

State of the Science of Sensory Integration Research With Children and Youth

Beth Pfeiffer, Teresa A. May-Benson, Stefanie C. Bodison

Many children and youth with and without disabilities are affected by challenges in processing and integrating sensations. Occupational therapy practitioners serve a pivotal role in the evaluation and treatment of this population. This special section of the *American Journal of Occupational Therapy* includes articles that elucidate the relationship between sensory processing and participation in valued occupations as well as articles that guide best practice, including systematic reviews on common occupational therapy interventions for children and youth with challenges in processing and integrating sensation. This editorial elaborates on key issues for future research.

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Beth Pfeiffer, PhD, OTR/L, BCP, FAOTA, is Associate Professor, Department of Rehabilitation Sciences, Temple University; bpfeiffe@temple.edu

Teresa A. May-Benson, ScD, OTR/L, FAOTA, is Executive Director, SPIRAL Foundation, Newton, MA.

Stefanie C. Bodison, OTD, OTR/L, is Assistant Professor of Research, Chan Division of Occupational Science and Occupational Therapy, University of Southern California, Los Angeles.

A substantial number of children with and without disabilities are affected by challenges processing and integrating sensations. Research suggests that 10%–55% of children without a diagnosed disability have difficulties in this area. This estimate increases to 40%–88% for children with various diagnoses (Ben-Sasson, Carter, & Briggs-Gowan, 2009; Cheung & Siu, 2009; Fernández-Andrés, Pastor-Cerezuela, Sanz-Cervera, & Tárraga-Mínguez, 2015), although it is important not to assume that all individuals with certain conditions experience these difficulties.

Internal and external responses to sensory stimuli vary greatly among individuals, but intervention is required when these responses affect participation in essential and meaningful occupations. Often, participation is affected when there is a mismatch between a person's neurophysiological sensory processing and integration abilities and his or her environment. The environment includes both the physical presence of sensory stimuli and specific tasks demands that require sensory processing and integration.

In recent years, the literature has shifted from a focus on sensory processing and

integration problems to an emphasis on the occupational performance challenges resulting from these problems (Critz, Blake, & Nogueira, 2015). Challenges in detecting, interpreting, and adaptively responding to sensory stimuli affect a child's ability to participate in meaningful and valued occupations. The World Health Organization (2001) has defined *participation* very broadly as "involvement in a life situation" (p. 10). More specifically, *participation* involves engagement in key occupations such as activities of daily living (ADLs), instrumental ADLs, rest and sleep, education, work, play, leisure, and social participation (American Occupational Therapy Association [AOTA], 2014). Participation is the context in which people develop important life skills and competencies that contribute to overall health and quality of life (Pfeiffer et al., 2017).

An emerging literature has identified the pervasive impact of problems in processing and integrating sensations on children with and without disabilities. These problems manifest in a range of symptoms that have varying degrees of impact on participation in childhood occupations. When the impact

becomes substantial, referrals to occupational therapy often result.

This issue of the *American Journal of Occupational Therapy (AJOT)* includes four articles that examine the relationship between sensory processing and integration problems and participation in important occupations. Three studies focus specifically on a general population of children. Dean, Little, Tomchek, and Dunn (2018) examine the relationships among certain types of sensory processing patterns, challenging behaviors, and protective factors. Roberts, Stagnitti, Brown, and Bhojpi (2018) describe the relationship between sensory processing and pretend play and Foitzik and Brown (2018) between sensory processing and sleep. In the fourth study, Celik, Elbasan, Gucuyener, Kayihan, and Huri (2018) explore the relationship between sensory processing and motor development in preterm infants. In all of these studies, sensory processing factors were predictors of important occupation-based outcomes, including sleep, motor development, play, behavior, and resiliency.

Occupational therapy researchers continue to build a body of research that demonstrates the relationship between processing and integrating sensations and many of the domains of occupational therapy practice (AOTA, 2014). This research suggests that the outcomes of our interventions can have effects on performance in a variety of occupations, requiring careful selection of outcome measures and assessments to guide intervention. This issue of *AJOT* contains two articles dedicated to the development and validity of tools that assess sensory features in children and youth, by Dugas, Simard, Fombonne, and Couture (2018) and Mailloux, Parham, Smith Roley, Ruzzano, and Schaaf (2018).

Information presented in this issue informs the use of specific occupational therapy interventions for children and youth with difficulties processing and integrating sensations. Four systematic reviews summarize the current state of the evidence on common occupational therapy interventions for these problems, including Ayres Sensory Integration[®] (Schaaf, Dumont, Arbesman, & May-Benson, 2018), sensory-based strategies and environmental changes (Bodison & Parham, 2018), cognitive and

occupation-based interventions (Pfeiffer, Frolek Clark, & Arbesman, 2018), and education and coaching (Miller-Kuhaneck & Watling, 2018).

Current State of the Science

Although an emerging body of research examines interventions for challenges in processing and integrating sensations among children and youth, problems with many of the studies have been identified. One problem is reproducibility. This problem is consistent with the state of research across multiple fields in basic science, preclinical, and clinical studies (Begley & Ioannidis, 2015; Ioannidis et al., 2014; Kenall et al., 2015). Generally speaking, *reproducibility* is the ability of a research study to be replicated using the same methods and analyses as the original study. It is commonly believed that reproducible research serves as the “foundation on which [scientific, medical, psychological, and rehabilitation] advances are built” (Begley & Ioannidis, 2015, p. 116), and the accurate reporting of both positive and negative findings contributes to propelling the field forward.

In a National Institutes of Health policy report, Collins and Tabak (2014) identified an array of factors that contribute to problems in reproducibility. These include a lack of training of researchers in experimental design, greater emphasis on making provocative statements than on presenting technical details, and failure of publications to report basic elements of experimental design including blinding, randomization, replication, sample size calculation, and effect of gender differences. These same problems have plagued research related to the investigation of sensory processing and integration problems in children (Miller, Schoen, James, & Schaaf, 2007).

Current State of Evaluation

In addition to the multifaceted problems related to reproducibility, Schaaf and colleagues (2014) identified three areas of need in research related specifically to sensory integration within occupational therapy:

1. Valid and reliable assessment tools to characterize populations who have chal-

lenges processing and integrating sensations and who would benefit from occupational therapy using a sensory integration approach

2. Meaningful and sensitive outcome measures that address both proximal and distal areas of concern
3. Measures that ensure adherence to the intervention principles of the intervention provided.

Characterizing Study Populations

A major difficulty in much of the reported literature and critiques of studies examining interventions for sensory processing and integration problems is the lack of adequate characterization of the study populations. People with certain disorders, such as autism spectrum disorder or attention deficit disorder, often demonstrate difficulties processing and integrating sensations. As a result, past research has identified study populations by these disorders, with the assumption that people with these disorders have sensory processing and integration problems. Failure of researchers to evaluate and characterize their study populations specifically for these problems has resulted in research outcomes that cannot validly be applied to clinical populations.

In effectiveness studies, the intervention should be appropriate for the participant receiving the intervention under examination. Failure to assess whether a participant has the specific problem the intervention was designed to address produces research results that lack generalizability and meaning.

In addition, challenges in processing and integrating sensations are complex and result in varying individualized patterns of dysfunction that must be treated in different ways. Interventions that do not target the specific patterns of dysfunction can produce ineffective intervention results. The systematic reviews of interventions for sensory processing and integration challenges in this special issue address this concern by including only participants who were specifically evaluated for sensory processing and integration problems using appropriate assessment measures (Bodison & Parham, 2018; Miller-Kuhaneck & Watling, 2018; Pfeiffer et al., 2018; Schaaf et al., 2018).

Measuring Outcomes

In addition to the need for assessments to accurately identify and characterize populations with challenges in sensory processing, Schaaf et al. (2014) reported the need for appropriate outcome measures to document changes through intervention. Historically, many assessments used in sensory integration intervention effectiveness research were designed not for use as outcome measures but rather as diagnostic tools to identify the presence of sensory processing differences. It is important for researchers to use outcome measures that measure the outcome they desire to change and that are sensitive to possible changes that occur over the intervention period. In addition, the outcomes measured must be meaningful to the client and their families.

Occupational therapy practitioners are often interested in distal outcomes related to participation in meaningful occupations, but they are also concerned with the proximal or underlying sensory, motor, and cognitive factors that influence a person's ability to participate. Although the systematic reviews presented in this special issue identified sensitive and meaningful outcomes that reflected change in children with problems processing and integrating sensations, there was little consistency in the use of outcome measures across studies. This is a major problem in intervention research because it limits the ability to combine outcomes across studies to determine the most meaningful results.

One of the first steps in identifying meaningful and sensitive outcome measures is to examine the relationship of sensory and motor factors to proximal and distal areas of functioning. Examination of these relationships ensures that the outcomes in question are, in fact, related to sensory processing and integration problems and are likely to be amenable to change by interventions targeting these problems. Proximal outcomes most often reflect change in underlying sensory, motor, postural, or cognitive skills that support participation in distal outcomes. Distal outcomes generally reflect participation and are often the areas most valued by families.

The ability to reliably and validly measure both proximal and distal outcomes is

challenged by the lack of adequate assessments that are sensitive to change over the small intervention periods typically used in intervention effectiveness research. The use of individually tailored functional goals that reflect these distal outcomes has been found to be the most sensitive to changes in this area (Schaaf et al., 2018), but additional outcome measures are needed.

Ensuring Fidelity

In sensory integration intervention research, little attention is paid to articulating the details of the intervention under study and describing how adherence to the intervention was measured in a systematic way. Manualization of and adherence to an intervention are often conceptualized as intervention fidelity. *Fidelity* ensures that an intervention is delivered as intended (Breitenstein et al., 2010) with consistency and that all active ingredients of the intervention are present. Lack of fidelity in implementation of intervention research can lead to Type II errors, which occur when faulty conclusions are made about potentially effective interventions that appear ineffective (Dobson & Singer, 2005).

A key component of fidelity is adherence of interventionists to the intervention protocol. This is often assessed through fidelity measures, although such measures are sometimes lacking or totally absent in research. Intervention effectiveness research addressing problems processing and integrating sensations has been fraught with poor manualization and a lack of fidelity measures, resulting in numerous studies claiming to provide a specific intervention (e.g., Ayres Sensory Integration) that in fact do not adhere to the core elements of that intervention. The systematic reviews in this issue address this concern by including only studies that provided adequate information on the intervention under examination to ensure that the intervention clearly was that which was represented (Bodison & Parham, 2018; Miller-Kuhanek & Watling, 2018; Pfeiffer et al., 2018; Schaaf et al., 2018). Future studies assessing the efficacy and effectiveness of any intervention within occupational therapy should include an intervention

manual unique to the intervention being studied and a well-articulated fidelity check to measure adherence to the intervention under investigation.

Conclusion

Effectiveness research for interventions that address problems with processing and integrating sensations in children is improving in quality and rigor. Occupational therapy researchers are increasingly attending to the important issues articulated in this editorial. The articles in this special issue advance our understanding of the needs of children and youth with problems processing and integrating sensations. The systematic reviews provide evidence for effective interventions for this population and identify outcomes that can be examined in future research and addressed in clinical practice. ▲

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