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Toward a Consensus in Terminology in Sensory Integration Theory and Practice: Part 3: Observable Behaviors: Sensory Integration Dysfunction

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Editor's Note. This is the third in a series of articles discussing the need to reach a consensus in how researchers and clinicians use terminology related to sensory integration dysfunction. Part 1 was published in the March 2000 issue, and Part 2 was published in the June 2000 issue.

Part 3 of this series focuses on describing the observable behaviors that occur within three types of sensory integration dysfunction (DSI) within a spectrum of disorders: sensory modulation dysfunction (SMD), dysfunction in sensory discrimination, and dyspraxia. In Part 2, we highlighted the importance of differentiating dysfunctional sensory integration behaviors from neurophysiological mechanisms. We further proposed that the term *response* describes a person's observable behavioral actions, whereas the term *reaction* describes neurophysiological mechanisms within the central nervous system. Thus, the language that we use to describe the behavioral, emotional, and attentional responses of a person with DSI should be different from how we describe central nervous system reactions (e.g., registration and modulation of sensory input) at the cellular level. Most importantly, as clinical therapists and as researchers, we must not assume that observed behaviors result from mechanisms that theoretically occur at cellular levels.

Much work remains to further delineate observable behaviors in various patterns of DSI. Tables 1–3 provide examples of behavioral manifestations of SMD, dysfunction in sensory discrimination, and dyspraxia. Our intent is to describe some of the observable patterns of behaviors in these three types of DSI because space precludes inclusion of all possible behaviors that one could observe within the overarching rubric of DSI. In earlier factor analytical studies, Ayres demonstrated relationships among test scores reflecting sensory processing, praxis, academic abilities, tactile defensiveness, hyperactivity, and distractibility (see Mailloux & Parham, 1996, for an in-depth summary of Ayres' factor analytical studies).

SMD

Recent empirical research has established SMD as a defined syndrome within the rubric of DSI in which a person under- or overresponds to sensory input from the body or environment (McIntosh, Miller, Shyu, & Hagerman, 1999). This response is a mismatch between the external contextual demands of a person's world (e.g., culture, environment, tasks, and relationships) and his or her internal characteristics (e.g., attention, emotions, and sensory processing) (Miller, Reisman, McIntosh, & Simon, in press). Many children and adults with SMD experience emotional and attentional symptoms as well as sensory-based behavioral responses (Table 1). Clearly, not all dysfunctional behaviors that a person may experience are always indicative of DSI; many behaviors can be the result of emotional or cognitive disorders in the absence of DSI (Greenspan & Wieder, 1998).

We provide examples of observable behaviors that accompany SMD in Table 1 as hypo- or hyperresponsivity to input (Dunn, 1997, 1999; McIntosh et al., 1999). Hyporesponsive behaviors involve a slow response to sensory stimuli and require high intensity or increased duration of the stimuli to invoke an observed behavioral response. Hyporesponsivity can take one of two forms: either the person has a diminished response, or he or she actively engages in "sensory seeking" to satisfy a basic need or desire for additional sensory input. On the other hand, hyperresponsive behaviors involve a quick or intense response to sensory stimuli that results in exaggerated responses ("fight or fright") or withdrawal from stimuli ("flight or freeze") that most other persons perceive as benign.

Persons with SMD may experience considerable fluctuations in their behavioral responses to input from day to day and during daily activities. Table 1 identifies typical behaviors that one must interpret carefully before diagnosing a person. Behaviors in any one column may describe a person's responses only in certain contexts and only during specific time periods.

In Part 2 of this series, we defined the term *threshold* as a neurophysiological process denoting the level at which synaptic activity occurs within the central nervous system in response to a stimulus. Although the term threshold has in the past described certain behaviors (e.g. "Jose has a low threshold to sound"), we recommend that occupational therapy practitioners use physiological terminology cautiously when describing observable behavior patterns. Dunn (1997, 1999) likewise differentiated between neurophysiological threshold and behavior in her conceptual model for the Sensory Profile. In the previous example, one can observe Jose's hyperresponsiveness to auditory input, whereas one can only presume a low threshold in the auditory system.

In addition to the dysfunctional behaviors in Table 1, other emotional and attentional behaviors of persons with SMD may be the result of problems with sensory processing. Emotional responses associated with hyporesponsive behaviors include a lack of a range of expression and passivity that limits engagement in social relationships. Examples of diminished attention include a lack of interest in

the physical and human environment that results in a narrow focus only on the task at hand. Emotional responses associated with hyperresponsive behaviors are typically explosive, aggressive, and hostile behaviors; when overstimulated, a person can easily become anxious, clingy, or even withdraw from all interaction and appear rigid in his or her interactions. Attention may fluctuate from distractibility to input and to an overfocused, vigilant approach to tasks in an effort to screen out noxious stimuli (Williamson & Anzalone, 1997).

Dysfunction in Sensory Discrimination

One of the most important contributions of Ayres's research and clinical practice was to highlight the contribution of the vestibular, proprioceptive, and tactile systems to a child's development in addition to the more recognizable senses of vision, hearing, taste, and smell. Some sensory systems have clear discriminatory functions. For example, somatosensory receptors in the skin transmit information about touch that guides our discriminate tactile ability. Discrimination of visual input begins with the receptors in the retina and is further refined at synapses within the central nervous system. The auditory system, although not as precise as the visual or tactile systems, has receptors and central connections that allow the discrimination and localization of sound. Discrimination between the gustatory and olfactory systems is closely linked because discrimination in one requires adequate functioning of the other.

However, in other sensory systems, discrimination abilities are not as well refined, which makes use of the term *discrimination* less clear. For example, the vestibular system can discriminate gross characteristics such as direction and velocity of movement but does not have fine discrimination capabilities such as detecting precise speed of motion or specific degrees of head movement. The proprioceptive system, which transmits information via somatosensory pathways, includes information relative to the force and direction of muscle contraction and joint movement but does not include the distinct levels of discrimination present within tactile, auditory, and visual systems. Nonetheless, the vestibular and proprioceptive systems provide critical information about body position and movement, and clinicians often identify and provide effective intervention for vestibular-proprioceptive difficulties in the absence of other DSI. Throughout her research, Ayres (1972, 1979, 1989) identified a type of DSI that she called *vestibular processing disorders* that we currently refer to as *deficits in bilateral integration and sequencing* (BIS). Both Ayres (1989) and Fisher (1991) suggested that a vestibular-proprioceptive disorder may contribute to a BIS deficit and recommended continued research to clarify its relationship to processing and discrimination in other sensory systems. Until more empirical evidence is available regarding the discriminatory properties of the vestibular and proprioceptive systems, we recommend that discussion of theories, evaluation, and treatment of "vestibular and proprioceptive problems" be carefully delineated as relating to only gross (rather than fine) discriminatory abilities.

Table 2 includes examples of behaviors associated with poor discrimination in tactile, visual, auditory, gustatory/smell, and vestibular/proprioceptive systems and is not an all-inclusive list of behaviors. Note that some of these impairments may have roots in higher-level cognitive deficits rather than DSI. We combined our examples of vestibular and proprioceptive behaviors in Table 2 (and not in Table 1) because of the differences between modulation and discrimination functions in these two systems. Although poor discrimination and underresponsive sensory systems in a person with DSI may be related, we propose the careful differentiation of behavioral descriptors of poor discrimination and underresponsive sensory modulation behaviors. Someone who exhibits the behaviors listed in the hyporesponsive column of Table 1 is additionally likely to have poor discrimination abilities. However, underresponsivity and poor discrimination are not the same construct. To determine whether a specific person meets criteria for underresponsiveness to sensory stimuli or poor discriminatory abilities, occupational therapists must examine these constructs separately.

Dyspraxia

Praxis (i.e., the ability to conceptualize, organize, and execute nonhabitual motor tasks) requires ideation, planning, modification, and self-monitoring for execution (Ayres, 1979, 1989). Thus, praxis includes both motor and cognitive elements. The occupational therapy literature defines dyspraxia as difficulty in planning and performing a novel motor act or series of motor actions that a medical diagnosis or developmental disability cannot explain. Dyspraxia refers specifically to disruption in sensory processing related to motor planning. (For an in-depth discussion of dyspraxia, see Ayres 1972, 1979, 1989; Cermak, 1991, in press; Fisher, 1991; and Mulligan, 1996, 1998.) Ayres (1989) emphasized that problems with praxis may manifest in different forms and that not all originate with DSI. Dyspraxia is often evident in conjunction with poor sensory discrimination and may co-occur with poor sensory modulation (Blanche, 1998; Guiffrida, in press). Table 3 provides examples of observable behaviors in the forms of dyspraxia associated with DSI.

Summary

This three-part series highlights the importance of clarifying the terminology that describes sensory integration function and dysfunction to communicate effectively within our profession and with researchers and clinicians in other fields. Our field urgently needs to communicate to build a consensus for a unified research and education agenda in DSI. The development of targeted assessment tools and intervention procedures additionally depends on the existence of a coherent and accepted terminology to describe the theoretical base. Another equally important reason to use a precise and universal language is to assist persons with DSI and their family members to understand the behaviors associated with DSI. A consensus in terminology can additionally have an effect on administrators and policymakers related to reimbursement of occupational therapy within a sensory integration framework. Finally, use of a shared language is essential as we strive to educate physicians, teachers, and family members to identify DSI and make appropriate referrals for evaluation and intervention. ■

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Table 1
Examples of Observable Behaviors in SMD

Sensory Domains	Hyporesponsive Behaviors	Hyperresponsive Behaviors
Dysfunction in Tactile Modulation	Diminished responses: "Out of touch" with the body, including unaware of messy hands and face or of twisted clothing; reduced reactions to pain or bruises; messy eating	Exaggerated responses: Responds aggressively to touch or imagined touch, upset by dressing, bathing, and/or eating
	Seeks sensation: Touches others too often or too hard (including peers, pets, and objects), touches or mouths hair and other objects constantly	Withdraws or avoids sensation: Avoids group activities, avoids tactile play
Dysfunction in Modulation of Vestibular Stimuli	Diminished responses: Slow to become dizzy, can spin or swing for long periods of time	Exaggerated responses: Afraid of or becomes sick with movement or when feet leave the ground (i.e., dislikes the playground or car rides)
	Seeks sensation: Overactive, continually seeks movement by jumping and running, engages in risky behaviors including climbing high or moving too quickly for safety	Withdraws and avoids sensation: Very cautious and unwilling to take movement risks; afraid of heights, elevators, and escalators
Dysfunction in Modulation of Proprioceptive Stimuli	Diminished responses: Unaware of body position and movement through space including knocking over drinks and bumping into walls and people; clumsy when dressing, playing, and writing; poor posture; unaware of how much force he or she uses in play, sports, and interpersonal interaction	Exaggerated responses: Overresponds to physical contact such as hugs, holding hands, or physical prompts; uncomfortable in jumping, running, or gymnastic activities and many sports
	Seeks sensation: Craves jumping or bump-and-crash activities; walks on toes; bangs or taps head, arms, and legs; constantly squeezes and bangs objects or sucks on hands and mouth	Withdraws or avoids sensation: Avoids or dislikes activities that demand movement of body parts such as jumping or hanging from a bar, insists on a diet of limited textures in foods
Dysfunction in Modulation of Visual Stimuli (assumes normal acuity)	Diminished responses: Does not notice details in surroundings or in books, cannot find a specific object from among many in drawers and shelves	Exaggerated responses: Difficulty shifting gaze from one object to another, tires easily or becomes irritable when attending to complex visual tasks
	Seeks sensation: Likes stimulating visual experiences including playing with flashlights and enjoying flickering lights, plays video games and in arcades for hours, gets close to the television and gazes for hours	Withdraws and avoids sensation: Avoids or feels uncomfortable in visually stimulating environments, avoids eye contact, likes dim lighting, always wears sunglasses
Dysfunction in Modulating Auditory Stimuli (assumes normal acuity)	Diminished responses: Difficulty adjusting his or her volume of speech	Exaggerated responses: Difficulty filtering noise in a classroom, dislikes and overreacts to loud sounds
	Seeks sensation: Prefers loud sounds and has television or radio sound loud all the time; constantly talks, sings, or makes noise with mouth and hands	Withdraws and avoids sensation: Shies away from loud sounds and may cover ears when he or she hears sirens or crying in a loud crowd or during fireworks
Dysfunction in Modulating Taste or Smell Stimuli	Diminished responses: Does not notice scents even when intense or offensive, cannot distinguish between scents, says all food tastes the same	Exaggerated responses: Dislikes certain restaurants, people, or pets because they smell "yucky"; avoids kitchen when dinner is being prepared; finds most scents offensive
	Seeks sensation: Prefers strong and distinct tastes to bland food, uses sense of smell in inappropriate ways, sniffs people and objects	Withdraws and avoids sensation: May refuse to eat anything that is not bland, will not try new foods

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Table 2
Examples of Observed Behaviors in Sensory Discrimination Dysfunction

Sensory System	Behavior
	May have difficulty with the following:
Dysfunction in Discriminating Tactile Stimuli	• Differentiating objects by touch or completing daily activities without visual cues (e.g., zippering, spoon to mouth, perceiving whether clothing is twisted, finding keys in a purse or a quarter in a pocket) • Identifying where body part has been touched without looking • Manipulating small objects and tools without vision (e.g., pencil, silverware, screwdriver)
Dysfunction in Discriminating Olfactory and Gustatory Stimuli	• Differentiating smells and tastes without visual cues • Alerting to the relevance of certain smells (e.g., burning toast or gas leaks)
Dysfunction in Discriminating Auditory Stimuli	• Differentiating and remembering similar words and sounds (e.g., bat, back, bad, bag) • Following two or more instructions, although he or she can easily do each one • Judging the source of sound (e.g., turning in the direction of a person who is calling his or her name) • Judging distance and location by sound (e.g., confused by echoes in hallways or the direction from which a car is approaching) • Focusing on or recognizing a specific sound in the presence of background noise
Dysfunction in Discriminating Visual Stimuli	• Perceiving form and space and relationships among objects (e.g., distinguishing between “p” from “q”) • Recognizing, matching, and categorizing color, texture, shape, and size • Scanning sequential images and changing visual focus rapidly • Visually guiding fine or gross motor movements (e.g., coloring within lines or hitting a ball with a bat) • Recognizing symbols and gestures • Perceiving depth, distance, location of boundaries, and space between objects • Differentiating foreground from background images
Dysfunction in Discriminating Vestibular-Proprioceptive Stimuli	• Maintaining balance, especially when moving • Knowing the position of the body in space and its relationship to surroundings • Maintaining an upright posture when sitting or standing still for a period of time • Determining position when riding on carnival rides or during similar activities (e.g., upside down or sideways) • Determining movement of the body versus movement of objects and people in the environment • Gauging the correct force to use with people or objects (e.g., writing with a pencil or giving a hug)

Table 3
Examples of Observable Behaviors in Dyspraxia

Components	Behavior
Cognitive	*May have difficulty with the following:*
Ideation	• Deciding what to do and how to do it (e.g., make a kite with string, glue, paper, and paint) • Creatively determining how to put together objects and materials for play or leisure activities and school or work projects • Translating ideas or images into language or actions for play, school, and work • Originating novel ideas about what to do or taking the role of leader • Spontaneity during play, school, or work activities
Planning	• Organizing a series of actions or activities to produce an intentional movement • Figuring out how to play a new game or incorporate new actions or movements (e.g., skate backwards)
Sequencing	• Combining several steps into an activity but can complete each piece separately
Motor	
Gross Motor	• Learning and smoothly executing novel motor activities that require large motions (e.g., riding a bike, pumping a swing) • Transitioning from one body position to another with appropriate sequencing and timing
Fine Motor	• Learning and smoothly executing novel motor activities that require small hand and finger motions (e.g., winding yarn) • Visually directing hand movements (e.g., cutting a picture from a magazine)
Oral Motor	• Coordinating respiration with mouth and tongue movements for sucking, chewing, and blowing activities • Using appropriate facial gestures during interactions
Visual Motor	• Eye–hand coordination (e.g., writing, coloring within lines, tying shoes) • Replicating three-dimensional structures (e.g., building with Legos)