several other challenges. For example, children with dyspraxia have difficulty conceiving of, organizing, and performing activities that involve a sequence of movements. Part of the reason for this may be that they cannot interpret tactile information appropriately to make an adaptive response with their bodies. Essentially, the tactile difficulty interrupts the brain's usual push toward integration.

Now let's consider the two hidden senses. Proprioception, sometimes called kinesthesia, allows us to sense the position and movement of our body and its parts. Sensory nerve endings in our muscles, tendons, and joints provide the input for the brain to register the body's position. Our awareness of this sense generally remains below the level of conscious awareness.

Proprioception helps integrate touch and movement sensations to let us know where each part of the body is relative to the others and how it is moving. It allows us to be aware of our position in space and our timing. This sense also plays a part in the process of becoming alert or calming down. This input is also referred to as "heavy work" because it requires us to use our muscles and joints in order for our brains to register this input. Children with proprioceptive dysfunction may look very clumsy and have difficulty grading the amount of force or pressure to use when interacting with objects or people. In an attempt to get a better sense of their bodies, they might constantly climb or jump.



Vestibular System

The vestibular system, which gives us information about balance and movement, is located in the labyrinth of the inner ear, just adjacent to the cochlea. It is composed of a series of semicircular canals that detect rotational movements and associated small sacs that detect linear movements. Because we are almost always in both kinds of motion, imagine the complexity of the input that has to be translated into output to the rest of the body/brain for us to function in the world. This sensory system responds to the pull of gravity, providing information about the head's position in relationship to the surface of the earth. It is also a unifying system that co-ordinates information from the vestibular organs in the inner ear, the eyes, muscles and joints, fingertips and palms of the hands, pressors on the soles of the feet, jaws, and gravity receptors on the skin, while adjusting heart rate and blood pressure, muscle tone, limb position, immune responses, arousal and balance (McAlpine, n.d.). This has been called our most robust sensory system, as input from this system can last four hours. As a result, part of its job is to prime our autonomic nervous system to function effectively in the fight-flight response as well as for self-soothing. As we would expect with these multiple integrative functions, the vestibular system has projections throughout the cortex and limbic areas, many of which are not yet well understood.

Children with a vestibular dysfunction may always be in motion, have poor balance, have poor timing and sequencing of movements, be unable to anticipate movements in time and space (like catching and throwing a ball, or navigating a crowded playground), have poor ocular control, and be emotionally labile, particularly prone to anxiety and panic attacks. Some children may also be afraid of or over-sensitive to movement. Because of the close connection with the auditory system and other areas of the brain, those with vestibular dysfunction may have difficulty processing language. A growing body of research including the work of Stephen Porges (2007) also suggests that the vestibular system plays a significant role in Acute and Post Traumatic Stress Disorders (which makes sense because of the close connection with the autonomic nervous

system), as well as the spectrum disorders of Autism.

As we consider the complexity of sensory processing, we might marvel that for most of us this continuous integration of information coming to us through our senses (touch, smell, taste, vision, hearing, movement, and proprioception) is automatic. We receive the information, organize and interpret it, and make a meaningful, adaptive response. We hear someone talking to us, our brains receive that input (along with multiple other inputs from inside and outside our bodies), recognize it as a voice talking in a normal tone, and we respond appropriately. Until fifty years ago, there was no clear definition or help for children (and adults) whose brains weren't able to achieve this kind of integrative functioning, often leading to frustration for parents who couldn't understand their children's differences.

Having struggled with similar learning difficulties as a child, A. Jean Ayres (1980/2005) became an occupational therapist and psychologist dedicated to the understanding, assessment, and treatment of what she identified as Sensory Integration Dysfunction (SID/SI/DSI), the inability of the brain to correctly process information brought in by the senses. Her work paved the way for a great deal of illuminating research, allowing Miller and Lane (2000) to clarify terminology and identify subtypes. We now recognize a range of Sensory Processing Disorders (SPD): Sensory Modulation Disorder (SMD), Sensory Discrimination Disorder (SDD), and Sensory-Based Motor Disorder (SBMD). These designations help practitioners in different fields communicate with one another with clarity and precision. In addition to behavioral and self-esteem issues, it appears that close to 90% of the children that mental health practitioners see may have underlying processing difficulties (Foster, 2006).

No two children or adults will be affected by SPD in the same way. Overall, children have varying problems with both understanding input and formulating output. SPD affects the way their brains interpret the information that comes in; it also affects how they respond to that information with emotional, motor, and other reactions. As we discussed above, some children are over-responsive to sensation and so feel as if they are being constantly bombarded with sensory information. They may try to eliminate or minimize this perceived sensory overload by avoiding being touched or being very particular about clothing, or only eating certain foods. Some children are under-responsive and have an almost insatiable desire for sensory input. They may seek out constant stimulation by taking part in extreme activities, playing music very loudly, or moving constantly (Miller, 2007).

Some of the most significant discoveries about how to improve outcomes have come from research with premature infants and children who have lived in international orphanages (Healy, 2002). The care of premature babies and newborns with traumatic pre- and post-birth histories provides clues about how to foster sensory integration in the nervous system. For instance, very early in development, Occupational Therapists (OTs) working in the NICU may diagnose premature babies with Sensory Defensiveness. The OTs help the parents understand how to relate with their babies. Often, these preemies need a quiet environment with less sensory input. In an effort to connect, parents often give babies too much—too much talking, proximity, and movement. What these tiny, highly sensitive beings need is soft, slow input that feels safe for their immature and already-taxed nervous systems.

Through the actions and sensitivities that support secure attachment from conception through infancy, parents in general can help improve the outcomes for any infant. When parents can read

the cues of their infants and respond to their needs with warm accurate care, they will be able to sense how to carry, touch, gently move them in different directions, and generally be aware of how the tone and pitch of the voice is being received. Research, as well as personal observation, indicates that infants are generally wonderful teachers for their parents, showing caregivers what they need, how much of it feels good, and when to stop. Infants often stop crying when picked up, which may indicate that they need the movement and/or touch/pressure to help modulate their sensory systems; babies also look away when over-stimulated with eye contact. Some of the ways that parents can stimulate and/or soothe their infants are by baby wearing in a sling, massaging the body during a baby's quiet alert moments where the skin-to-skin contact reduces cortisol and increases oxytocin, and breastfeeding, which exercises the muscles of the tongue, lip, and jaw. In addition to the nutritional and immune system benefits, breastfeeding also helps stimulate all the sphincter muscles of the body cavities, including the pupils of the eyes, which later may translate into a better capacity to focus (Gross-Loh, 2006; Bluestone, 2006). As parents, we can provide the safe, warm contact that encourages optimal integration throughout the brain.

As we are learning more about how the human infant brain and nervous system develop in the prenatal period and in the first two years of life, we have reason to rethink some popular early childhood practices. The need for parental support in the development of a healthy sensory system suggests that spending excessive amounts of time in car seats, strollers, and front-to-back infant swings may be quite detrimental. In general, when parents have the inner resources to truly see their children and respond accurately to their unique needs, their children's capacity for sensory integration can be maximized. This is true through all the rituals of childhood: eating, sleeping, dressing, playing, relating.

For example, we know that integration is supported when babies crawl before walking. As children grow, they benefit from play, especially in natural environments. Just look at some of the activities that help to develop the vestibular system: rolling (down a grassy hill), swinging (but never forced), spinning, sliding, riding vehicles like bikes and scooters, walking on unstable surfaces (such as a sandy beach), rocking, riding and balancing on a teeter-totter, balancing on a large therapy ball, jogging, horseback riding, and swimming to name a few. Jaak Panksepp (2007) suggests that the diagnosis of ADHD could be reduced if children in schools had more time for recess, play, and general movement, especially on swings.

Before leaving this topic, let's talk a bit about SPD and adults. Many people may have had undiagnosed SPD in their childhoods, and may have chosen lifestyles that have helped them self-correct or better compensate for this problem. Often, adults find careers that help them learn to live with their particular learning style or difference. For instance, a person who needs more stimulation may wake up early to surf in the morning, go to work in construction, and in the evening play an electric guitar. When faced with transitions or changes to their lifestyle, such as going back to school, managing their own business, or changing careers, adults may have to revisit how they learn best. Even in the therapeutic environment, it is helpful for a clinician to consider an individual's unique style of interpreting sensory information, to develop an understanding of the patient's learning style—visual, kinesthetic, or auditory, and to be aware of any learning differences they may have experienced. Such interest in and understanding of the uniqueness of their sensory experience can amplify the sense of being seen and known.

The discomfort of SPD often leads adults to take steps to manage their physical and emotional universe. Addictions may be one of the ways that adults self-medicate. Smoking is an example.

Besides the chemical addiction of nicotine, adults may use the sucking in and blowing out of cigarette smoke to self-soothe as well as to improve focus. Having to go outside to smoke also gives the individual an opportunity for self-soothing by increased movement and separation if they are feeling awkward in a social situation. Using a silly straw for drinking, blowing bubbles with a wand, chewing gum, or blowing out candles are similar therapeutic activities for sensory processing dysfunction, if one craves oral input to help calm them down. (A small caution—drinking through silly straws is not advised during pregnancy.)

Many clinicians and researchers who had SPD as children suggest that individuals who demonstrate repetitive behaviors or touch certain areas of their body are giving clues to ways that will help them self-regulate or compensate. Exploring how the behavior and movement is helping the individual can lead to a reduction of stress and an increased capacity to calm the nervous system. Social activities and interpersonal skills of both children and adults with sensory integration issues are often impaired in a variety of ways. However, recent research has also found that as individuals become more aware of their internal physiological responses, they can increase their ability in a variety of ways, including expanding their empathic capacity.

While these ideas about assessment and treatment just brush the surface, they may pique your interest in learning more. Today, there are numerous tests and resources available—including research, support for parents, listings for qualified Occupational Therapists who specialize in treating SPD, and a great deal of encouragement. At the end of this Quarterly, you will find a list of websites that can give you a good start.

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Resources for understanding and raising children with Sensory Processing Disorder:
www.kidfoundation.org (research and wonderful SPD resources for parents and teachers)
www.sensoryresources.com (workshops and resources for parents)
www.sinetwork.org (many research articles)
www.spdnetwork.org (research and helpful information for parents)

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