



# Sensory integration: A review of the current state of the evidence

Nancy Pollock

Sensory integration, sensory integrative dysfunction, sensory processing disorder, sensory modulation, sensory diets; all somewhat confusing terms for many occupational therapists, other health professionals, and educators. Imagine how most families must feel! In the 45 years since Jean Ayres presented her Eleanor Clark Slagle Lecture (Ayres, 1963) introducing her concept of sensory integration, the field of sensory integration research and practice has seen tremendous growth and continues to engender strong reactions within and outside the field of occupational therapy. The controversy has recently moved from the professional literature to the lay press. Time Magazine (December 10, 2007) featured an article entitled “*Is this Disorder for Real?*” reporting on the controversy surrounding the move to have sensory processing disorder included in the next revision of the *Diagnostic and Statistical Manual*.

Given the controversial nature of sensory integration, it is important to ensure that practitioners are up to date on the current state of the literature and the evidence. Part of the mandate of the *CanChild Centre for Childhood Disability Research* located at McMaster University in Hamilton, Ontario, is to provide synthesized reviews to assist in translating knowledge from research to practice. Available on our website [www.canchild.ca](http://www.canchild.ca), these reviews are called *Keeping Current* and are written so that families, service providers, and researchers can access them. The *Keeping Current in Sensory Integration*, last updated in 2006, remains one of the most frequently accessed titles on the website, with an average of 650 hits per month. As it is now time to update it, we thought it could also be an important contribution to this special issue of *OT Now*. In this article, I will review the discussions and debates about terminology, identification and diagnosis, review the evidence for the effectiveness of sensory integration interventions, and provide some suggestions for clinicians and families.

## Defining sensory integration

Sensory integration is a theory. As with all theories, sensory integration has a set of assumptions underlying it that propose to explain observed phenomena. As first described by Ayres (1972), sensory integration

is defined as “the organization of sensory information for use” (p.1). It is a neurological process that enables us to make sense of our world by receiving, registering, modulating, organizing, and interpreting information that comes to our brains from our senses. Ayres (1972) hypothesized that some children have an impairment in sensory integration which manifests in difficulties observed in purposeful behaviours. This dysfunction in sensory integration may explain why some children have trouble learning new skills, organizing themselves, regulating their attention, participating in school or play activities, and engaging in positive social experiences. Ayres, and many who have followed her, have worked to establish the validity of this theory through clinical and basic science research.

Through these past decades, researchers and clinicians have explored many aspects of sensory integration in a variety of populations including typically developing children, children with learning disabilities, autism, Aspergers, and attention deficit hyperactivity disorder (ADHD). As well, assessments of sensory integration have been developed and treatment strategies evaluated. Through all of this work, different ideas and understandings about sensory integration have evolved and authors have begun to use different terms to describe their perspectives of sensory integration and propose new models.

Roley, Mailloux, Miller-Kuhaneck, and Glennon (2007) describe the rationale for the recent move to trademark the term Ayres Sensory Integration®. They suggest that the use of this term denotes the adherence to the core principles of Ayres original theoretical framework and distinguishes it from other sensory-based theories and



### About the author –

**Nancy Pollock, MSc, OT Reg (Ont)** is an Associate Clinical Professor in the School of Rehabilitation Science and an Investigator at the CanChild Centre for Childhood Disability Research at McMaster University in Hamilton, Ontario.

treatment approaches. Miller, Anzalone, Lane, Cermak, and Osten (2007) have proposed a taxonomy to enhance diagnostic specificity. They do not suggest a change to the term sensory integration to describe the theory or sensory integration treatment for the intervention approach, but suggest that the diagnostic term be sensory processing disorder (SPD) to distinguish the disorder from the theory. This group has described three subtypes within SPD in their proposed taxonomy which differ from the subtypes identified through the factor analytic studies conducted by Ayres and colleagues (Ayres, 1972b; Ayres, 1989). In an article describing fidelity in sensory integration intervention research, Parham and colleagues (2007) have defined ten core elements that they feel must be present in order for the treatment method to be truly sensory integration treatment. These varying perspectives reflect the difficulties in describing and defining a complex phenomena, and indicate that at present, there is no clear consensus. These controversies also reinforce the importance of practitioners and researchers being very precise and clear in describing their thinking to colleagues and families when using terms related to sensory integration.

### Identifying sensory integrative dysfunction

‘He’s clumsy, and frequently bumps into things.’ ‘She’s a very picky eater.’ ‘He has emotional meltdowns when plans change.’ ‘She insists on wearing the same pair of socks everyday.’ ‘He is too rough when he plays with other children.’ ‘She can’t organize her backpack to bring home the right things from school.’ These are all descriptors that parents frequently offer when talking about their children who may be experiencing difficulties in sensory integration. Parents aren’t very interested in our controversies about terminology. They want to understand what is happening with their child and what to do about it.

Occupational therapists have a number of tools at their disposal to help in understanding what might be happening with these children. Well developed standardized assessments such as the Sensory Profile (SP) (Dunn, 1999) and the Sensory Integration and Praxis Tests (SIPT) (Ayres, 1989) are frequently used. These measures help to describe and measure the child’s behaviour, either directly, in the case of the SIPT, or indirectly through parent completed questionnaires, as in the SP. As norm-referenced measures, the results can be compared to the results of typically developing children and patterns of differences described. Considerable research has shown that these measures are psychometrically robust and able to discriminate differences across children (Ayres, 1989; Dunn & Westman, 1997; 1999; Ermer & Dunn, 1998; Mulligan, 1998).

Several articles have explored the relationship between indicators of sensory processing difficulties and children’s occupational performance (Ahn, Miller, Milberger, & McIntosh, 2004; Baranek et al., 2002; Bar-Shalita, Vatine, & Parush, 2008; Bundy, Shia, Qi, & Miller, 2007; Dunbar, 1999; White, Mulligan, Merrill, & Wright, 2007). More recently, researchers have used neurophysiological measures such as electroencephalography (EEG) (Davies & Gavin, 2007), and measurement of electrodermal activity (changes in the conductivity of the skin related to nervous system activity) to identify differences between typically developing children and those with developmental disorders (Mangeot et al., 2001; Miller et al., 1999; Schaaf, Miller, Seawell, & O’Keefe, 2003).

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Clinical assessments, observations, interviews, and more direct measures of neurophysiological activity present a strong case that some children do indeed have differences in their behaviours that fall into certain patterns. These children can be clearly identified through the clinical and laboratory tools at our disposal. The questions remain though, as to why they show atypical neurological activity and behaviour. Is it because they have sensory processing problems? Most occupational therapists would answer “yes”. Others outside the field of occupational therapy, for example Heilbroner (2005), disagree and suggest that these sensory processing differences do not represent a distinct disorder but are markers of neurodevelopmental immaturity or symptoms of anxiety. Ultimately, does it matter what causes these patterns of behaviour or only that we can identify them and describe them? Where it does matter of course, is when we move to the question of what do we do about it. If we can identify patterns of behaviour that are interfering with the child’s development, learning, play and participation, we need to determine how best to intervene.

### Sensory integration therapy

Most of the practitioners who use sensory integration therapy are occupational therapists and, as such, the goals of intervention are aimed at enhancing the child’s ability to participate in the daily occupations which are meaningful and satisfying for that child in their natural context. The route to achieving that goal is individually defined, but can be broadly categorized as aiming either to remediate underlying impairments or to enable participation through accom-

modation and adaptation; essentially two different roads to one place. In the former category is sensory integration therapy (SIT) as originally developed by Jean Ayres (1972). This form of therapy is sometimes referred to as classical SIT (Parham & Mailloux, 2005) or now, according to the trademark, as Ayres Sensory Integration© therapy. This treatment approach aims to provide the child with various sensory experiences. These experiences are matched during therapy with

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a “just right” challenge, an activity that requires the child to give an adaptive response. SIT is an active therapy. The child must be motivated and engaged in the choice of activities; hence, play is the medium of choice. Activities usually involve large pieces of equipment such as big rolls and balls, trampolines, and suspended equipment that provide intense proprioceptive, vestibular, and tactile experiences. The child is encouraged to explore the equipment and the therapist sets up the activities and the environment to challenge the child to use the sensory input to organize an adaptive response. It typically involves one-to-one direct intervention in an environment that has a variety of specialized equipment.

Over the past four decades, dozens of research studies have been carried out to evaluate the effectiveness of SIT using a wide variety of study methods and designs (Deams 1994; Miller, 2003). Additionally, there have been two meta-analyses (Ottenbacher, 1982; Vargas & Camilli, 1999) and four research reviews (Arendt, MacLean, & Baumeister, 1988; Hoehn & Baumeister, 1994; Polatajko, Kaplan, & Wilson, 1992; Shaffer, 1984). The majority of studies have focused on the use of “classical” SIT with children with learning disabilities and has aimed at improving motor skills, academic performance, behavioural performance and/or sensory and perceptual skills. The results from studies published in the 1970s and early 1980s were very promising; however as research methodologies have become more rigorous, the results have been less favourable for SIT. The more recent meta-analysis concluded that children receiving SIT improved no more than children who received alternate treatments or, in fact, no treatment at all (Vargas & Camilli, 1999). Research reviews, particularly those done outside of the field of occupational therapy have been very critical. Proponents of SIT argue that the studies done to date have not been valid due to methodological

flaws (Miller, Schoen, James, & Schaaf, 2007; Parham et al., 2007). They highlight weaknesses in study design related to the inclusion criteria for the study samples, fidelity to sensory integration treatment principles and limitations in the outcome measures to detect a difference. A recent randomized controlled trial conducted by some of these same authors showed some positive outcomes, but again suffered from many of the methodological flaws they were critical of in other studies (Miller, Coll, & Schoen, 2007).

There has been more effectiveness research conducted on sensory integration therapy than any other intervention in the field of occupational therapy. To date, the evidence of its effectiveness is weak at best. We can continue to argue that the supportive evidence is limited due to methodological limitations and attempt to address these weaknesses in future trials, or we can accept that the results are valid and that classical SIT, used with the populations that have been studied, is not supported by the evidence.

Occupational therapists use other forms of intervention which are based on sensory integration theory, but which differ from classical SIT. These approaches use a sensory integration framework to help understand and explain children’s behaviour, but rather than trying to remediate an underlying impairment, these methods are embedded in the child’s daily routines and focus on working with the children, parents, and educators to adapt the child’s environment in ways that will facilitate the child’s ability to participate. This approach may include such things as modifications to the child’s clothing, altering room configurations, noise or light levels, experimenting with food textures, adapting tools and materials, changing program demands, and so on. These approaches are designed to help children function to the best of their ability given their sensory processing capabilities as opposed to trying to change their underlying neurological functioning. In this way, they are distinct from classical SIT.

Most of the effectiveness research on these types of approaches has been preliminary in nature. While some positive results have been found, for example, in the use of specific interventions such as weighted vests (Fertel-Daly, Bedell, & Hinojsa, 2001; Vandenburg, 2001), the research designs have been less rigorous, such as single-subject designs, case studies, and quasi-experimental designs. The population being studied has also shifted with many of these studies being conducted with children with autism. Case-Smith and Arbesam (2008) in a review of interventions for children with autism cite some positive findings, but again conclude that the evidence for sensory integra-

tion and sensory-based interventions for children with autism is weak and requires further study.

These research findings are of course concerning for those therapists and parents who believe that they see positive changes in the children treated using SIT and for those who want to base their practices on strong evidence. Sensory integration as an explanatory framework has intuitive appeal. We have strong evidence that there are children who present with behaviours and neurological responses consistent with hypothesized sensory processing challenges. We also have strong evidence that these children have difficulties in their daily occupations. The question remains, how do we help these children? The evidence for the types of interventions we have studied to date is weak, yet a significant proportion of occupational therapists report that they continue to use sensory integration as a primary intervention approach (Brown, Rodger, Brown, & Roever, 2007; Rodger, Brown, & Brown, 2005). We need to be careful that the appeal of a treatment approach that, unlike many of our

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approaches, was developed by an occupational therapist, doesn't overshadow our commitment to evidence-based practice and to the provision of the highest quality of care to our clients. SIT is a resource-intensive intervention and the time and resources devoted to this therapy mean that the child is not receiving another type of intervention that may potentially have greater benefits.

In summary, the topic of sensory integration remains contentious. Its theoretical underpinnings, its existence as a distinct disorder, and the effectiveness of treatment approaches based on the theory are still under debate. Given the current state of the evidence, here are a few suggestions:

1. Remember that you are occupational therapists, not sensory integration therapists. Focus first and foremost on the occupations identified by the child and family that are of concern.
2. In your occupational analysis, be sure to consider multiple hypotheses for why the child might be having difficulties. Keep an open mind. Remember the old adage “If the only tool you have is a hammer, you'll view every problem as a nail”.
3. If you hypothesize in your clinical reasoning that sensory factors may be impacting on this child, use psychometrically sound measures to support or refute your hypothesis.
4. Set specific and measurable goals that target the

occupation and participation levels of function.

5. Involve the family as partners and think about the changes you can make in the tasks and the environment that will benefit the child more immediately.
6. If you want to use SIT, clearly explain to the family the state of the evidence so they are making an informed choice.

If parents and therapists decide to use SIT, it should always be approached as a trial. Clear, measurable, and functional outcomes should be established. A baseline period of measurement should be undertaken prior to the initiation of treatment. Education of families, teachers, and other team members should always accompany the therapy. Re-assessment using the pre-established outcomes should take place after 8 - 10 weeks of intervention. If SIT is going to be an effective intervention, some positive benefits will be evident by then. If these benefits are not apparent, another approach should be investigated.

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Abnormal sensory-based behaviors are a defining feature of autism spectrum disorders (ASD). Dr. A. Jean Ayres was the first occupational therapist to conceptualize Sensory Integration (SI) theories and therapies to address these deficits. Her work was based on neurological knowledge of the 1970s. Since then, advancements in neuroimaging techniques make it possible to better understand. Read More. Neural Foundations of Ayres Sensory Integration. ASI intervention is based on the concept of neuroplasticity, that is, that the nervous system changes in response to experience. 23 The sensory side of Tourette's disorder Robin Jewers 26 Sensory processing and sleep challenges in children with fetal alcohol spectrum disorder Brenda Fjeldsted and Ana Hanlon-Dearman. 29 Announcing the 2009 CAOT Award Recipients. ISSN: 1481-5532. Canada Post agreement #40034418. read full colour version @ www.caot.ca. 1. Statements made in contributions to Occupational Therapy Now (OT Now) are made solely on the responsibility of the author and unless so stated do not reflect the official position of CAOT, and CAOT assumes no responsibility for such statements. OT Now encourages dialogue ... From the clinical perspective of the author, sensory integrative function is but one aspect of a thorough evaluation and treatment plan for all patients. The manifestations of sensory integration dysfunction (SID), also known as sensory processing dysfunction (SPD), can occur alone or be concurrent with a variety of known medical, behavioural and neurological diagnoses. A review of the effectiveness research identified few studies that reflected true adherence to the core principles of sensory integration intervention (Parham et al 2007). The mother of the two other boys stated: Sensory integration gave us a clearer direction and understanding of both my sons' difficulties with movement. The normative basis of the evidence integration framework and its ability to explain perceptual discrimination behavior suggest that its principles are generally relevant to understanding decision making. But at present, potential limitations on the practicable timescale of integration are a critical obstacle to this generalization. While perceptual discrimination tasks afford tight experimental control and embody many important aspects of decision making, they rarely demand integration over durations that are characteristic of complex natural behaviors.