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## The Sensations of Everyday Life: *Empirical, Theoretical, and Pragmatic Considerations*

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The experience of being human is imbedded in the sensory events of everyday life. When we observe how people live their lives, we discover that they characterize their experiences from a sensory point of view. People talk about the intensity or dullness of an image. When they explain a dream or an event of the prior day, they use sensory words to characterize the dream's elements. Sensation is the common language by which we share the experience of being human; it provides a common ground for understanding.

Yet sensation also is so intimate and personal that we use it to define our individuality. We describe the difference between one person and another in relation to those persons' interest in, tolerance for, and pleasure with sensations. Because of our personal experiences with sensation, it is sometimes hard or even inconceivable to imagine another person's experience with an object or event or context. We want to frame the sensory experiences within our own parameters; we think of another person's description as "same," "somewhat similar," or "very different" from our own. All art is an expression of the artists' personal experiences with the universe and might be described as their personal sensory history shared in the form of the art; everyone responds differently to particular art.

The discipline of occupational therapy has had a collective interest in sensory processing across the entire evolution of our profession. We have generated and continue to generate a wealth of information about how persons process sensory information and how those methods guide choices. These choices ultimately affect a person's ability to live a satisfying life. Everyone is personally interested in the experiences of sensation, and occupational therapists can advance thinking about the contribution of sensory processing to our understanding of the human experience both in the typical course of the day and as it might interfere with living a satisfying life.

The unique contribution of occupational therapy knowledge is in attaching understanding and meaning to sensory experiences. We make the applications to daily life to which other disciplines only allude. We might characterize our role as translator: We stand in the

space between abstract constructs and application to practice, looking back and forth, translating for each group what the other has to say. Therefore, we can inform colleagues about the meaning of their research and families about their situations, enabling each group to advance their own thinking and ultimately advance knowledge overall.

## **Background Knowledge Related to Sensory Processing**

Scholars from many disciplines have studied aspects of sensory processing. Their work provides evidence about how the sensory systems contribute to the experience of being human. Neuroscientists have identified the unique qualities of each sensory system that make it possible for humans to take in information for the brain's use (Kandel, Schwartz, & Jessell, 2000). The brain initially becomes a repository for this sensory input, creating maps of the body and the environment from each sensory system's point of view (Dunn, 1998). As these maps form, the brain begins to integrate information from multiple sensory systems, forming higher order schemas of performance in contexts. Throughout life, these maps are modified in relation to the person's activities, forming the background for learning and understanding.

In addition to considering the basic sensory input and processing occurring in the nervous system, scientists have reported on the nervous system's methods for mediating its own input (Kandel et al., 2000). Neural regulation occurs through mechanisms that balance excitation and inhibition, creating thresholds for responding at the point that the proper amount of input has accumulated (Dunn, 1998). Genetic and environmental factors contribute to each person's ways of responding to excitation and inhibition. Therefore, people have different thresholds for noticing, responding to, and becoming irritated with sensations; these thresholds, in turn, affect their daily choices and are reflected in their mood, temperament, and ways of organizing their lives (Baranek, 1999; Dunn, 1997, 2000; Rothbart & Jones, 1999; Zuckerman, 1994).

Cognitive mechanisms, such as attention, organization, memory, and problem solving, operate with information from the sensory systems and, therefore, illustrate balancing threshold demands. A natural tension exists in the brain's processing between internal information (sensations of the body, i.e., touch, visceral) and external information (sensations of the environment, i.e., auditory, visual). Cognitive processing is optimal when internal and external information processing afford task performance together (Gijsbers van Wijk & Kolk, 1997b). For example, Shumway-Cook and Woollacott (2000) tested cognitive processing in relation to internal and external information processing in young and older adults. They created several conditions of imbalance in internal and external information processing demands and found that older adults need to have both external (visual) and internal (somatosensory, vestibular, proprioceptive) cues available for postural control in order to perform a demanding cognitive task.

The mechanisms of sensory processing are intertwined with many other brain functions. By studying these phenomena in various combinations, the actual contributions and relationships can be revealed and then applied to other scholarly inquiries, such as the role of sensory processing in individual differences and various human conditions.

## **Data Indicating Individual Differences in Sensory Processing**

Studies employing psychophysiological methods provide evidence about the nature of individual differences when processing sensory events in the nervous system. Researchers have produced a body of literature about sensation seeking as a biosocial phenomenon in humans (Carton, Morand, Bungenera, & Jouvent, 1995; Glicksohn & Abulafia, 1998; Sarmany-Schuller, 1999; Zuckerman, 1994; Zuckerman, Ulrich, & McLaughlin, 1993). Zuckerman (1994) reported on physiological differences in persons with high and low sensation-seeking traits. Persons who are high sensation seekers experience a reduction in heart rate with the introduction of a new stimulus, which is interpreted to be an orienting response that makes the person available to receive the stimuli. Conversely, low sensation seekers experience an acceleration of heart rate, presumably triggering fear or threat, leading to inhibition and avoidance of new stimuli.

Interdisciplinary teams, including occupational therapy researchers, have taken advantage of psychophysiology methods to investigate the relationships among the nervous system's responses and patterns of sensory processing in daily life. In studies with preschoolers (McIntosh, Miller, Shyu, & Dunn, 1999) and adults (Brown, Tollefson, Dunn, Cromwell, & Fillion, 2001), researchers found distinct patterns of noticing and habituation that coincided with the four categories of sensory processing proposed in Dunn's Model of Sensory Processing (Dunn, 1997). These findings suggest that we can characterize the ways that humans take in sensation and that individual differences exist in how we use those sensations to construct our daily lives.

## **Data Indicating Differences in Sensory Processing Related to Human Conditions**

In addition to identifying patterns of individual difference in sensory processing, researchers have studied the unique features of sensory processing that occur for persons with various conditions. These data reveal the broad influence that sensory processing has on every aspect of daily life. The studies suggest that attention to the person's sensory processing patterns may provide insight for understanding these conditions and for deriving meaning from the person's performance repertoire. Knowledge about a person's patterns of sensory processing may contribute to the design of more effective interventions and the advancement of knowledge.

Accumulating evidence identifies distinct sensory processing patterns in children and adults with various conditions (Ayres, 1989; Baranek, 1999; Baranek, Foster, & Berkson, 1997a; Brown & Dunn, in press; Brown et al., 2001; Case-Smith, Butcher, & Reed, 1998; Cermak & Daunhaur, 1997; Cooper, Majnemer, Rosenblatt, & Birnbaum, 1993; DeGangi & Greenspan, 1989; Dunn, 1999, 2000; Dunn & Daniels, 2001; Johnson-Ecker & Parham, 2000; Larson, 1982; Provost & Oetter, 1993; Royeen & Fortune, 1990; Wiener, Long, DeGangi, & Battaile, 1996). Researchers use a variety of data collection methods, including criterion measures, direct evaluation of performance, interviews, questionnaires, and observations, to characterize sensory processing. In spite of the variety of methods, researchers

have reported distinct sensory processing characteristics in persons with various human conditions.

*Genetic and developmental disorders.* Some researchers have studied sensory processing patterns in children with genetic disorders. Belser and Sudhalter (1995) measured skin conductance and found that boys with Fragile X syndrome are more physiologically aroused by eye contact than boys with Down syndrome. They also found that boys with Fragile X syndrome who also had autism demonstrated more avoidant reactions than boys with autism only. Belser and Sudhalter concluded that difficulty with modulating arousal may be a distinguishing characteristic of Fragile X syndrome. Other researchers also have verified that both children with Fragile X syndrome and children with sensory modulation disorder responded to sensory stimuli at higher levels, at higher rates, and with lack of habituation (McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1998) than peers without disabilities. Therefore, conditions that affect the nervous system, like Fragile X syndrome and Down syndrome, also change the ways that persons respond to sensory input.

Baranek et al. (1997a) studied sensory defensiveness and its relationship to stereotypic behaviors in children and adults with developmental disabilities. They reported on two factors emerging from the data: auditory and other hypersensitivities and tactile defensiveness. In another report, Baranek et al. (1997b) identified a relationship between tactile defensiveness and rigid, inflexible behavior patterns. Hotz and Royeen (1998) found that children rated their own tactile defensiveness as more intense than did their mothers, although a high correlation existed between the mothers and their own children. Kinnealey (1998) reported on a preschooler with sensory defensiveness who also had difficulty with age-appropriate learning at preschool; the child also demonstrated anxiety and need for control, which affected her school and family relationships. Kinnealey and Fuiiek (1999) tested adults with sensory defensiveness and found them to be more anxious and depressed, but they did not experience more pain than their peers without defensiveness. Perhaps rigidity and inflexibility are behaviors reflective of coping with very low thresholds that quickly overwhelm some persons' nervous systems.

In another set of studies, Baranek (1999) found that children with autism and developmental disabilities displayed different ways of responding to visual, auditory, touch, and body position stimuli in relation to each other and cohorts without disabilities. DeGangi and Greenspan (1989) found tactile defensiveness, vestibular dysfunction, and poor ocular motor control in children with developmental delays and children with regulatory disorders. Lai, Parham, and Johnson-Ecker (1999) reported a strong relationship between sensory defensiveness (i.e., overresponsiveness to stimuli) and sensory dormancy (i.e., underresponsiveness to stimuli) in children with disabilities, suggesting interrelatedness between these two ways of responding. The children with disabilities in their study had a higher rate of both dormancy and defensiveness than the comparison group of children without disabilities, suggesting that modulation of input was in question.

*Brain disorders.* Sensory processing also affects cognitive performance for persons with brain dysfunction; auditory factors seem particularly relevant (Arciniegas et al., 1999; Denney, 1997; Madigan, DeLuca, Diamond, Tramontano, & Averill, 2000; Ragneskog & Kihlgren,

1997). Ragneskog and Kihlgren (1997) found that auditory environments affected level of cognitive awareness in patients with dementia; background music engendered calming, whereas more uncontrolled sounds increased agitation. Denney (1997) also found that persons in a rehabilitation unit demonstrated 57% less agitation after 1 week of quiet music in the dining room. The negative behaviors rebounded when the music was stopped and returned to lower levels when the music was reintroduced, providing stronger evidence that the music affects the cognitive state.

Although cognitive processing speed is slower for most persons who have had traumatic brain injury, auditory input slows these persons' processing even more (Madigan et al., 2000). For example, in a study of persons with traumatic brain injury, researchers found that attentional mechanisms failed in persons who were unable to filter stimuli and took a longer time to respond to auditory cues (Arciniegas et al., 1999). Therefore, it is possible to understand the relationship between cognition and sensory processing by looking at performance when the balance in attention to internal (body) and external (environment) sensory cues is disrupted.

*Schizophrenia.* Sensory processing challenges are also prominent for persons who have schizophrenia, and these challenges are linked to the cognitive impairments characteristic of the disorder (e.g., Bunney et al., 1999; Cromwell, 1993; Frith, Blakemore, & Wolpert, 2000; Hemsley, 1993; Jin et al., 1998; Light & Braff, 2000; McGhie & Chapman, 1961; Venables, 1969). In a classic article, McGhie and Chapman (1961) identified disturbances of attention, perception, and changes in motility and body awareness as key features of the onset of schizophrenia. They categorized persons' descriptions of their early experiences with schizophrenia and described them having to face an unstable and newly fluctuating relationship between perception of self (body sensations) and the environment. During this early period, persons seem to have increasing awareness of all stimuli and cannot organize the myriad of sensations, making it more and more difficult to function. Authors have proposed that delusions emerge from attempts to make meaning out of this increasingly undifferentiated sensory input (Frith et al., 2000; Light & Braff, 2000).

*Fatigue.* Not only chronic brain disorders provide information about sensory processing. Scholars studying fatigue also have reported relationships to sensory processing primarily related to balancing internal and external information processing. Authors have reported evidence of fatigue when persons are experiencing low internal and external information processing demands (Finkelman, 1994; Gijsbers van Wijk & Kolk, 1997a) and when persons have both too high and too low external demands (Bensing, Hulsman, & Schreurs, 1999; Rijk, Schreurs, & Bensing, 1999). For example, Rijk et al. (1999) studied fatigue in general medicine practices and found that fatigue was high when persons experienced overload of external stimuli and decreased when persons found their external stimulation attractive. Because fatigue reports are generally related to internal cues (e.g., tiredness, dullness, body complaints), Gijsbers van Wijk and Kolk (1997b) concluded that both too few (leading to boredom) and too many (leading to being overwhelmed) external cues can lead to increased attention to internal cues and, therefore, higher rates of fatigue. They recommended changes in daily life to reestablish the balance between

internal and external information processing demands to reduce fatigue and therefore improve performance and satisfaction.

This review provides a sample of the extensive interdisciplinary interest in phenomena related to sensory processing and its impact on performance. Data from children and adults, persons with and without disorders, and out-of-laboratory and natural environment settings indicate that sensory processing has a pervasive influence on the human experience. Furthermore, the apparently far-reaching effect of sensory processing on peoples' ability to experience a satisfying life underscores the importance of studying sensory processing from many perspectives, including the unique perspectives offered from the discipline of occupational therapy.

### Explanation of Dunn's Model of Sensory Processing

In 1997, I proposed a model for sensory processing that accounted for the nervous system's thresholds for acting and the person's propensity for responding to those thresholds (Dunn, 1997). The original model evolved from the literature, such as that described previously, and analysis of data gathered with the Sensory Profile measure from a national sample of children without disabilities (Dunn, 1999; Dunn & Brown, 1997; Dunn & Westman, 1997). This model of sensory processing has proven useful in guiding subsequent research and providing a structure for gaining insights into the nature of sensory processing across the life span.

The primary features of this model are (a) consideration of one's neurological thresholds (i.e., reactivity), (b) consideration of one's responding or self-regulation strategies, and (c) consideration of the interaction among thresholds and responding strategies. Figure 50.1 illustrates the model, with thresholds on the vertical axis and responding strategies on the horizontal axis.

In this model, thresholds and responding strategies represent a continuum of possible conditions, such that a person's ways of responding to sensory events in daily life can be characterized as reflecting both a particular threshold *and* a responding strategy. Although a person's responses to sensory events could fall anywhere on this model, the four outer-

most interaction points are named for the purpose of dialogue. High thresholds with passive responding strategies are called *low registration*; high thresholds with active responding strategies are called *sensory seeking*; low thresholds with passive responding strategies are called *sensory sensitivity*; and low thresholds with active responding strategies are called *sensory avoiding* (see Figure 50.1). These concepts

Thresholds/Reactivity	Responding/Self-Regulation Strategies	
	Passive	Active
High	Low Registration	Sensory Seeking
Low	Sensory Sensitivity	Sensory Avoiding

**Figure 50.1. Dunn's Model of Sensory Processing.**  
 Note. From "The Impact of Sensory Processing Abilities on the Daily Lives of Young Children and Families: A Conceptual Model" by W. Dunn, 1997, *Infants and Young Children*, 9(4), 23–25. Copyright © 1997 by Aspen Publishers, Inc. Adapted with permission.

are explained in greater detail in other sources (Brown et al., 2001; Dunn, 1997, 1998, 2000; Dunn & Brown, 1997; Dunn & Daniels, 2001; Huebner & Dunn, 2000).

### **Description of Anchor Points in the Model**

Persons who have high neurological thresholds require a lot of sensory input for responding. When persons have low registration, they do not notice sensory events in daily life that others notice readily (i.e., passive responding strategy). They may not notice when other people come into the room or food or dirt on their face and hands. Others may have to call the person's name several times or use additional cues such as touching to get the person's attention. Persons who are sensation seekers enjoy sensory experiences and find ways to enhance and extend sensory events in daily life (i.e., active responding strategy). They like physical movements such as climbing, twirling, swinging, and bouncing. They search for additional sensory experiences for themselves, such as humming and other mouth noises, touching objects, feeling vibrations in stereo speakers and appliances, wearing perfume, and smelling flowers (Brown et al., 2001; Dunn, 1997; Dunn & Brown, 1997; Dunn & Daniels, 2001).

Persons who have low neurological thresholds, or sensory sensitivity, notice sensory stimuli quite readily and more sensory events in daily life than do others. They are easily distracted by movements, sounds, or smells while in groups of people, such as in class or at the movie theatre. They notice food textures, temperatures, and spices more rapidly than others. They may be uncomfortable with clothing tags, elastic, or certain fabric textures. Their high rate of noticing while continuing to experience all of these is a more passive responding strategy (i.e., letting things happen) than is seen in sensation avoiders. Sensory avoiders find ways to limit sensory input throughout the day. They stay away from distracting settings; for example, they leave the room if others are moving, talking, or bumping into them. They create rituals for daily routines, which may be an active strategy to generate only familiar, predictable sensory patterns for themselves. They also become unhappy when these rituals are disrupted perhaps because of increasing unpredictability (Brown et al., 2001; Dunn, 1997; Dunn & Brown, 1997; Dunn & Daniels, 2001).

Sensory processing is a complex endeavor. People do not experience sensory events of daily life in a unitary manner. As the literature has shown, internal and external conditions affect the way people process sensory information. They may be more sensitive (have lower thresholds) for some types of sensory input, while being less attentive (have higher thresholds) for other types of sensory input. A model must symbolize complex processes without being complex itself so that it affords further conceptualization and synthesis. This model of sensory processing is meant to provide a framework for studying, interpreting, and gaining insights into the nature of sensory processing, including all of its complexities, and the impact of sensory processing on daily life.

### **Evidence Emerging From Studies Using Dunn's Model of Sensory Processing**

Dunn's Model of Sensory Processing reflects concepts for consideration toward understanding the impact of sensory processing in daily life. My colleagues and I have used the various

forms of the Sensory Profile—the Infant/Toddler Sensory Profile for children birth to 3 years of age, the Sensory Profile for children 3 years to 10 years of age, and the Adult Sensory Profile for adolescents and adults—to conduct studies about the nature of sensory processing as a core feature of the human experience. These measures contain descriptions of sensory events in daily life; the informant (self or parent) uses a 5-point Likert scale (almost always to almost never) to record the frequency they engage in the behaviors described in each item. We have reported good internal consistency estimates for each measure. Findings from specific studies have been and are being reported elsewhere; when considering the findings across ages and human conditions, some consistent patterns emerge that provide insights and furnish information for future interpretations and discoveries.

*Sensory seeking is a prominent feature for everyone.* To date, we have conducted factor analyses on infants and toddlers (Dunn, in press; Dunn & Daniels, 2001), children (Dunn, 1999; Dunn & Brown, 1997), and adults (Brown et al., 2001) without disabilities. In each case, sensory seeking has emerged as a prominent factor accounting for a large amount of the variance in the groups (infants and toddlers, 8%–11%; children, 22%; adults, 7.8%) (see Table 50.1).

Perhaps the sensory seeking factor illustrates the predominant method that people use for gathering information and keeping track of themselves and what is going on around them. As Coren, Porac, and Ward (1984) stated:

The brain, the organ that is responsible for your conscious experience, is an eternal prisoner in the solitary confinement of the skull . . . and must rely on information smuggled into it from the senses . . . the world is what your brain tells you it is, and the limitations of your senses sets the boundaries of your conscious experience. (p. 2)

In implementing responsibility for the conscious experience, the brain exercises vigilance in monitoring the moment-to-moment changes in body integrity, environmental conditions, and the continuous and changing relationship of the body with the environment (Damasio, 1999). In all the factor structures, the sensory seeking factor contained items from multiple sensory systems. Not one sensory modality but, rather, one theme characterized sensory seeking: searching for and enjoying sensory experiences. Perhaps the sensory seeking factors provide evidence of the brain's multisensory vigilance and the universality of seeking sensation as part of the experience of being human.

*The factor structures reflect thresholds and reactivity rather than sensory system organization.* Evidence suggests that some children who have learning and behavioral disabilities exhibit

**Table 50.1. Selected Items From the Sensory Seeking Factor of Each Factor Analysis**

Sensory Profile Form	Item
Infant/Toddler	My child finds ways to make noise with toys. My child enjoys physical activity (bouncing, being held up high in the air).
Child	My child twirls/spins self frequently throughout the day. My child loves to be barefoot.
Adult	I enjoy being close to people who wear perfume or cologne. I hum, whistle, sing, or make other noises.

difficulties processing input from particular sensory systems (Ayres, 1979, 1989; Ayres & Tickle, 1980; Fisher, Murray, & Bundy, 1991; Kimball, 1986). Additionally, researchers and practitioners in occupational therapy have traditionally constructed sensory histories using sensory system groupings (i.e., auditory, visual, touch, vestibular, proprioceptive, taste, smell) (Ayres, 1979; Brown & Dunn, in press; Case-Smith et al., 1998; Cooper et al., 1993; DeGangi & Greenspan, 1989; Dunn, 1999, in press; Dunn & Daniels, 2001; Johnson-Ecker & Parham, 2000; Larson, 1982; Provost & Oetter, 1993; Royeen & Fortune, 1990). Consequently, one might hypothesize that these sensory system groupings would emerge as factors in factor analyses.

However, the findings from the factor analysis studies of the Sensory Profile indicate that the items cluster on the basis of the person's level of reactivity (i.e., thresholds for responding) rather than by sensory system (Brown et al., 2001; Dunn, in press; Dunn & Brown, 1997; Dunn & Daniels, 2001). When persons tend to seek or avoid sensory input, they are likely to seek or avoid input from more than one sensory system.

Perhaps the questions on the Sensory Profile enable persons to characterize the excitation and inhibition needs of their own nervous systems. Preliminary evidence shows that persons with distinct sensory processing patterns consistent with the quadrants in Dunn's model also have distinct patterns of amplitude and habituation responses in skin conductance measures (Brown et al., 2001; McIntosh, Miller, Shyu, & Dunn, 1999; McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1998). For example, Brown et al. (2001) found that amplitude measurements were higher for persons with low threshold patterns (sensory sensitivity, sensory avoiding) than persons with high threshold patterns (low registration, sensory seeking). However, persons with sensory avoiding and low registration habituated quickly, whereas persons with sensory sensitivity and sensory seeking habituated more slowly. McIntosh, Miller, Shyu, and Hagerman (1999) also reported a similar pattern when testing children. These psychophysiology measures are considered involuntary nervous system responses. The fact that persons with distinct sensory processing matching each quadrant on Dunn's Model of Sensory Processing also displayed a unique pattern of skin conductance (i.e., the pattern of amplitude plus habituation) lends psychophysiological support to the model. Possibly the Sensory Profile measures tap persons' awareness of their own (or their child's) nervous system's responding patterns, providing valuable information about nervous system operations in an accessible format.

*Patterns emerge across ages to reveal both stability and developmental factors.* Most of the data from the Sensory Profile studies indicate that responsiveness and reactivity patterns remain the same across the life span. Despite the wide range of ages we have tested, generally the levels of responding remain the same across both the sensory systems and the patterns of sensory processing (i.e., the categories) from Dunn's model. These findings suggest that there is something inherent about sensory processing that is separate from specific learning or experiences. Certainly, persons learn from every experience, and sensory processing provides the information for that learning. Preliminary cross-sectional data suggest that people use consistent sensory processing patterns across time. A person who has low registration, even with variability due to biobehavioral state, environmental variables, and motivation, will likely

have a range of registration that reflects lower registration than others in similar situations. Thus far, we only have cross-sectional data and will need to collect longitudinal data to verify these hypotheses.

Two notable exceptions to these stability patterns seem to reflect active changes in particular developmental periods. Our data on *infants and toddlers* indicate the existence of developmental trends for some of the sensory systems (Dunn, in press; Dunn & Daniels, 2001). In the *tactile system*, the youngest infants (birth to 6 months of age) are very responsive to their parents and rarely resist being held or cuddled. Children between 1 and 3 years of age have a wider range of responses to tactile input, with the average scores between seldom and occasionally. Perhaps as children grow older, they begin to differentiate the wider range of tactile inputs and learn about becoming part of the world outside the mother's womb. They also develop more skills for negotiating their responses during this period (Gormly, 1997). For the *visual and oral sensory systems*, scores steadily progress across the ages of birth to 3 years, with the youngest infants responding frequently to stimuli and the older toddlers responding seldom to occasionally. Again, as the children experience sensations of living in the world, they accumulate information and then habituate to some sensory events as those events become familiar patterns to the nervous system.

For older adults, low threshold factors (sensitivity, sensory avoiding) continue to function at the same level as younger adults, but high threshold factors (registration, seeking) change (Pohl, Dunn, & Brown, 2001). Specifically, after 70 years of age, registration gets worse (i.e., it gets progressively harder to notice stimuli), and persons seek stimuli less (i.e., they engage in fewer and fewer behaviors to add sensation to their experiences). One explanation for this phenomenon is that older adults have poorer sensory acuity, such as hearing and vision, thus reducing their actual input. Another explanation is related to the wider experiences of older adults; perhaps as persons grow older, more experiences are familiar, thus not triggering thresholds for responding as often as younger adults. The low threshold patterns continue throughout the adult period; consistency in low threshold patterns may reflect the nervous system's continuing vigilance for protective responses to potentially harmful stimuli, whereas familiarity with a broader range of information produces less responding in day-to-day familiar situations. Nonetheless, this finding offers information about strategies we might employ for supporting older adults to remain actively engaged and participatory as they age.

*Evidence differentiates patterns of sensory processing across human conditions.* Studies that include persons with various disabilities, such as attention deficit hyperactivity disorder (ADHD), autism, Asperger syndrome, schizophrenia, Fragile X syndrome, and sensory modulation disorder, indicate that sensory processing is significantly different for persons with these disorders compared with peers without disabilities (Brown et al., 2001; Dunn & Bennett, in press; Kientz & Dunn, 1997; McIntosh, Miller, Shyu, & Dunn, 1999). Additionally, some evidence suggests that disability groups are significantly different from each other in their patterns of sensory processing. For example, Ermer and Dunn (1998) conducted a discriminant analysis on data from children with autism, children with ADHD, and children without disabilities and were able to categorize the children with 89% accuracy on the basis

of factor analysis scores alone. (Remember the factor scores are groupings of items that reflect Dunn's Model of Sensory Processing.) Low threshold items related to inattention and distractibility differentiated children with ADHD, whereas poor oral sensory processing differentiated children with autism.

When combined with the data presented in the earlier section about sensory processing differences across a number of human conditions, strong evidence appears to indicate that sensory processing information can enhance our understanding of human disorders specifically and the human experience in general. The normative data on the Sensory Profile suggests a continuum of responding, with persons who have disabilities occupying the ends of the ranges. Significant differences in sensory processing from the patterns most people experience may be a considerable factor contributing to the overall behavioral, cognitive, and psychosocial manifestations of particular disorders.

### **Integrating Data Across Disciplines Provides Insights**

If we are to understand the role of sensory processing in our humanity, including how it affects people's lives, we must consider how knowledge generated across disciplines informs our conception of being human. Researchers have studied personality, temperament, self-regulation, and traits related to responsiveness to understand the nature of being human (Bagnato & Neisworth, 1999; Costa & McCrae, 1987; Rothbart, Ahadi, & Evans, 2000; Rothbart & Jones, 1999; Zuckerman, 1994). These bodies of work offer important constructs that characterize people's ways of being. When combined with sensory processing constructs, we begin to see the possible impact of sensory processing on behavioral and personality traits.

*Studying temperament and personality.* Just as in the sensory processing literature, temperament and personality researchers have conducted factor analytic studies to uncover the constructs underlying self-regulation, personality, temperament, and behavioral response traits (Bagnato & Neisworth, 1999; Costa & McCrae, 1987; Rothbart et al., 2000; Rothbart & Jones, 1999; Zuckerman, 1994). These scholars have found factor structures that seem to reflect levels of reactivity.

For example, Rothbart and colleagues have studied the temperament characteristics of infants and young children and identified factors they called "surgency" (i.e., positive affect, activity level), fear, irritability/anger, and persistence. These same characteristics emerge in studies of children through school age (Rothbart et al., 2000; Rothbart, Derryberry, & Hershey, 2000; Rothbart & Jones, 1999). Rothbart and Derryberry (1981) believed that these temperament characteristics of development precede and underlie the development of self-regulatory processes.

Researchers studying adults have reported similar constructs of temperament and have linked these constructs to personality traits (Caspi, 2000; Rothbart et al., 2000; Starratt & Peterson, 1997). Rothbart, Ahadi, and Evans (2000) reported a four-factor temperament structure that is consistent with the child temperament factors. They also studied the relationship between this temperament structure and the Big Five personality factor structure defined by Costa and McCrae (1987) and found considerable convergence in the two structures. Table 50.2 illustrates the convergence of constructs from the child and adult factor structures.

**Table 50.2. Comparison of the Factor Structures of Infant/Child Temperament and Adult Temperament and Personality Scales and Sensory Processing Scales**

Infant/Child Temperament	Adult Temperament and Personality	Sensory Processing
Fear	Negative affect Neuroticism	Sensory avoiding
Irritability/anger	Orienting sensitivity	Sensitivity
Surgency		
Positive affect	Intellect/openness Agreeableness Extraversion	Sensory seeking
Persistence	Effortful attention Conscientiousness	Low registration

*Hypothesizing about relationships among temperament, personality, and sensory processing.*

Four distinct constructs continue to emerge from the temperament and personality literature (see Table 50.2). The characteristics of these constructs appear to be consistent with the four constructs that have emerged from the sensory processing factor analyses as well. Table 50.2 also contains a column that illustrates hypothesized relationships between the constructs from Dunn's Model of Sensory Processing and the temperament and personality constructs. In this proposed set of relationships, sensory seeking is associated with agreeableness and extraversion of adulthood and surgency of childhood. Sensory avoiding is associated with fear, negative affect, and neuroticism. Sensitivity is associated with irritability and anger and orienting sensitivity. Finally, I hypothesize that the temperament characteristics of persistence and effortful attention and the personality trait of conscientiousness explain a different facet of task persistence than low registration. That is, the sensory processing pattern of low registration (high thresholds and passive responding patterns) seems to enable task performance because of lack of noticing other stimuli. Table 50.3 lists some sample items from the adult temperament and adult sensory processing measures discussed here.

Does this mean that we do not need to study sensory processing because the substantial temperament and personality literature could tell us all there is to know? I do not think so. What I believe to be true about these hypothesized relationships is that these different areas of inquiry are getting at some universal truths about being human, but from different points of view. When we have multiple viewpoints, we can inform knowledge development because one way of looking at something can only reveal a portion of the overall truth.

*Illustrating relationships among temperament, personality, and sensory processing.* Following the tradition of Keogh's (1982, 1994) work, Rothbart and Jones (1999), prominent researchers on children's temperament, wrote about how to apply temperament knowledge to classroom situations. They discuss the fact that positive affect and negative affect are not anchor points on the same scale—an important point because it means that children are not “doomed” to experiencing distress and fear if they have a high degree of negative affect. Rather, studies reveal that children can have various degrees of each temperament trait; thus, they can be

**Table 50.3. Sample Items From the Temperament and Sensory Processing Questionnaires**

	Temperament		Sensory Processing
Fear Negative affect	<ul style="list-style-type: none"> <li>• Loud noises sometimes scare me.</li> <li>• Sometimes I feel a sense of panic or terror for no apparent reason.</li> </ul>	Sensory avoiding	<ul style="list-style-type: none"> <li>• I wear gloves or avoid activities that will make my hands messy.</li> <li>• When others get too close, I move away.</li> </ul>
Irritability/anger Orienting sensitivity	<ul style="list-style-type: none"> <li>• I often notice mild odors and fragrances.</li> <li>• I am often aware how the color and lighting of a room affects my mood.</li> </ul>	Sensitivity	<ul style="list-style-type: none"> <li>• I become dizzy easily (e.g., after bending over, getting up too fast).</li> <li>• I startle easily to unexpected or loud noises (e.g., vacuum cleaner, dog barking, telephone ring).</li> </ul>
Surgency Positive affect	<ul style="list-style-type: none"> <li>• When listening to music, I usually like to turn up the volume more than other people.</li> <li>• I would enjoy watching a laser show with lots of bright, colorful flashing lights.</li> </ul>	Sensory seeking	<ul style="list-style-type: none"> <li>• I enjoy being close to people who wear perfume or cologne.</li> <li>• I enjoy how it feels to move about (e.g., dancing, running).</li> </ul>
Persistence Effortful attention	<ul style="list-style-type: none"> <li>• I can easily resist talking out of turn, even when I'm excited and want to express an idea.</li> <li>• When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.</li> </ul>	Low registration	<ul style="list-style-type: none"> <li>• I don't notice when people come into the room.</li> <li>• I get scrapes or bruises but don't remember how I got them.</li> </ul>

*Note.* Temperament questions from the Adult Temperament Questionnaire, version 1.3, Mary Rothbart. Sensory processing questions from Adult Sensory Profile, Tana Brown and Winnie Dunn.

prone to distress or fear and still possibly experience a positive affect. This complexity in the relationships among temperament traits precludes parents and teachers from labeling children according to only one feature. Rothbart and Jones concluded that this insight enables caregivers “to accentuate the child’s positive tendencies, while at the same time diminishing negative reactions that could lead to discouragement or conflict” (p. 39).

If we add knowledge about children’s sensory processing patterns to this story, we provide caregivers information about how to make adjustments to “accentuate the child’s positive tendencies” and “diminish negative reactions” and supply data about why these changes might be effective in supporting the child’s performance. Sensory processing knowledge adds a level of awareness about the conditions necessary for the child to negotiate the demands of the day successfully. Rothbart and Jones (1999) gave the example of creating a clear routine for a child who is highly anxious, describing a cognitive method for helping the child to develop expectations. Sensory processing knowledge would indicate which sensory systems are likely to trigger anxious reactions (e.g., low threshold responses) and which sensory input mechanisms might be easier for the child to manage. Armed with this information, the teacher could refine instructions, routines, and guidance to minimize low threshold inputs

and take advantage of less sensitive forms of sensory information. Without sensory information, the teacher might create a routine that continues to employ a sensitive sensory system and conclude that the overall approach to the problem was not effective.

*Speculating about sensory processing using insights from the personality and temperament literature.* Many examples just like this one illustrate the importance of interdisciplinary perspectives if we are to understand universal truths about the experience of being human. However, knowledge will not advance unless each discipline considers how other perspectives might inform its work and provide a host of questions that could not be generated from a single discipline's perspective. The fact that consistent patterns about temperament, personality, and sensory processing emerge across studies of children and adults suggests that there is insight to be had in understanding how these constructs interact with each other.

For instance, we might infer some characteristics about sensory processing (a newer line of research) from the relationships we hypothesize to exist between the more established temperament and personality literature and sensory processing. Earlier in the temperament line of research, some controversy existed about whether temperament characteristics were stable throughout life and whether early temperament characteristics predicted personality traits in adulthood (Starratt & Peterson, 1997). The now substantial body of evidence seems to illuminate two important factors. First, longitudinal studies indicate fairly high stability in personality (McCrae, Costa, & Arenberg, 1980); even studies that showed some changes reported that the fluctuations were small overall (e.g., Eysenck, 1987). Cross-sectional data on sensory processing traits provide preliminary evidence that sensory processing patterns are stable across the life span. We might hypothesize that sensory processing patterns manifest as do temperament and personality (i.e., that they also are stable across ages), although our hypothesis needs to be tested explicitly.

Second, personality and temperament researchers indicate that context can affect the manifestation of one's personality traits. Starratt and Peterson (1997) suggested that people may not express their personality traits as strongly in contexts that have variable relevance for them. Perhaps this same tendency to express traits differently across contexts also occurs with one's pattern of sensory processing. A person might construct a home environment so that it minimizes sensory experiences that are more sensitive, whereas at work the person would have to confront these sensory challenges. Starratt and Peterson also hypothesized that the expression of one's personality traits may change across the context of time. Extraverts may express themselves differently in their 20s than in their 60s. We see this same phenomenon of changes across time with the infants, toddlers, and older adults in the sensory processing data (Dunn & Daniels, 2001; Pohl et al., 2001). Perhaps a person's underlying sensory processing traits remain the same, and the demands of life at different ages expose different aspects of his or her sensory processing strategies.

*Speculating about personality and temperament using insights from the sensory processing literature.* We are not limited to speculating from the more established personality and temperament literature to the newer sensory processing literature. We can also speculate about developed lines of research from newer work.

Some studies have linked sensory processing to cognitive, behavioral, and psychosocial performance, suggesting that linking to temperament and personality also would be fruitful. Baranek et al. (1997a) studied sensory defensiveness and its relationship to stereotypic behaviors in children and adults with developmental disabilities. They reported a relationship between tactile defensiveness and rigid, inflexible behavior patterns. Kinnealey and Fuiiek (1999) tested adults with sensory defensiveness and found that they were more anxious and depressed but did not experience more pain than their peers without defensiveness. Stephens and Royeen (1998) found an inverse relationship between self-esteem and school-aged children's responses on the Touch Inventory for Elementary Children, with increasing levels of tactile defensiveness correlated with poorer self-esteem. Parham (1998) reported changing relationships between cognitive performance at school and sensory processing; reading scores were more highly related in younger grades, whereas math performance was more highly related in later elementary grades. Kinnealey (1998) reported on a preschooler with sensory defensiveness who also had difficulty with age-appropriate learning at preschool, anxiety, and need for control, which affected her school and family relationships.

With some association between sensory processing and psychosocial and cognitive performance, we can consider how sensory processing knowledge might inform the temperament work. First, sensory processing evidence informs about how to support persons to be successful in their daily lives. Although the personality and temperament literature makes clear that certain traits are more (or less) conducive to certain situations, discussions about what to do about poorly matched situations are more general. Cohn, Miller, and Tickle-Degnen (2000) found that children want to participate in social interactions, engage in self-regulation, and perceive competence in performance. Parents in the same study reported the desire to learn strategies to support their children and to obtain personal validation for their role as parents. The authors concluded that the therapeutic process needs to center on supporting children and parents in their daily lives and natural contexts; parents need specific information to do this successfully.

Jarus and Gol (1995) found that adding kinesthetic input to skills acquisition routines improved performance in both children with and children without sensory integrative dysfunction. They hypothesized that proprioceptive information gained through kinesthesia provides body scheme information for postural control to support task performance. Stratton and Gailfus (1998) used sensory integrative approaches to address overreactivity in adolescents and adults with ADHD who were abusing substances and could not persist through the substance abuse treatment sessions. They found that the sensory integrative approach enabled the clients to take advantage of the substance abuse program. Woodbury (1997) used an auditory and visual desensitization technique with children with autism. Fewer than half could complete the intervention, but those who did could participate more adaptively. This finding suggests that we must take care in applying desensitization and that it can be effective with selected persons.

Kinnealey, Oliver, and Wilbarger (1995) found that adults with sensory defensiveness had strategies for coping with their daily lives, including avoiding aversive stimuli, imbedding predictability, preparing mentally for situations, talking themselves through situations,

counteracting uncomfortable sensations, and confronting discomfort. This array of strategies suggests that intervention methods must include methods not only to resolve the sensory defensiveness, but also to manage it within daily life. These persons had insight about their sensory defensiveness, yet it was still part of their identity, suggesting that low thresholds persist across an extended period of life and, therefore, may be underlying factors to one's temperament.

Second, all the temperament and personality constructs represent types of engagement. One of the sensory processing constructs, low registration, represents lack of engagement. Perhaps lack of noticing is another facet underlying the personality–temperament traits of persistence, effortful control, and conscientiousness because without being distracted by external stimuli, persons can persist at task performance. This area may be one in which sensory processing literature can inform personality and temperament research by expanding the notion of the underlying features that enable persistence.

This construct of low engagement also has been useful in studies involving disability groups. For example, persons with schizophrenia simultaneously have low registration and sensory avoiding (Brown et al., 2001). We hypothesize that this pattern of poor noticing (low registration) and hyperresponsiveness leading to withdrawal (sensory avoiding) may reflect the small range within which these persons can receive sensory input and use it to participate successfully. These possible sensory processing relationships may provide information about applying temperament constructs to disability groups because our work has been fruitful in this area.

Third, one's sensory processing patterns seem to reflect the way a person's nervous system functions (Brown et al., 2001; McIntosh, Miller, Shyu, & Dunn, 1999; McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1998); one's temperament and personality may be the behavioral manifestation of one's sensory processing patterns and nervous system functions. Thus, by knowing a person's sensory processing patterns, one can construct explicit environmental conditions and activities that support both the nervous system's functions and its temperament (e.g., enhance positive affect while minimizing negative affect).

We need to conduct studies using both sensory processing and temperament–personality measures to investigate the nature of these relationships and gain further insights. Thus far, adequate evidence suggests that these lines of investigation would be fruitful.

## **Application to Practice**

So what does this knowledge mean for practice? The idea that one's sensory processing patterns are relatively stable across one's life creates a slippery slope for possible application to practice. One could deduce that with the view that "we are what we are," there is no reason to provide intervention because it would be futile; but this would be incorrect. Human beings have many relatively stable traits, ones that characterize both our collective humanity and our individuality, such as the way the circulatory system works or our need to be connected with other human beings. Although we might characterize our need to be connected to other human beings as a limitation, we also might consider the advantages of that need for

supporting the overall human experience. I think that in knowing one's "features" we might be set free to learn, evolve, and live a satisfying life.

I believe that the essential gift of our sensory processing knowledge is in providing opportunities for insight. Occupational therapists have crafted an entire focus in our discipline out of coming to understand sensory processing; we have information that will inform others about the nature of their humanity. *Sensory processing patterns are reflections of who we are: These patterns are not a pathology that needs fixing.* Intervention addresses the interference between our desired life and our current performance; sensory processing knowledge can narrow this gap and reduce interference, thereby affording a satisfying life.

We must take care in sharing this gift. Sensory processing is a deeply personal experience. Because our discipline has studied sensory processing, we can offer people, families, and colleagues information about the impact of sensory processing in daily life. We must not fall into the trap of thinking that in knowing something about a person, we as therapists must set out to change it. The way a person processes sensory information is just that—the way the person processes sensory information. No way of processing sensory information is inherently good or bad—it just is. People with every pattern of sensory processing are living successfully and unsuccessfully; you are not doomed to failure if you have low registration or guaranteed success if you are a sensation seeker. A sensation seeker in an impoverished environment will flounder, whereas a sensation avoider may flourish there.

*So ask yourself: What would take so much effort for me to do that I would lose myself in the process?* Let us consider an example. If I find the place where you can barely hear my voice, do you see it as an opportunity to work on your listening, or do you want me to just speak up? If I just speak up, this is an adaptation to support your current auditory skills so that you can participate in the ideas being shared. People who wear glasses say that they hear better with their glasses on. Glasses do not affect hearing per se; they provide support for the load on the nervous system, making attentional resources available for hearing. Conversely, if I find the place where my voice is quite irritating, do you want me to keep it up so you can adjust your frequency range, or do you want me to tone down the screeching so you can pay attention? Your nervous system is unavailable for learning when it is in a fight-or-flight mode. Knowing about your own sensory processing patterns provides you with a method for managing daily life; knowing about your needs and limits on sensory input enables you to increase or decrease input to support your needs and yield more successful outcomes.

The primary and essential intervention using sensory processing knowledge is information. Knowledge about one's own; a family member's; or a friend's, student's, or coworker's sensory processing patterns is the most powerful tool we have to give. When people have insight about why the movie theater is so challenging, the food is so difficult to eat, the concert is too boring, or the stark bedroom is so comforting, they can generalize to other life situations and make better decisions for themselves in collaboration with your ideas. Kinnealey et al. (1995) suggested that insight and designing a sensory diet are primary ways to address sensory defensiveness in adults; Cohn and Cermak (1998) concurred, stating that educating caregivers so that they can provide a nurturing sensory environment is critical for children's outcomes.

Beyond sharing information so people can know themselves better, therapeutic intervention is only appropriate when there is something the person wants or needs to do and their way of sensory processing interferes with that aspect of living a satisfying life. Intervention must focus on living; to that end, we construct intervention options based on what is respectful and compatible with the person's life. For example, persons with low registration notice much fewer cues than others. Although we have the knowledge to construct an intensive sensory program, and persons with low registration will respond to sensory intensity and might come to notice more aspects of engagement during intense sensory stimulation, it is likely that at the end of this intensity, these persons will still have low registration. Low registration is not a problem to resolve; living a satisfying life is the challenge to address. We must use our information so that the person comes to know how to construct work and living environments and establish rituals to provide intensity routinely as a support for daily life so that he or she can be successful. Many persons have low registration; only some are struggling in their daily lives. Those who are struggling may lack insight about the nature of their sensory processing and, therefore, do not make choices that support both their sensory processing needs and the activities of interest in their lives. We have the knowledge and skills to bridge this gap.

## Summary

Sensory processing is a core feature of our humanity. Understanding the nature of one's sensory processing needs provides background knowledge for constructing daily life routines and contexts that are respectful of the nervous system's need for some balance of excitation and inhibition. It is possible that sensory processing mechanisms underlie the manifestations of one's temperament and personality, and these relationships need to be tested.

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