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Evolution of the Sensory Integration Frame of Reference



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Sometimes a normal problem... resists [solving,] revealing anomalies (problems)... then begins the extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science: a scientific revolution... tradition-shattering compliments to the tradition-bound activity of normal science. (Kuhn, 1970, p. 6)

We are honored to be the guest editors for this issue of the *American Journal of Occupational Therapy*, which explores the evidence for occupational therapy for children and adolescents experiencing difficulties processing and integrating sensory information. Occupational therapy using a sensory integrative approach (OT/SI) is one of the most used and researched approaches within occupational therapy (American Occupational Therapy Association [AOTA], 1996; Mulligan, 2002). Therapists use OT/SI to frame their clinical reasoning when working with people whose participation restrictions appear related to difficulty processing and integrating sensory information. The charge to conduct an evidence-based review of the literature on this topic came from the AOTA Representative Assembly (RA) in 2004 by Carolyn Baum, then president of AOTA. With this initiative, Baum and the RA recognized the valuable contribution that the sensory integration frame of reference provides for occupational therapists and the urgent need to generate and document evidence.

In light of the impact of the sensory integration frame of reference on occupational therapy, the task of conducting an evidence-based review of the literature takes on an important significance. Consumers are more savvy in their choices for interventions, and insurance company, school,

and treatment facility administrators are demanding that interventions be evidence based. Concurrently, interest in applying sensory integration principles in interventions for children with autism and other clinical diagnoses has grown. With the increased public demand, a surge in theoretical and research articles, both inside and outside the profession of occupational therapy, has occurred. With it has come myriad information—some of it conflicting and confusing—regarding terminology and defining the intervention approach, including who should provide it and what outcomes should be expected. Hence, a “perfect storm” has arrived, and we must seize this opportunity to emerge as the leaders in the evolution of the theory of sensory integration and the treatment of people who experience participation limitations related to problems in processing and integrating sensory information. Our terminology must be clear, our role must be clearly delineated, our expertise must be defined, and our interventions must be evidence based.

An important first step toward this end is to appreciate that sensory integration is an evolving theory (Schaaf & Smith Roley, 2006; Smith Roley, Blanche, & Schaaf, 2001). As with many areas of science, as new findings are revealed through research and practice, theoretical paradigms are modified and adapted to capture and describe new findings, integrate them with existing knowledge, and classify them in ways that will guide practice and research. Thomas Kuhn (1970) called this process *scientific revolution*—the complex and dynamic growth process of knowledge evolution that results in a paradigm shift. *Paradigm shifts* are a modification in perception or a breaking from a traditional view (Kuhn, 1970); they take place in an attempt to respond to problems, anomalies, and insufficiencies that arise. The

hope is that through the scientific revolution, a new paradigm is created by building on knowledge accumulated under previous paradigms while addressing their problems or insufficiencies.

Such is the state of the scientific evolution of the sensory integration frame of reference. Several models and taxonomies describe the theoretical constructs and subtypes associated with it, and new knowledge is being generated and old paradigms are being challenged. The original paradigm came from Ayres' early work on patterns of perceptual-motor dysfunction (Ayres, 1965) and further evolved with her work on refinement of these patterns throughout the 1970s and 1980s (see Bundy, Lane, & Murray, 2002, or Parham & Mailloux, 2009, for a review). In her final work, Ayres (1989) proposed a typology of *sensory integrative dysfunction* that was based on a series of multivariate factor and cluster analyses of the Sensory Integration and Praxis Tests (SIPT). Mulligan (1998) later conducted a confirmatory factor analysis on more than 10,000 children using SIPT scores. She found that the best fit for the data was a higher order general factor termed *practic dysfunction* and four first-order factors: visual-perceptual deficit, bilateral integration and sequencing deficit, dyspraxia, and somatosensory deficit.

Building on this work and that of others, Fisher, Murray, and Bundy (1991) and Bundy et al. (2002) proposed a model that delineates two major subtypes of sensory integrative dysfunction: dyspraxia and poor modulation. With the development of measurement tools that specifically evaluated sensory modulation, such as the Sensory Profile (Dunn, 1999) and the Sensory Processing Measure (Miller-Kuhaneck, Henry, Glennon, Parham, & Ecker, 2008), new data guided the development of models to further describe sensory modulation. The models described a linear continuum from over-responsiveness and under-responsiveness to sensation (e.g., Fisher et al., 1991; Royeen & Lane, 1991) to more complex models that describe behavioral responses to sensation on the basis of proposed underlying sensitivity to sensation (e.g., sensory modulation, low registration, sensa-

tion seeking, sensory sensitivity, and sensation avoiding; Dunn, 1997; Dunn & Bennett, 2002).

Recently, a group of occupational therapy scholars proposed a paradigm shift related to the terminology to describe the clinical problem (Miller, Anzalone, Lane, Cermak, & Osten, 2007). Their proposal called for *sensory integrative dysfunction* to be renamed *sensory processing disorders*. They advocated that their proposed nosology is not intended to change the terminology used to describe the sensory integration theory, intervention, or evaluation process, only the terminology for diagnostic categorization (Miller, Anzalone, et al., 2007). Although Miller and colleagues' extension of Ayres work is admirable and forward thinking in terms of embracing this scientific revolution, it is preliminary, and there is no consensus in the field regarding it. Further testing is needed to generate empirical evidence about these proposed classifications and subtypes.

As a consequence of this evolution of knowledge, there is confusion within and outside the field of occupational therapy regarding terminology for the clinical problem (e.g., sensory integrative dysfunction vs. sensory processing disorder) and the proposed subtypes (the subtypes of Ayres, as cited in Dunn, 1997; Fisher et al., 1991; Miller, Anzalone, et al., 2007; or Mulligan, 2000). To further complicate the issue, the terminology for the intervention approach is often confused because the literature frequently lumps all sensory-based interventions under the rubric of sensory integration. To address this latter issue, Smith Roley and Mailloux (2007) suggested that we must distinguish intervention based on the principles developed by Ayres (now known as *Ayres Sensory Integration*[®]) from other interventions that use sensory stimulation merely as an applied input or as a reward for positive behaviors. By contrast, Ayres Sensory Integration includes specific components (e.g., a focus on purposeful activity), requires an adaptive response and active participation by the child, and is provided in the context of play. This distinction is important and useful, particularly in conducting evidence-based reviews

of this area. Smith Roley and Mailloux (2007) noted,

Part of the controversy [about the effectiveness of the sensory integrative approach] stems from the many publications and intervention programs that do not truly reflect the principles of Ayres's work but that nonetheless have been mistakenly associated with sensory integration. (p. CE-1)

Clearly, the data and literature are not conclusive regarding terminology and classification of treatment approaches, and further inquiry is needed. Thus, we are in what Kuhn (1970) would refer to as the "crisis stage" of the scientific revolution—the stage when problems or anomalies arise that cannot be explained by existing paradigm(s).

To move from this stage into the creation of a new paradigm, we might look to Iarocci and McDonald's (2006) work in the field of autism. They proposed a research agenda to define sensory integration in autism and suggested several important points. First, researchers and practitioners must evaluate existing paradigms by recognizing their strengths and limitations, analyzing the components of each model, and examining the rigor of the research used to develop the models. Second, a rigorous definition of the construct based on neuroscience and behavioral research must be created and used to generate testable hypotheses that include multiple modalities, using multiple methods and contexts, go across and within specific time frames, and use specific clinical groups. Third, they recommended the use of multiple perspectives such as neuroscience, dynamical systems theory, learning theories, and cognitive neuroscience in work on this topic and systematic documentation of findings.

Fortunately, there has already been significant effort toward this end. A cohort of occupational therapy researchers is investigating aspects of this phenomenon from a neuroscience perspective (e.g., Brett-Green, Miller, Gavin, & Davies, 2008; Davies & Gavin, 2007; Davies, Chang, & Gavin, 2009; McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1999; Parush,

Sohmer, Steinberg, & Kaitz, 1997; Reynolds, Lane, & Gennings, 2009; Schaaf & Benevides, 2007; Schaaf, Miller, Seawell, & O'Keefe, 2003; Schneider et al., 2007), and a cohort of non-occupational therapy researchers is applying their work to the study of specific aspects of sensory processing and sensory integration (see www.spdfoundation.net/library/summary.html for a summary of this work). Clinical investigations are examining the feasibility and utility of occupational therapy using a sensory integrative approach with specific clinical populations (Baranek, Wakefield, & David, 2009; Miller, Coll, & Schoen, 2007; Schaaf, Benevides, Kelly, & Mailloux, 2009). We have developed tools that will enhance the rigor of our clinical investigations, including a fidelity-to-treatment measure specific to Ayres Sensory Integration (Parham et al., 2007, in press) and a method to systematically document clinical outcomes (Mailloux et al., 2007). This work will lay the foundation for defining the constructs associated with sensory integration/sensory processing and will lead to rigorous randomized clinical trials of the intervention.

One thing is clear—as we continue to conduct this work, we will emerge as the leaders in this area by being systematic, rigorous, and open minded in our approach. We must critically evaluate the existing literature for its scientific rigor and its foundational philosophies, and we must have tolerance and patience as the scientific revolution unfolds. We must be clear and articulate as we communicate with others about what we do as practitioners and researchers. Above all, we must use evidence to guide our practice and research.

This *AJOT* special issue takes a first step in this journey by documenting the current state of evidence in our field. The first article, by Arbesman and Lieberman (2010), documents the process that guided our investigations. The authors carefully and thoughtfully guided the work of each group of authors to ensure that the evidence-based review followed a systematic approach with rigorous methods.

The second article, by Lane and Schaaf (2010), provides a synopsis and analysis of the neuroscience evidence that provides an

underpinning to the theoretical principles of occupational therapy using a sensory integrative approach. This task was both daunting and exciting—it revealed data in the contemporary neuroscience literature that support many of Ayres' original ideas about the impact of sensation, active participation, and meaningful activity on brain development and expression.

The third article (Davies & Tucker, 2010) reviews the literature related to subtypes of sensory integrative dysfunction or sensory processing disorders.

The evidence-based review on intervention was divided into two subquestions: The fourth article (May-Benson & Koomar, 2010) reviews evidence of treatments that used the sensory integrative approach, and the fifth article (Polatajko & Cantin, 2010) examines interventions other than the sensory integration approach. These articles should help inform clinicians about what approaches are most useful with different populations of children.

Finally, Koenig and Rudney's (2010) article on the performance difficulties for children and adolescents with problems in processing and integrating sensory information provides a strong link back to occupational therapy intervention to address participation restrictions.

It is our hope that this compilation of articles will serve as a guidepost for occupational therapists using a sensory integrative approach. As a final thought, it is important to explain our rationale for the terminology used in this issue. When appropriate, we chose to describe the problem (i.e., children and adolescents with difficulty processing and integrating sensory information) rather than name a disorder (sensory integrative dysfunction or sensory processing disorder). This decision was made after much reflection, discussion, and analysis of the literature. Clearly, at this time no critical mass of research supports the naming of a disorder; thus, we felt it would be presumptuous and assumptive to suggest it at this time. We recommend describing the problem rather than naming a disorder until there is more research to guide terminology. We felt it was important to be clear to researchers and clinicians outside the field (who will surely read this

volume) that children and adolescents with difficulty processing and integrating sensory information are an important clinical population. Finally, to accurately reflect the intent of each article reviewed, we recommended that the authors report the data with the labels used by the authors of each article reviewed.

We do feel strongly, however, that the interventions for children with participation challenges related to difficulty processing and integrating sensory information be contextualized within the professional domain that is using them. Thus, we term the intervention *occupational therapy using a sensory integrative approach*, or OT/SI, when appropriate, to recognize and define the interventions that used this perspective. We feel strongly that the interventions we perform as occupational therapists, regardless of their theoretical slant, be based on occupational therapy best practice. We invite you to continue this scholarly dialogue by conducting, participating in, and critically analyzing new research. We hope you accept our challenge to be leaders in research providing evidence for this important area. ▲

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