

Concept Evolution in Sensory Integration: A Proposed Nosology for Diagnosis



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Sensory integration is a long-standing and growing area of practice in occupational therapy. Debate and discussion with colleagues have led us to develop a proposed taxonomy reflecting a new classification scheme to enhance diagnostic specificity. The nosology proposed here is rooted in empirical data first published by Ayres (Ayres, 1972b, 1989) that has evolved based on empirical and theoretical information. This new nosology provides a viewpoint for discussion and research.

Two sociopolitical trends contribute to the timeliness of the ideas presented. First, a call exists throughout health and developmental services for evidence-based practice (Sackett, Richardson, Rosenberg, & Haynes, 1997). Diagnostic precision is crucial for homogeneity of samples in empirical research, affecting the validity of the research findings. Second, the condition of sensory processing disorders (SPD) has recently been acknowledged outside the occupational therapy profession in three diagnostic classification references: the *Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood, Revised* (known as the *DC: 0-3R*) (Zero to Three, 2005), the *Diagnostic Manual for Infancy and Early Childhood* of the Interdisciplinary Council on Developmental and Learning Disorders (ICDL, 2005), and the *Psychodynamic Diagnostic Manual* (PDM Task Force, 2006). Both manuals include diagnostic taxonomies with subtypes of SPD suggested by a committee of occupational therapists, who assisted in developing guidelines for diagnostic specificity related to

sensory-based disorders (Miller, Cermak, Lane, Anzalone, & Koomar, 2004).

Legacy of Dr. A. Jean Ayres

The term *sensory integration dysfunction* was first used by Ayres in 1963 (Ayres, 1963). A pioneer with educational degrees in occupational therapy and academic psychology and postdoctoral training as a neuroscientist, Ayres explored the association between sensory processing and the behavior of children with learning, developmental, emotional, and other disabilities in scientific journals and later in her groundbreaking book, *Sensory Integration and Learning Disorders* (Ayres, 1972a). On the basis of knowledge of neural science and detailed observation of child behavior, Ayres theorized that impaired sensory processing might result in various functional problems, which she labeled *sensory integration dysfunction*. The condition was initially based on studies of the Southern California Sensory Integration Tests (Ayres, 1972b) and later from studies of the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989) and related clinical observations.

Later scholars clarified the many uses of the term *sensory integration* (Bundy, Lane, & Murray, 2002; Clark & Primeau, 1988). Sensory integration *theory* refers to constructs that discuss how the brain processes sensation and the resulting motor, behavior, emotion, and attention responses. Sensory integration *assessment* is the process of evaluating persons for problems in processing sensation. Sensory integration *treatment* is a method of intervention. Ayres's original

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term, *sensory integration dysfunction*, had referred to the disorder as a whole.

As Ayres published and taught about sensory integration (Ayres, 1965, 1972a), her new frame of reference was used, primarily in occupational therapy. Ayres's early conceptualizations defined six syndromes of dysfunction (Ayres, 1972a), later refined with data from her new test battery (Ayres, 1989). Although Ayres's own conceptualizations evolved frequently as she completed new empirical studies, no suggestion of a substantive evolution from Ayres's original diagnostic conceptualization has been proposed since her last publication in 1989 (Ayres, 1989).

Moving Beyond the Legacy

Discussion of a new diagnostic taxonomy is increasingly important because the intervention, occupational therapy with a sensory integration approach (OT-SI), is used with many people who cannot be tested using the SIPT. Importantly, the SIPT formed the primary empirical basis for the diagnostic categories. To achieve consensus on an alternative taxonomy for diagnosis, Miller and colleagues held focus groups in 1998–2000 that resulted in three publications (Hanft, Miller, & Lane, 2000; Lane, Miller, & Hanft, 2000; Miller & Lane, 2000). Results were not unanimous, but most participants agreed that terminology for the diagnosis and the treatment of the disorder should diverge. In addition, concern was expressed related to use of the term *sensory integration*, which many participants in the focus groups believed is often interpreted differently within and outside the field of occupational therapy. (For example, use of the term *sensory integration* often applies to a neurophysiologic cellular process rather than a behavioral response to sensory input as connoted by Ayres.)

The committee consulting to the *DC: 0–3R* and the ICDL examined published and unpublished empirical data and conferred numerous times over a 2-year period to arrive at a consensus on a new nosology for SPD. The taxonomy resulting from the committee's work was first summarized in 2004 (Miller, Cermak, Lane, Anzalone, & Koomar, 2004) and, later, subtypes reflecting components of the work were pub-

lished in the diagnostic manuals of both the ICDL (2005) and Zero to Three (2005). Our long-term intention is to propose one or more subtypes for the upcoming revision of the *Diagnostic and Statistical Manual of Mental Disorders IV–TR* of the American Psychiatric Association (2000), due out in 2012.

Kuhn (1996) discussed the process of paradigm shift that explains the evolution of ideas in science. During this process, each new study or theory builds on preceding ideas and slowly change evolves. At times, a substantial change is required to move forward. Kuhn (1996) termed this *revolutionary change* because either new empirical evidence disproves previous conceptualizations, or enough evolutionary changes have accumulated to create a need for reconceptualization and paradigm adjustment. We believe that sensory integration as a diagnosis has achieved the latter state and thus has reached the tipping point toward a paradigm shift.

Since Ayres (1963) first proposed the theory of sensory integration, many theorists, researchers, and clinicians have further developed the theory. Models building on Ayres's work have been proposed (e.g., Dunn, 2001; Miller, Reisman, McIntosh, & Simon, 2001; Mulligan, 1998; Parham, 2002; Williamson & Anzalone, 2001), and new empirical evidence providing insight into differential diagnosis has been published (DeGangi, 2000; Mangeot et al., 2001; McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1999; Schaaf, Miller, Seawell, & O'Keefe, 2003).

In an attempt to reach Kuhn's (1996) state of *equipoise*, a state when a profession universally agrees to a shift in thinking, we propose a nosology that differentiates diagnostic subtypes. The intent of this proposal is to provide a structure for scholarly debate.

Proposed Nosology

The categories proposed here are based on previous work by many theorists and researchers (e.g., DeGangi, 2000; Dunn, 2001; Mulligan, 1998). This diagnostic taxonomy does not suggest changes in terminology for sensory integration theory, sensory integration treatment, or the sensory

integration evaluation process, only in the diagnostic categorization of people with sensory-based processing challenges. Diagnostic subgroups within sensory integration dysfunction encompass immense individual differences in detecting, regulating, interpreting, and responding to sensory input. We propose that a diagnosis of SPD be made if, and only if, the sensory processing difficulties impair daily routines or roles.

Sensory "processing" rather than sensory "integration," when used for the diagnosis of sensory-based processing challenges, distinguishes the *disorder* from both the *theory* (i.e., sensory integration theory) and the *intervention* (i.e., OT-SI). In addition, the terminology differentiates the condition of SPD from the cellular process of sensory integration. Diagnostic specificity will enhance the homogeneity of the samples used for empirical research and will promote targeting of intervention approaches to specific diagnostic subtypes.

The proposed nosology depicted in Figure 1 and described below includes three classic categories of SPD. Each pattern is further refined into subtypes, delineated below.

Pattern 1: Sensory Modulation Disorder (SMD)

Sensory modulation occurs as the central nervous system regulates the neural messages about sensory stimuli. SMD results when a person has difficulty responding to sensory input with behavior that is graded relative to the degree, nature, or intensity of the sensory information. Responses are inconsistent with the demands of the situation, and inflexibility adapting to sensory challenges encountered in daily life is observed. Difficulty achieving and maintaining a developmentally appropriate range of emotional and attentional responses often occurs. Three subtypes of SMD exist as detailed below.

SMD Subtype 1: Sensory Overresponsivity (SOR). People with SOR respond to sensation faster, with more intensity, or for a longer duration than those with typical sensory responsivity. Overresponsivity may occur in only one sensory system (e.g., tactile defensiveness) or in multiple sensory systems (e.g., sensory defensiveness). The wide variation observed in the expression of

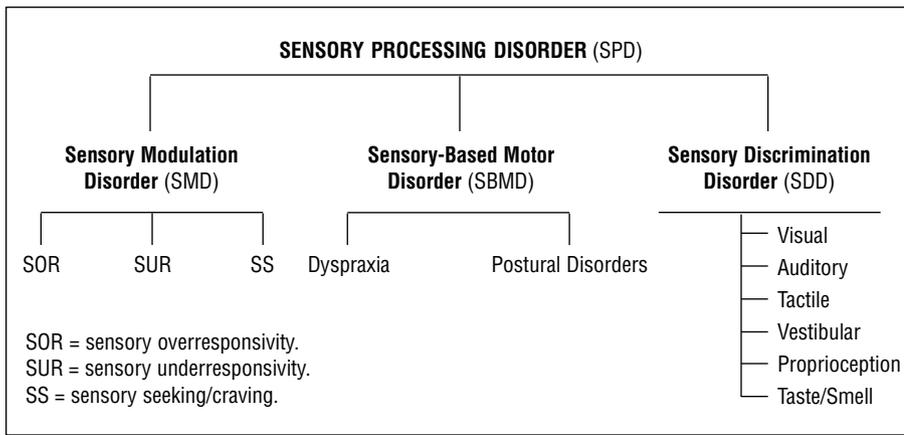


Figure 1. A proposed new nosology for sensory processing disorder.

SOR depends on various personal and contextual factors. SOR prevents people from making effective functional responses. Difficulties are particularly evident in new situations and during transitions. The intrapersonal range of responses may appear as willful behavior, seemingly illogical and inconsistent.

However, the atypical responses observed are not willful; they are automatic, unconscious physiologic reactions to sensation. More intense responses generally occur if the stimulation is unexpected rather than self-generated. In addition, sensory input often has a summative effect; thus, a sudden exaggerated response may occur to a seeming trivial event because of the accumulated events of the day. Behaviors in SOR range from active, negative, impulsive, or aggressive responses to more passive withdrawal or avoidance of sensation. Sympathetic nervous system activation is a marker of SOR (Miller et al., 1999), which may result in exaggerated fight, flight, fright, or freeze responses (Ayres, 1972a). Emotional responses include irritability, moodiness, inconsolability, or poor socialization. People with SOR are often rigid and controlling. SOR may occur in combination with other sensory modulation disorders (e.g., sensory seeking, sensory overresponsivity in vestibular and proprioceptive systems) and is often observed concomitantly with sensory discrimination disorder (SDD), dyspraxia, or both.

SMD Subtype 2: Sensory Underresponsivity (SUR). People with SUR disregard, or do not respond to, sensory stimuli in their

environments. They appear not to detect incoming sensory information. This lack of initial awareness may lead to apathy, lethargy, and a seeming lack of inner drive to initiate socialization and exploration. However, in SUR, inaction is not due to a lack of motivation but rather to a failure to notice the possibilities for action. A failure to respond to pain (e.g., bumps, falls, cuts) or extreme temperatures (hot or cold) is typical. Behavior of people with SOR is often described as withdrawn, difficult to engage, inattentive, or self-absorbed. Compensatory strategies may lead to procrastination, and people with SUR are often labeled “lazy” or “unmotivated.”

Commonly, SUR is not detected in infancy or toddlerhood. The child may be considered a “good baby” or “easy child” because few demands are made on caregivers. However, because people with SUR need high-intensity salient input to become involved in a task or interaction, when children are older, the necessary arousal level to participate across contexts may not be available. Reports of inconsistency are common (e.g., the child’s behavior is acceptable at home but not at school). SUR occurring in tactile and proprioceptive systems usually leads to poor tactile discrimination and a poor body scheme with clumsiness. Thus, people with SUR often have concomitant SDD, dyspraxia, or both.

SMD Subtype 3: Sensory Seeking/Craving (SS). People with SS crave an unusual amount or type of sensory input and seem to have an insatiable desire for sensation. They energetically engage in actions that add more intense sensations to

their bodies in many modalities (e.g., spicy food, loud noises, visually stimulating objects, constant spinning). Invasive SS behaviors can influence social interactions with peers (e.g., other people are crowded and touched, physical boundaries are not observed). Active SS often leads to socially unacceptable or unsafe behavior, including constant moving, “crashing and bashing,” “bumping and jumping,” impulsiveness, carelessness, restlessness, and overexpression of affection. The actions of these people often are interpreted as demanding or attention-seeking behavior.

Some degree of sensory-seeking behavior is typical in children as they learn, explore, and master new challenges; however, children and adults who meet criteria for SS are extreme in their quest for sensory input. When unable to meet sensory needs, children may become explosive and aggressive. They are frequently labeled “troublemaker,” “risk-taker,” “bad,” and “dangerous” and expelled from preschool. Disciplinary trouble in elementary school is also common. Extreme SS can disrupt attention so profoundly that learning is compromised or activities of daily living are difficult to complete.

SS may also occur to obtain enhanced input when reduced perception of sensation occurs. For example, if a child cannot feel his zipper well, he may play with the zipper over and over until he has adequate perceptions of the feel and movement of the zipper so that he can complete a zipping task.

SS often occurs as the person tries to increase his or her arousal level. For those with SS, the need for constant stimulation is difficult to fulfill, particularly in environments where quiet behavior is expected. Unfortunately, obtaining additional sensory stimulation, if unstructured, may increase the overall state of arousal, resulting in even more disorganized behavior. Specific, directed types of sensory input, however, can have an organizing or self-regulatory effect. Some children with SOR will engage in SS behaviors as an attempt at self-regulation (e.g., stereotypy in a child with autism). A challenge is that overactive and impulsive symptoms in SS can easily be confused with (and often co-occur with) attention deficit hyperactivity disorder (ADHD).

Pattern 2: Sensory Discrimination Disorder (SDD)

People with SDD have difficulty interpreting qualities of sensory stimuli and are unable to perceive similarities and differences among stimuli. They can perceive that stimuli are present and can regulate their response to stimuli but cannot tell precisely what or where the stimulus is. SDD can be observed in any sensory modality. A person with SDD may have different capacities in each modality (e.g., a visual or auditory discrimination disorder but good discrimination in all other modalities).

Traditional models of sensory discrimination focus on visual, auditory, and tactile perceptions. Unique to the model proposed here is the focus on somatic senses. Discrimination in the tactile, proprioceptive, and vestibular systems leads to smooth, graded, coordinated movement. SDD in these three systems results in awkward motor abilities. SDD in the visual and auditory systems can lead to a learning or language disability. A person with SDD may require extra time to process the salient aspects of sensory stimuli, leading to “slow” performance. Low self-confidence, attention-seeking behavior, and temper tantrums may result.

Normal sensory discrimination forms the foundation of adequate body scheme because accurate interpretation of sensory stimulation is the basis of feed-forward mechanisms for planning movement and postural responses. SDD frequently co-occurs with SUR, resulting in poor body scheme and dyspraxia. However, people with SDD also may have SOR; in this situation, overresponsivity is seen to override the discriminative perceptions from the body.

Pattern 3: Sensory-Based Motor Disorder (SBMD)

People with SBMD have poor postural or volitional movement as a result of sensory problems. The two subtypes of SBMD are detailed below.

SBMD Subtype 1: Postural Disorder. *Postural disorder* (PD) is difficulty stabilizing the body during movement or at rest to meet the demands of the environment or of a given motor task. PD is characterized by

inappropriate muscle tension, hypotonic or hypertonic muscle tone, inadequate control of movement, or inadequate muscle contraction to achieve movement against resistance. Poor balance between flexion and extension of body parts, poor stability, poor righting and equilibrium reactions, poor weight shifting and trunk rotation, and poor ocular–motor control also may be noted.

Postural control provides a stable yet mobile base for refined movement of the head, eyes, and limbs, which arises from integration of vestibular, proprioceptive, and visual information. When postural control is good, the child is able to execute functional behaviors such as reaching and resistance against gravity. When postural control is poor, people often slump in a standing or sitting position and cannot easily move body and limbs in antigravity positions. They also may exhibit difficulty maintaining or automatically adjusting a position so tasks can be performed efficiently. For example, when writing at a desk, they may need to bend far over the paper or lay their head on their arm as they write.

PD commonly occurs in combination with one or more other subtypes. The arousal level of the person (e.g., SOR or SUR) and discrimination of sensory information (e.g., SDD) can affect postural control. PD also can occur with dyspraxia, which usually includes difficulty with bilateral integration activities and problems with rhythmic activities.

Some people with PD may tend to avoid movement, preferring sedentary activities. Others with PD may be physically active but lack body control and therefore engage in unsafe movements. Avoidance of movement due to PD can be differentiated from avoidance of movement due to SOR in the vestibular system by observing whether the child (a) is unstable or fearful in challenging positions (PD) or (b) seems to have an aversive response to the movement (SOR).

SBMD Subtype 2: Dyspraxia. *Dyspraxia* is an impaired ability to conceive of, plan, sequence, or execute novel actions. People appear awkward and poorly coordinated in gross, fine, or oral–motor areas. Dyspraxia can occur in the presence of either SOR or SUR but most commonly occurs in the

presence of SUR or SDD in the tactile, proprioceptive, or vestibular domains. Visual–motor deficits also are common in this disorder.

People with dyspraxia seem unsure of where their body is in space and have trouble judging their distance from objects, people, or both. They may seem accident-prone, frequently breaking toys or objects because of difficulty grading force during movement. People with dyspraxia usually have poor skills in ball activities and sports. They display difficulty with projected action sequences that require timing. People with dyspraxia, like most children, learn by trial and error, but they require significantly more practice than is typical and demonstrate decreased ability to generalize skills to other motor tasks.

Often dyspraxia is associated with ideational problems (e.g., formulating goals or ideas for actions). Because people with dyspraxia are unable to generate new ideas of what to do, they may resort to rigid or inflexible strategies, perseverating and preferring the familiar to the novel. Execution of discrete motor skills (e.g., standing, walking, pincer grasp) may be age appropriate and of adequate quality. However, the performance of more complex tasks as part of functional activities in a dynamic environment is compromised. Particular difficulty is observed when tasks require subtle adaptation of timing in movement.

Many people with dyspraxia also have trouble with fine motor manipulative activities as well as oral–motor activities. Daily activities, such as using utensils and dressing, often are slow to develop or are imprecise. People with dyspraxia often are disorganized and may appear disheveled.

Some people with dyspraxia are highly creative and verbal, preferring fantasy games to actual “doing.” They may try to mask their dyspraxia by clowning around as a way to mask their reticence for participating in new activities. People with dyspraxia often are inactive, preferring sedentary activities such as watching TV, playing video games, or reading a book, which can result in a tendency toward obesity. However, dyspraxia may co-occur with ADHD, in which case the child’s behavior is characterized by increased activity in the context of poor coordination. Self-esteem may be

poor because of dissatisfaction with abilities and repeated feelings of failure. Children often have low frustration tolerance and may be perceived as manipulative or controlling. Some children with dyspraxia have an overreliance on language as a compensatory tool. However, dyspraxia also can occur with language or speech impairments.

Conclusion

Ayres based her original diagnostic classifications primarily on analysis of standardized test data, although clinical observations also were considered. The model proposed here is based on empirical analysis of subgroups of children diagnosed with sensory integration dysfunction. The proposed new nosology differentiates three classic patterns: SMD, SDD, and SBMD, with subtypes in each pattern.

This taxonomy is intended for use by both clinicians and researchers to provide homogeneity for sample selection in research studies and substantive discrimination of subtypes for planning intervention. Additional evolution in thought is expected as our knowledge base in this field grows and empirical data expand. Use of samples selected for specific attributes of SPD subtypes will increase the power of research studies (e.g., less unexplained variance in samples). Use of specific diagnoses also will increase treatment specificity for clinical practice.

In summary, appropriate diagnosis forms the cornerstone of rigorous research and high-quality practice. This new nosology is proposed as a step in that direction. ▲

Acknowledgments

This issue of the *American Journal of Occupational Therapy* contains the work of many people, representing the range from clinician to researcher. An effort has been made to be inclusive on all levels. Thus, readers will find information from clinicians and researchers, on humans and primates, using group and single-subject design, addressing the development of assessments and the effects of intervention, discussing OT-SI as the only treatment approach and OT-SI combined with other sensory and behavioral approaches. In these articles the definition of *sensory integra-*

tion deficits varies to some degree, reflecting our current struggle to empirically define these constructs. This is where the proposed nosology comes into play.

In the field of occupational therapy we have a relatively large number of published studies on sensory integration, but as noted above and in this volume, many are fraught with methodological errors. We still have a long way to go, but the work included in this volume reflects our collective effort to continue to move our field forward and to do so from a broad perspective. My gratitude goes to the contributors; I appreciate the opportunity I have had to collect these works and advance our understanding of SPD.

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