The Impact of Sensory Processing Abilities on the Daily Lives of Young Children and Their Families: A Conceptual Model

The article describes a proposed model for considering sensory processing an important factor in young children's performance. The author reviews constructs from neuroscience and behavioral science to propose how the transaction among these constructs may provide a framework for understanding various patterns of behavior and for developing methods for handling young children's sensory processing needs in a functional and supportive manner. The author reviews data from a series of studies on the Sensory Profile, a family-report measure of a child's responses to sensory experiences during daily life, to illustrate the utility and possible quantitative support for the proposed model components in young children with and without disabilities. Key words: *habituation, modulation, neuroscience, performance, regulatory disorders, sensation, thresholds sensitivity*

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ALTHOUGH THERE are many frameworks for observing and interpreting young children's behaviors, the role of sensory processing in performance has received increasing attention in recent years."[5] Professionals and parents are recognizing that when young children have poor sensory processing abilities, it can affect social, cognitive, and sensorimotor development.' -[b] With this awareness, it becomes important to understand the mechanisms that support or create barriers to sensory processing abilities because these mechanisms can also affect functional performance in daily life.[7]

This article examines some of the key constructs that may be operating to enable young children to create responses to sensory events in their daily lives. We propose that both neuroscience and behavioral science knowledge can offer information that is useful to professionals and care providers who support young children. We also propose that the neuroscience factors provide a mechanism for interpreting behavioral factors, providing insight for practice, because this interaction offers a more complex view of young children's evolving

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performance repertoires. Data from studies of children's responses to sensory events in daily life (using a sensory history called the *Sensory Profile)* support this initial thinking about possible model components.

A PROPOSED WORKING MODEL

We propose that there is an interaction between neuroscience and behavioral concepts, such that the neuroscience concepts can help us interpret young children's behavior and performance. Figure 1 depicts our working proposal about this interaction. Neurological thresholds indicate the amount of stimuli needed for the nervous system to notice or react to stimuli (ie, the vertical axis), while the behavioral responses indicate the manner in which the young child responds in relation to the thresholds (ie, the horizontal axis). Each axis represents a continuum of actions; young children's performance can be characterized at any place along these axes related to the intensity of response and the children's current biobehavioral state. For example, young children can have a slightly or very low threshold for responding to stimuli. Similarly, young children could have a tendency to challenge the thresholds (ie, counteract) or could aggressively challenge their thresholds. It is also likely that young children have variability within their central nervous systems (CNS) on particular days (eg, when more rested or tired) and within particular sensory systems (eg, the system that responds to touch [ie, *somatosensory]* being more sensitive than the system that responds to movement [ie, *vestibular\).*

Concepts from neuroscience

Neuroscience provides a background for understanding how the sensory receptors receive and transmit stimuli, how the CNS codes and interprets the information, and how the information gets used to design motor output.[8,9] The more recent neuroscience literature also emphasizes the importance of modulation of all input as part of optimal CNS functions.[10] *Modulation* is the ability to monitor and

Neurological Threshold Continuum	Behavioral Response Continuum	
	responds in ACCORDANCE with threshold	responds to COUNTERACT the threshold
HIGH (habituation)	Poor Registration	Sensation Seeking L.
LOW (sensitization)	Sensitivity to Stimuli	Sensation Avoiding

Figure 1. Relationships between behavioral responses and neurological thresholds.

regulate information in the interest of generating an appropriate response to particular stimuli.

Key neurophysiological processes related to modulation of input are habituation and sensitiza-tion.'"[12] *Habituation* is considered the simplest form of learning in the CNS and occurs when the nerve cells and CNS systems recognize the stimulus as familiar and decrease transmission among the cells because there is not a perceived need to continue to respond to the stimulus.'[2] Young children need habituation responses; for example, if a child's CNS continued to send information about how clothing felt, it would be difficult for the child to focus on anything else throughout the day. Habituation enables the young child to screen out the familiar sensations of the clothing to attend to friends, toys, and play schemas. *Sensitization* in the CNS involves enhancement of cells. During sensi-tization, the CNS recognizes the stimulus as important or potentially harmful and generates a heightened response. Sensitization can sometimes be associated with anatomical changes, such as an increase in the number of neuron connections available for a task.[12] Young children use sensitiza-tion to remain aware of what is going on in their surroundings. For example, Sensitization enables young children to notice a bug landing on the skin while playing outside and to brush it away.

Neurological thresholds continuum

The CNS is complex; none of its systems contains only habituation or only Sensitization patterns. In order to produce functional behaviors, the CNS must modulate information by creating a continuous interchange among habituation and sensitiza-tion. The patterns for the interchange are called *thresholds* and are established by young children's experiences and genetic endowment.[121_'] When young children have poor modulation between habituation and Sensitization, they exhibit mal-adaptive behaviors, such as being overly excitable or hyperactive (ie, too much Sensitization—low thresholds) or overly lethargic and inattentive (ie, too much habituation—high thresholds).

Young children who have high neurological thresholds react less readily to stimuli or take a longer time to react; the mechanisms of habituation support high thresholds.[12] When young children have low thresholds (ie, there is Sensitization), neurons trigger more readily and, therefore, cause more frequent reactions to stimuli in the environment. It is likely that young children have a typical threshold level that reflects their particular overall CNS makeup. However, it is also likely that there is a range for this typical threshold and that shifts in the range are based on additional factors, such as which sensory systems are involved in a task or the child's capacity for that day (eg, rested or tired).

Concepts *from* behavioral science

Young children are not simply a collection of neurons and other cells. They are human beings with interests, motivations, skills, and behavioral patterns to support their performance needs.[14] Researchers from the behavioral sciences have long sought ways to interpret the meaning of individual differences in behavior as well as the meaning of behavioral repertoires in certain groups of children.[13,15]

Stellar and Stellar'[6] described several conditions they believed were necessary to produce goal-**directed behavior:**

- an internal environment that supports the behavior
- an external environment that provides reasonable opportunities
- a stimulus to trigger the behavior
- opportunities to learn

If we were to characterize these conditions in relation to sensory processing, the internal environment would be the CNS's capacity for processing and modulating sensory input. The external environment would represent the sensory experiences available to young children throughout their daily lives. As children notice and respond to particular sensory stimuli (ie, the triggers for behaviors), they discover (ie, leam) their own capacities to act.

Young children can have difficulties with performance in daily life as a result of dysfunction with

any of these conditions.[14] If the CNS is not processing sensory information, a young child may not be able to learn about the environment and may appear unresponsive or clumsy. In an impoverished environment, a young child will not have opportunities to develop knowledge for acting, even with an adequate internal environment.[17] Those of us who serve young children and their families must recognize the potential impact of these factors on young children's behavioral repertoires, so we can interpret the meaning of behaviors effectively.

In addition to considering the conditions necessary to support behavior, we must also consider the factors that generate motivation to act. Brody'" offered three factors that contribute to a person's tendency to perform a task. First, the person must need and value the goal, that is, have an incentive to perform. Second, the person must understand and believe that performance of a particular task will lead to the goal, that is, have an expectancy about performance. Third, the person will select tasks based on his or her needs to complete the task correctly, that is, to be successful.

Although adults try to guide their interests and choices, young children have many ways to display their motivational tendencies. Some children are very assertive about performing tasks of interest;
they persist in finding a way to get a desired toy or engage in a self-care or play ritual over and over again, fascinated by the experience of the ritual itself. Other young children are responsive but seem to need more external support for performance and do not generate experiences for themselves as easily. At the extremes of the range of motivated behavior, there are some children who appear to be so driven to act that their behaviors interfere with daily life activities and others who seem so disengaged that daily life passes by them.

To put motivational tendencies in the sensory processing framework, we must consider that young children have preferences for certain sensory experiences and that sensory experiences can support or be disruptive to their learning and performance. Persistence in a play schema (eg, placing blocks into a bottle, spilling them, and placing them in again) can be viewed as a set of sensorimotor experiences that are satisfying because of their predictability and the support they provide for cognitive development. The young child obtains touch and body position input from holding and releasing the blocks and from shifting the body to reach the blocks, there is visual input as the child locates each block and watches it drop into the bottle, and the sound of each block dropping into the bottle and all of them spilling onto the floor provides auditory input to the schema.

When observing young children, their preferences for sensory experiences become apparent. For some children, the noise of the blocks is exciting; these children will find many ways to obtain additional auditory input (ie, banging pots, making vocal noises, choosing musical toys). For other children, the noise of the blocks will be disruptive; they might hold their ears as blocks drop. These children are more likely to select activities that have fewer auditory features and may display less functional performance when the environment or activity contains a lot of auditory stimuli (eg, a noisy day-care center). Experience and genetic endowment also play a role in the evolution of behavioral repertoires.[13] From a sensory processing perspective, the tendency to act in certain ways is a manifestation of the young child's needs for certain sensory information (ie, internal motivation) to support performance and learning. Neuroscience knowledge provides a means of interpreting behavioral observations.

Behavioral responses

When considering young children's daily life needs, we must observe behavior rather than gather data from electrodes in the brain that could indicate the neurological thresholds. The model in Figure 1 proposes a continuum of behavioral responses, with the farthest points being characterized to facilitate initial discussion.

On the one end of the continuum, young children can *respond in accordance with their thresh-*

olds; this suggests that their behavioral repertoire mirrors their thresholds. In this case, young children with high thresholds would respond to very few stimuli, while young children with low thresholds would respond to many stimuli. On the other end of the continuum, young children can *respond to counteract their thresholds,* these children might either try to exert excessive energy seeking stimuli to try to meet high thresholds or exert energy to avoid triggering low thresholds.

FINDINGS THAT PROMOTE THINKING ABOUT THE PROPOSED MODEL

Occupational therapists are interested in young children's daily experiences. Within this general area of expertise, there has been a particular interest in the way that young children respond to sensory experiences in daily life—an interest that stems from the study of sensory integration. There are standardized tests that document sensory processing abilities, but they do not provide data about how particular sensory processing problems affect performance in daily life.[6] To address performance in daily life, occupational therapists solicit information from parents, teachers, and children themselves.[19,22] In 1992, Dunn and colleagues[17] began collecting formal data about children's performance as reflected in these informal measures. The Sensory Profile contains 125 items that describe various responses children have to sensory experiences during their day; caregivers report the frequency with which these behaviors occur (ie, always, frequently, occasionally, sometimes, never). Since the items were derived from interviews with parents of children who had disabilities, therapists presumed that all the items represented some sort of sensory processing difficulty, but this had never been tested. To address this issue, Dunn and colleagues[17,24,28] conducted a series of studies to identify the nature of the items on the Sensory Profile, including which items were uncommon for children without disabilities, which items were characteristic of specific disabilities, and which items might be used to discriminate among various disabilities.[29]

Findings about children with and without disabilities

A pilot study (*N* = 64) and a national study (*N* = 1,115, matching the 1990 census on density of state populations) were conducted to investigate how parents of children without disabilities (3-10 years of age) responded to the items.[21,24] There were no age or gender differences among the items, and more than two thirds of the items were uncommon for children without disabilities (ie, at least 80% of the parents reported that their children displayed the behavior "seldom" or "never"), suggesting that the items held promise for helping to understand sensory processing abilities in children with disabilities.

The Sensory Profile then needed to be tested on children with various disabilities. A series of studies is being conducted, including studying children with autism (*N* - 34),[26] children with attention deficit hyperactivity disorder (ADHD; *N*- 61),[27] and children with tic disorders (in process). The children in all of these groups displayed significantly higher rates of behaviors on the Sensory Profile when compared to children without disabilities; however, each diagnostic group had higher rates on different items, suggesting that the behaviors on the Sensory Profile might be useful in differential diagnosis and more refined intervention planning.

Findings that support model components and extend thinking

Also conducted was a principal component factor analysis on the data from the children without disabilities to examine patterns of performance. Found were factor groupings that were like behavioral patterns seen in children with disabilities.[25] The nine factors are the following (see Table I):

1. sensory seeking (*n* = 17 items)
2. emotionally reactive (*n* = 16)
3. low endurance/tone (n = 9)
4. oral sensitivity (*n* = 9)
5. inattention/distractibility (w = 7)
6. poor registration (*n* = 8)
7. sensory sensitivity (w = 4)

Table 1. Factor analysis item loadings

Factor	Sensory System	Sensory Profile Items	Factor Loading
1: Sensory	Movement	Takes excessive risks during play	.72
seeking	Movement	Takes movement or climbing risks during play that compromise personal safety	.68
	Movement	Continually seeks out all kinds of movement activities	.67
	Body	Seeks opportunities to fall without regard to personal safety	.65
	Movement	Seeks all kinds of movement and this interferes with daily routines	.62
	Movement	Twirls/spins self frequently throughout the day	.60
	Body	Appears to enjoy falling	.59
	Movement	Becomes overly excitable after a movement activity	.58
	Movement	Turns whole body to look at you	.58
	Touch	Is always touching people and objects	.56
	Activity	Is always "on the go"	.53
	Touch	Avoids wearing shoes; loves to be barefoot	.47
	Auditory	Enjoys strange noises/seeks to make noise for noise's sake	.46
	Emotion	Is overly affectionate with others	.46
	Activity	Jumps from one activity to another so frequently it interferes with play	.44
	Body	Hangs on other people, furniture, objects even in familiar situation	.44
	Touch	Doesn't seem to notice when face or hands are messy	.42
2: Emotionally	Emotion	Has difficulty tolerating changes in plans and expectations	.70
reactive	Emotion	Displays emotional outbursts when unsuccessful at a task	.66
	Emotion	Has poor frustration tolerance	.66
	Emotion	Cries easily	.66
	Emotion	Has difficulty tolerating changes in routine	.64
	Emotion	Seems anxious	.62
	Emotion	Is sensitive to criticisms	.62
	Emotion	Seems to have difficulty liking self	.60
	Emotion	Expresses feeling like a failure	.57
	Emotion	Is stubborn or uncooperative	.56
	Emotion	Has definite fears	.54
	Emotion	Has trouble "growing up"	.53
	Emotion	Has temper tantrums	.52
	Emotion	Needs more protection from life than other children	.52
	Emotion	Has difficulty making friends	.52
	Emotion	Is overly serious	.48
3: Low	Body	Seems to have weak muscles	.74
endurance/ tone	Body	Tires easily, especially when standing or holding particular body position	.69
	Body	Has weak grasp	.66
	Body	Locks joints for stability	.63
	Body	Can't lift heavy objects	.58
	Movement	Has poor endurance/tires easily	.57
	Body	Props to support self	.56
	Body	Moves stiffly	.56
	Movement	Appears lethargic	.45
4: Oral	Taste	Shows preference for certain tastes	.74
sensory	Taste	Will only eat certain tastes	.74
sensitivity	Taste	Shows strong preference for certain smells	.74
	Taste	Avoids certain tastes/smells that are typically part of children's diets	.64
	Touch	Picky eater, especially regarding textures	.62

continues

Table 1. Continued

Factor	Sensory System	Sensory Profile Items	Factor Loading
	Taste	Craves certain foods	.60
	Taste	Seeks out certain tastes/smells	.57
	Touch	Limits self to particular food textures/temperatures	.53
	Taste	Routinely smells nonfood objects	.42
5: Inattention/	Auditory	Is distracted or has trouble functioning if there is a lot of noise around	.68
distractibility	Activity	Has difficulty paying attention	.60
	Auditory	Appears not to hear what you say	.59
	Auditory	Can't work with background noise	.55
	Auditory	Has trouble completing tasks when the radio is on	.52
	Auditory	Doesn't respond when name is called	.52
	Visual	Looks away from task to notice all actions in the room	.44
6: Poor	Emotion	Doesn't express emotions	.61
registration	Emotion	Doesn't perceive body language or facial expressions	.60
	Emotion	Doesn't have a sense of humor	.57
	Touch	Doesn't seem to notice when someone touches arm or back	.54
	Visual	Doesn't notice when people come into the room	.48
	Taste	Doesn't seem to smell strong odors	.48
	Touch	Has decreased awareness of pain and temperature	,46
	Touch	Avoids going barefoot especially in sand or grass	.42
7: Sensory	Movement	Becomes anxious or distressed when feet leave ground	.75
sensitivity	Movement	Fears falling or heights	.71
	Movement	Dislikes activities where head is upside down, or rough-housing	.71
	Movement	Avoids climbing, jumping, bumpy or uneven ground	.70
8; Sedentary	Movement	Prefers sedentary activities	.79
	Movement	Seeks sedentary play options	.75
	Activity	Spends most of (he day in sedentary play	.72
	Activity	Prefers quiet, sedentary play	.71
9: Fine	Visual	Has trouble staying between the lines when coloring or when writing	.74
motor/	Visual	Has illegible writing	.66
perceptual	Visual	Has difficulty putting puzzles together	.54
	Emotion	Has temper tantrums	.40
Other items;	Auditory	Responds negatively to unexpected or loud noises (ie, vacuum cleaner	
items that did	dog harking, hairdryer)		
not load on	Auditory	Holds hands over ears	
the typical	Auditory	Talks self through task	
children	Auditory	Seems oblivious within an active environment	
factor	Visual	Expresses discomfort or avoids bright lights (ie, sunlight through	
analysis	window in car)		
	Visual	Is happy to he in the dark	
	Visual	Looks carefully or intensely at objects/people	
	Visual	Becomes frustrated when trying to find objects in competing	
backgrounds (eg, an overfilled drawer)			
	Visual	Prefers to be in the dark	
	Visual	Hesitates going up or down curbs or steps	
	Visual	Gets lost easily	
	Visual	Is bothered by bright lights after others have adapted to the light	

continues

Table 1. Continued

Sensory System	Sensory Profile Items	Factor Loading
Visual	Has hard time finding objects in competing backgrounds (ie, shoes in a messy room, favorite toy in the "junk drawer")	
Visual	Stares intensely at objects or people	
Visual	Covers eyes or squints in bright lights	
Visual	Watches everyone when they move around the room	
Visual	Avoids eye contact	
Activity	Avoids quiet play activities	
Taste	Chews/licks on nonfood objects	
Body Movement	Walks on toes	
Movement	Avoids playground equipment or moving toys	
Movement	Rocks unconsciously during other activities (ie, while watching television)	
Movement	Dislikes riding in a car	
Movement	Holds head upright, even **when bending over or leaning**	
Movement	Holds onto walls or banisters	
Movement	Becomes disoriented after **bending over sink or table**	
Movement	Rocks in desk/chair/on floor	
Touch	Avoids getting "messy" (ie, in paste, sand, finger painting, glue, tape)	
Touch	Expresses distress during grooming (ie, haircutting, face washing, fingernail cutting)	
Touch	Prefers long-sleeved clothing when it's warm or short-sleeved clothing when it's cold	
Touch	Expresses discomfort at dental work or toothbrushing	
Touch	Is sensitive to certain fabrics (ie, is particular about certain clothes or bedsheets)	
Touch	Touches props and objects to the point of irritating others	
Touch	Reacts emotionally or aggressively to touch	
Touch	Has rigid rituals in persona] hygiene	
Touch	Withdraws from splashing water	
Touch	Has difficulty standing in line or close to other people	
Touch	Rubs or scratches out a spot that has been touched	
Touch	Gags easily with food textures, food utensils in mouth	
Touch	Displays unusual need for touching certain toys, surfaces, or textures	
Touch	Mouths objects frequently (ie, pencil, hands)	
Touch	Leaves clothing twisted on body	
Emotion	Uses inefficient ways of doing things	
Emotion	Seems accident prone	
Emotion	Has nightmares	
Emotion	Has fears that interfere with daily routines	

Note: The complete factor analysis is reported in Reference 25.

8. sedentary (w = 4)
9. fine motor/perceptual (*n* = 4)

This analysis provides preliminary evidence about the nature of sensory processing for all children; perhaps some of the patterns of behavior seen in children with disabilities are different in relation to rate, intensity, or the manner that they do or do not interfere with daily life.[29] For example, both children without disabilities and children with ADHD display sensory-seeking behaviors (Factor 1); however, children with ADHD also show high rates of inattention/distractibility (Factor 5). Perhaps sensory-seeking behaviors enable children without disabilities to learn but generate distract-ibility in children with ADHD.

Also conducted was a discriminant analysis with data from children without disabilities, children with ADHD, and children with autism.[28] Using the nine factors, the three groups of children were compared, and children were placed correctly in groups 89% of

the time. Four factors (1, 4, 5, 9) contributed to the differences; children with autism had the opposite pattern of performance from children without disabilities, which is consistent with the pervasive nature of this disability. Children with ADHD were more like children without disabilities. However, distractibility was apparent only in children with ADHD; this may be a key factor in the performance difficulties of children with ADHD.

PERFORMANCE PATTERNS THAT EMERGE FROM THE PROPOSED MODEL

When the impact of the neurological thresholds on the behavioral response continua is considered, a wider range of possible interpretations of behaviors emerges. Professionals can consider potential effects of high or low thresholds on performance and possible effective interventions for children with various sensory processing responses. Based on the data from the studies of the Sensory Profile thus far, we are proposing names for the four comers of the model (see Figure I): Poor Registration, Sensitivity to Stimuli, Sensation Seeking, and Sensation Avoiding. The model components are also supported by the work completed to specify types of regulatory disorders in infants and young children.[2]

Poor registration

When young children have difficulty registering stimuli due to high neurological thresholds and act in accordance with those thresholds, they tend to have a dull or uninterested appearance. The data from the Sensory Profile studies suggest that there may be three factors that fall into this pattern: Factor 3 (low endurance/tone), Factor 6 (poor registration), and Factor 8 (sedentary). Factor 8 may be related to sensation-avoiding behaviors (see below) rather than poor registration, if the sedentary behaviors serve to reduce the amount of input the person must process. Young children who have a behavioral response pattern congruent with these factors may not have adequate neural activation to sustain focus or endurance for tasks or contextual cues.

The National Center for Clinical Infant Programs (NCCIP) Task Force[2] characterized a Type II regulatory disorder as *underreactiue.* Children in this category can be withdrawn and difficult to engage or self-absorbed. Those who are withdrawn are easily exhausted, appear apathetic, and need highly salient stimuli to engage them. The children sometimes engage in repetitive play, presumably to increase the stimuli so they can "fully experience" the activities. This description is consistent with "poor registration" proposed in this model.

When serving young children who have poor registration, this model suggests that providers would want to find ways to enhance the task and contextual experiences so that there is a greater likelihood that thresholds will be met. One can increase the contrast and reduce the predictability of cues in the task; for example, make objects weigh more, change the color of items, or add the angular movement of bending (ie, a more arousing input) to the task routine. For young children who have poor registration, the provider works to make the experience more dense with sensory stimuli;

the more they have the opportunity to trigger their thresholds, the more they are likely to improve functional performance. The NCCIP Task Force[2] also suggests using "robust" responses to the child's cues as a means to enhance responsivity for children who are withdrawn and underreactive.

Sensitivity to stimuli

Young children who are sensitive to stimuli due to low thresholds and who act in accordance with those thresholds tend to be hyperactive or distract-ibie. Data indicate three factors might support this pattern of neurological threshold and behavioral response: Factor 4 (oral sensory sensitivity), Factor 5 (inattention/distractibility), and Factor 7 (sensory sensitivity). Young children who demonstrate behaviors congruent with these factors would have difficulty remaining on task to complete them or to learn from their experiences.Their behavioral repertoire of responding in accordance with their low neurological thresholds would keep directing their attention from one stimulus to the next, whether it was part of the ongoing task or not.

The NCCIP Task Force[2] characterizes a Type I regulatory disorder as *hypersensitive*. Children who

are hypersensitive can be either fearful and cautious or negative and defiant. Those who are fearful and cautious are easily upset, are fragmented, have excessive fears, and may be easily distracted. This description is consistent with our proposed category of sensitivity to stimuli.

When serving young children who have sensitivity to sensory stimuli, it may be important to emphasize the discriminating features of sensory systems,[30,31] because these aspects of sensory input do not increase arousal. For example, touch-pressure stimuli (ie, firm contact with the skin) do not excite the reticular formation, a generalized arousal center in the brain stem, but light touch stimuli (ie, tickling, soft contact with skin) do activate the reticular formation.[32] Therefore, it would be better to make contact with a young child who has tactile sensitivity using touch-pressure input; this would reduce the possibility of generating more generalized arousal. Young children with sensory sensitivity may need organized input that does not generate additional arousal to draw them away from the task at hand. The more nonarousing (ie, organizing) input these young children can obtain, the better their chances for completing tasks and learning from them. The NCCIP Task Force[2] suggests that caregivers employ flexibility and assertiveness in caring for these children. It also agrees that it is important to use empathy when observing and responding to the children's affective responses.

Sensation seeking

When young children have high thresholds but develop responses to counteract their thresholds, they may engage in behaviors to increase their sensory experiences. Factor 1 (sensation seeking) contains items that represent more intense sensory experiences. According to the items in this factor, young children who are sensation seeking add movement, touch, sound, and visual stimuli to every experience. They might make noises continuously, fidget in their seats, touch everything, handle objects or people, or chew on things in an attempt to meet their high thresholds.

The NCCIP Task Force[2] characterizes a Type III regulatory disorder as *motorically disorganized* and *impulsive.* Children with this type of regulatory disorder display high activity levels, lack caution in play, display excitability, and crave sensory input. This description is consistent with our proposed category of Sensation Seeking. The high need to seek sensation can be associated with impulsive behavior and poor motor modulation.

When serving young children who seek sensation, it may be important first to observe them carefully to obtain information about what sensations they add to their behavioral repertoire in an attempt to meet their high neurological thresholds. The most effective interventions for these young children may be to incorporate the sensations they need into their daily life repertoires. For example, if a young child seeks movement input, but this is interfering with life performance, we can reconstruct the functional tasks to include more movement, so the child gets the input desired as part of the daily life routine. In this example, we can move clothing items to different parts of the room, so it will require more walking, bending, and reaching to get ready for the day. Honoring the input these children seek might also reduce the anxiety associated with trying to meet high thresholds and assist with attentional focus. The NCCIP Task Force[2] suggests that caregivers support exploration that is creative and purposeful, so the children can obtain the sensory input they desire and need.

Sensation avoiding

When young children have low thresholds and develop responses to counteract their thresholds, they try to avoid activating their thresholds; they might appear to be resistant and unwilling to participate. Data indicate that Factor 2 (emotionally reactive) supports this pattern of behavioral response and neurological threshold; the behaviors represented in the items in Factor 2 indicate a need to reduce unpredictable stimuli that occur during activities (ie, routines and rituals become predictable patterns of input and responses). Possibly meeting their neurological thresholds is uncomfort-

able, and, therefore, young children may try to circumvent this event by reducing their activity, many times through withdrawal. For example, with a low threshold for ambient noise, the child might become ill or have an emotional outburst when it is time to go to the church performance; these behaviors reduce the possibilities that the child would have to cope with the inevitable noise level in the community room. Young children who avoid sensation may also develop rituals for conducting daily life tasks; perhaps these rituals provide a pattern of neural activity that is familiar and acceptable. Factor 8 may also be related to sensation avoiding, if the child's motive for selecting sedentary tasks is to keep away from other sensory experiences.

There are two possible NCCIP regulatory disorder types that would coincide with the sensation-avoiding category proposed here. If the children displayed more stubborn, controlling behaviors, preferring repetition to manage input, this would be consistent with the negative and defiant Type I hypersensitive regulatory disorder. However, if the children display more inattention to stimuli, preoccupation with certain stimuli, and more solitary focus and pursuits, this would be consistent with Type II underreactive regulatory disorder—the self-absorbed subtype. Further documentation of the differences between these types will be needed to characterize more clearly their meanings for assessment and intervention planning.

When serving young children who avoid sensation, providers may need to honor the discomfort they experience. Observing their rituals and analyzing the features of the rituals provide a wealth of information. It is often successful to begin intervention with one of the rituals, expanding it in some small way, so that there is a blending of familiar and new stimuli.[31] This enables the child to incorporate the new stimuli into a comfortable pattern. Disrupting the rituals too aggressively can only lead to more avoidance behaviors and further decline of functional performance. For children who tend to be negative and defiant, the NCCIP suggests a flexible, supportive caregiving strategy that avoids power struggles. This strategy supports the proposal here that overloading the children who avoid sensation can cause more withdrawal and avoidance. For those who tend to be self-absorbed, the NCCIP suggests caregiving that acknowledges the children's cues and signals about what they need and combines these needs with play rituals.

Relationships among behavioral repertoire categories

To test this model, discrimination among its behavioral categories is required so that providers can identify problems correctly and design effective interventions. For example, it may be important to discriminate young children who avoid sensation from those who have poor registration. Young children with poor registration may not appear to notice what is going on, while young children who are avoiding sensation would display behaviors that indicate the child notices and withdraws from the situation. The interventions for young children who have poor registration need to address meeting a high threshold, while the interventions for young children who avoid sensation need to honor their discomfort due to typical levels of sensory input. If providers mistake withdrawal behaviors for poor registration, they would design intense sensory experiences for the person, which would lead to further withdrawal rather than adaptation. The NCCIP regulatory disorders descriptions and suggestions can provide guidance for investigations of the various types of regulatory disorders.

OTHER FACTORS

The factor with the weakest loading is not accounted for in this working model (ie, Factor 9, fine motor/perceptual). The items that loaded on this factor clearly relate to fine manipulation and tended to be more age-sensitive in earlier studies.[2324] It is interesting that these items loaded together and without items that have a more clear sensory processing component. Separate factor loading is consistent with findings in other studies of fine manipulation and sensory processing (ie,

the motor accuracy [MAc] subtest of the Sensory Integration and Praxis Tests [SIPT]). In factor analytic studies, MAc was associated with tests of dyspraxia, visual motor skills, and ocular pursuits,[33,36] suggesting that the MAc performance measured eye-hand coordination and is affected by praxis and visual motor coordination.[6] Future studies of the Sensory Profile on children with disabilities may or may not indicate whether there are relationships between Factor 9 and the other eight factors in this analysis.

This working model is a crude version of what is likely to be true about the interactions among neurological thresholds and behavioral response continua; additional studies and skilled observa

tions of providers and families are needed to advance this thinking. Additional factors, such as the intensity of a child's behaviors, the rate of dysfunctional performance, the rate of recovery from disruptions in activity, and the child's general capacity from one day to the next, all must be considered in a comprehensive model for interpreting the meaning of children's performance patterns for daily life.

The four types of regulatory disorders identified for infants and young children[2] seem congruent with the categories proposed here. It would be interesting to compare the NCCIP regulatory disorders diagnoses with parent reports on the Sensory Profile as a method to validate the diagnoses and the strength of parent-report data as a critical piece of the diagnostic process.

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