



INFORMATION PAPER

Research to Inform Practice



Sensory Differences and Autism Spectrum Disorder

It is frequently reported that individuals with Autism Spectrum Disorder (ASD) respond to sensory stimuli differently than their typically developing peers. Sensory issues are often among the earliest symptoms observed by parents, with studies reporting anywhere from 45-95% of children with ASD presenting sensory-perceptual abnormalities of some kind (Watling et al, 2001; Ben-Sasson et al, 2007; Baranek et al, 2008; Tomchek et al, 2007).

More specifically, some individuals with autism may present as over-responsive/hyper-sensitive and go to great lengths to avoid stimuli they find aversive such as loud or unexpected sounds, certain food textures or smells, or the feel of specific fabrics. On the other hand some individuals may be described as under-responsive/hypo-sensitive to sensory input, and may have a diminished response to stimuli in their environment (e.g., may appear to have a decreased reaction to painful or aversive stimuli). Others may seek out certain sensations and interests and may engage in repetitive, stereotypic and/or at times self-injurious behaviour (e.g., mouth non-food items, touch everything or everyone in the environment, repetitively flick a toy/object in a non-functional manner, make noises) (Miller, 2007). Table 1 (adapted from Leekam et al, 2007) highlights the most commonly reported atypical behaviours to sensory input.

To date, sensory symptoms have not been included among the core diagnostic features of autism because of a need for stronger empirical evidence for their prevalence and specificity in autism spectrum disorders (Foss-Feig et al. 2012). However, it has been proposed that the criteria for ASD in the fifth edition of the Diagnostic Manual of Mental

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Information Papers provide topical research summaries and recommendations based on empirical evidence in the field of Autism Spectrum Disorders. It is our aim that the information will guide thoughtful educational planning within the context of informed evidence-based practice and build awareness of potential benefits and risks for any intervention implemented.

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Disclaimer

This document synthesizes current knowledge and offers recommendations for consideration.

It does not constitute provincial education policy or commit Departments of Education to the activities described. This document originates with the Interprovincial Autism Advisory Group.



Disorders - DSM-V (anticipated release Spring 2013) include associated sensory issues under the category of repetitive behaviours; *“hyper- or hypo-reactivity to sensory input or unusual interest in sensory aspects of the environment: such as apparent indifference to pain/heat/cold, adverse response to specific sounds or textures, excessive smelling or touching of objects, fascination with lights or objects,”* (American Psychiatric Association, 2012).

While the empirical evidence is converging in describing the sensory differences in individuals with ASD, the efficacy of approaches for detection and intervention remains controversial. Inconsistent and inconclusive evidence of the link between sensory systems and core symptoms of ASD continues to limit our understanding of the nature of these symptoms and the most effective therapeutic practices to mitigate these symptoms (Ben-Sasson, 2009; Foss-Feig et al, 2012).

Why is understanding sensory differences in children with ASD important?

Understanding the difficulty children with ASD may have in tolerating or processing sensory information is an important educational concern. Sensory differences in children with ASD pose a unique challenge to educators in terms of their potential impact upon the child’s ability to manage the demands of his or her environment in a manner that allows him or her to participate and learn (Saurez, 2012). As a result, it is critical for educators to be part of the process in determining if/when sensory differences are interfering with a child’s learning and to implement evidence-based interventions to support the child’s learning in light of these challenges.

What does the research tell us about sensory differences and intervention practices for children with ASD?

There are a variety of intervention approaches to address sensory differences as part of a student’s comprehensive educational plan. These often include behaviourally-based strategies that have been demonstrated to be effective in the research (Prior et al, 2011; Odom et al, 2010; National Standards Project (NSP), 2009). Commonly, however, sensory-based interventions founded upon theories of sensory processing are recommended as a component of a child’s treatment and educational plan to address perceived sensory difficulties.

Sensory-based interventions such as sensory integration therapy (SIT), auditory integration training (AIT), and sensory diets have evolved from a theory of neurodevelopment first proposed by A. Jean Ayres, an occupational therapist. In the early 1970’s Ayres set forth a hypothesis to explain the brain’s ability to perceive sensory information from the environment, organize and interpret it, and then formulate a physical or emotional response. Ayres proposed that in addition to the basic five senses (hearing, vision, taste, smell and touch), the body must also process information from the vestibular system (movement, speed, balance and direction) and the proprioceptive system (feedback from muscles and joints regarding where our body parts are in relation to each other and how they are moving). According to Ayres’s theory, the sensory system integrates these seven senses with each other to provide an appropriate and functional interaction with a variety of contexts and people (Cook, 1990; Lee et al, 2009; Ayres, 1972).

Ayres proposed that the ability to do this skillfully develops over time and when this does not progress correctly, sensory integration or processing dysfunction occurs (Miller et al, 2007; Hoehn & Baumeister, 1994; Ayres, 1972).

Proponents of sensory integration theory hypothesize that many symptoms of autism are behaviours caused by sensory abnormalities associated with this underlying deficit in processing and modulating sensory input. They contend the central nervous system ineffectively interprets environmental stimuli which interfere with an adaptive response (Addison et al, 2012). Sensory integration therapy (SIT) and/or sensory-based therapies have evolved from this theory of sensory processing and integration. The intervention attempts to change how the brain processes and organizes sensations with the belief that through facilitating sensory integration, the individual will be able to make more adaptive responses, i.e. restore effective neurological processing by enhancing the sensory systems (Devlin et al, 2011). Examples of atypical responses to sensory stimuli are well delineated in a number of parent/caretaker questionnaires utilized by practitioners in the assessment of sensory systems in children with ASD and other developmental disorders, e.g., the Sensory Profile (Dunn, 2002) and the Sensory Processing Measure – SPM (Glennon, Miller-Kuhaneck, Henry, Parham, & Ecker, 2007).

For a more detailed account of the most commonly used questionnaires please refer to TARGET: Texas guide for effective teaching sensory assessment (Texas Statewide Leadership for Autism Training, 2009).

Sensory integration therapy involves a variety of activities that typically include a blend of controlled sensory stimulation and motor activity (Ayres, 1972; Bundy & Murray, 2002; Hoehn & Baumeister, 1994; Vargas & Camilli, 1999). Sensory stimulation involves directly applying one type of sensation to the individual, such as deep pressure, with the intention of evoking a behavioural response and facilitating the reorganization of the vestibular, tactile and proprioceptive systems (Hodgetts & Hodgetts, 2007; Bundy & Murray, 2002). SIT is an active, child-centered therapy in which the child explores materials and equipment that challenge the use of sensory input to organize an adaptive response. Activities are selected through the use of specialized equipment and materials such as brushes, net swings, trapezes, scooter boards, therapy balls, blankets, weighted vests and ramps (Parham et al, 2007; Pollock, 2009).

A related intervention involves the use of "sensory diets". This intervention is based upon sensory integration theory, but requires less equipment than classical SIT and is often recommended for an inclusive setting. In a school or home program the child is provided a schedule of applied stimulation such as brushing (Wilbarger Brushing Protocol) and deep pressure (massage, joint compression weighted vests, etc.) followed by a set of activities that are assumed to meet the sensory needs of the child (Smith et al, 2005). A sensory diet is designed to help the individual use modulating activities to stay calm, yet alert and organized. These activities are integrated into the child's daily schedule and are typically provided under the supervision of a trained therapist. The various techniques used within a sensory diet are usually incorporated within a broader sensory-integration based program, but also are used in isolation, e.g., therapy balls as alternative seating, weighted vests, etc. (Kimball et al, 2007; Case-Smith & Arbesman, 2008).

Despite the fact SIT is the most widely studied treatment within the discipline of occupational therapy, there is still little evidence to support SIT and related sensory-based interventions as they relate to children with ASD. Studies are threatened by weak treatment fidelity (operationalization of the intervention) and methodological rigor (adequate selection and description of participants, random assignment to alternative interventions, adequate sample sizes and variable outcome measures) which makes it difficult to draw inferences regarding SI outcomes with any degree of confidence (Lang et al, 2012; Baranek, 2002; Parham et al, 2007;

Comprehensive reviews of sensory integration therapy (SIT) and related sensory-based techniques report inconsistent and limited evidence that these interventions can correct underlying sensory problems and/or benefit children with ASD.

(Prior et al. 2011; Sinha et al, 2011;

Pollock, 2009). Comprehensive reviews of sensory-based interventions including weighted vests, brushing programs (e.g., Wilbarger brushing protocol), sensory diets, multi-sensory environment (e.g., Snoezelen room, sensory rooms) and auditory integration training (AIT), provide limited evidence these interventions correct underlying sensory problems and benefit children with ASD (Lang et al, 2012; Prior et al, 2011; Sinha et al, 2011; Odom et al, 2010; Leong and Carter, 2008, National Standards Project, 2009; Kane et al, 2005).

One such systematic review worth noting was recently released by the Australian Government in 2011. The review was conducted by The Australian Society for Autism Research (ASFAR) and identifies the most

effective models of practice in early intervention for children with ASD (up to the age of seven). The review reports that although children may show marked responses to sensory information, “there is currently no evidence that SIT, sensory diets, brushing programs or weighted vests can correct underlying sensory problems” (Prior et al, 2011; p.37).

Additionally the review indicates that there is very limited research in the use of multi-sensory environments (Snoezelen/ sensory rooms) with children and adults with ASD. These rooms were initially developed by two Dutch therapists in the 1970s and were designed to provide a soothing and stimulating environment for institutionalized patients with dementia and profound developmental disorders by delivering stimuli to various senses, using lighting effects, color, sounds, music, scents, etc. (Kwok et al, 2003). The review concludes, “There is no evidence to support the rationale of this practice and multisensory rooms do not meet the principles and elements of best practice and effective intervention” (Prior et al, 2011; pg 36). This is especially significant given that Snoezelen rooms or versions of such sensory rooms, are located and utilized in a number of schools across the Atlantic Provinces.

The most limiting factor in the research concerning sensory integration therapy is that many studies fail to directly link changes in the purported area of dysfunction to specific changes in behaviour. It is also questioned if the reported treatment effects are truly the result of the prescribed intervention or the result of other factors such as parental expectations, approval, added attention, practice, desensitization to stimuli, and/or imposed structure (Devlin et al, 2011; Stephenson & Carter, 2009; Baranek, 2002; Myers et al, 2007; Perry & Condillac, 2003).

It is important to note much of the literature refers to unusual responses to sensory information as a sensory processing disorder (SPD); yet it is not clear whether SPD exists as an identifiable developmental diagnosis. Researchers continue in their efforts to identify significant biomarkers of sensory processing difficulty in children with ASD (e.g., markers of parasympathetic nervous system activity; a system which serves to maintain homeostasis and self-regulation (Schaaf, 2010; Miller et al, 2007). However, currently there is no strong evidence that the sensory pathways of the brain are disordered or that these sensory differences are unique to children with ASD (American Academy of Pediatrics, 2012). Difficulty in tolerating or processing sensory information is evident in other developmental disorders such as intellectual disabilities, attention deficit/hyperactivity disorder and learning disabilities (Watling et al, 2007; Perry et al, 2003; Tomchek, 2007). These observations have led the American Academy of Pediatrics to recommend pediatricians not use SPD as a diagnosis. As well, the committee preparing the revisions to the upcoming DSM-V has recommended more research be done before considering sensory processing disorder a separate diagnostic category (American Academy of Pediatrics, 2012).

A second prominent explanation for many behaviours reported as atypical sensory responses is provided by the field of behaviour analysis. Applied behaviour analysis is defined as “*a scientific approach for discovering environmental variables that reliably influence socially significant behaviour and for developing a technology of behaviour change that takes practical advantage of those discoveries*” (Cooper et al, 2007; p 3). This definition reflects the influence of the work of Baer, Wolf, and Risley, which was first published in 1968. From a behaviour analytic perspective, atypical sensory responses observed in children with ASD can be explained by understanding the relationship between the environment and the behaviour. Specifically of interest is the effect of the behaviour on the environment and/or the purpose (function) of the behaviour for the individual (Hanley et al, 2003; Addison et al, 2012; Devlin et al, 2011).

Proponents of this approach contend that in order to address behaviour (including those believed to be responses to sensory information) it is necessary to explicitly identify the events or conditions in the environment that precede and follow that behaviour (Healy et al, 2011). Behaviours believed to be associated with sensory differences may be explained by the effect these behaviours produce for the individual which, in turn, serve to maintain the behaviour (Hanley et al, 2003). The understanding of behaviour is drawn from established principles of learning based in operant conditioning (Devlin et al, 2011; Cooper et al, 2007; Ryan, 2008). The principle of operant conditioning demonstrates that behaviours are learned through interactions with the environment and are maintained by the direct reinforcement they provide (i.e. behaviours that produce a desired effect are more likely to occur in the future). This reinforcement can involve access to a desired outcome/object or social reinforcement such as attention or escape; and/or avoidance of a non-preferred or aversive outcome/stimulus (negative reinforcement); or consequences that are pleasurable in and of themselves (automatic reinforcement) e.g., pleasurable sensory stimuli from finger mannerisms, humming or tapping (Dounavi, 2011; Hanley et al, 2003; Hodgetts et al, 2010).

Behaviour analysis focuses on determining the underlying function of a particular behaviour (i.e. the environmental influences on these behaviours). Practitioners conduct a functional behaviour assessment (direct observation and measurement of behaviour) to assess the sensitivity of behaviours to contingencies of positive, negative, and automatic reinforcement (Hanley et al, 2003). This analysis provides a means to determine which reinforcement-based intervention package is likely to be effective in addressing the target behaviour/s. Intervention may include procedures to teach or increase alternative behaviours/skills (e.g., differential reinforcement of alternative responses, prompting, shaping, and modeling) as well as to reduce or prevent interfering or problem behaviours (e.g., response blocking, extinction, desensitization to stimuli and environmental modifications) (ASAT 2012).

Behaviour analytic procedures have proven efficacy across an array of behaviours including those often associated with sensory difficulties such as aggression, tantrums, self-injury, vocal and motor stereotypy (Dounavi, 2011; Devlin et al, 2007; Cooper et al, 2007; Odom et al, 2003; Prior et al, 2011).

Behaviour analytic procedures have proven efficacy across an array of behaviours including those often associated with sensory difficulties such as tantrums, self-injury, vocal and motor stereotypy, food refusal due to taste/smell, etc. (Dounavi, 2011; Devlin et al, 2007; Ryan 2008; Potoczak et al, 2007; Cooper et al, 2007; Addison et al, 2012). In well controlled studies, it has been repeatedly demonstrated that challenging or interfering behaviours are amenable to change in response to specific, carefully programmed, constructive interactions with the environment (Hanley et al, 2003). Several systematic reviews conducted over the past 6 years have highlighted the efficacy of behavioural approaches in treating the many symptoms associated with ASD in children (Odom et al, 2003; Prior et al, 2011; National Standards Project, 2009). Additionally recent studies have demonstrated the effectiveness of behavior analytic procedures over sensory integration strategies (Devlin et al, 2007; Dounavi, 2011).

Summary

Although not all children with autism display sensory difficulties, there is evidence these types of difficulties are prevalent in this population and may interfere with performance and learning (Ben-Sasson et al, 2009; Baranek, 2002; Myles et al, 2004; Foss-Feig et al, 2012). Currently there is empirical evidence to support the use of behaviourally based interventions in the treatment of sensory differences when they interfere with learning. However, the lack of research supporting sensory integration therapy (SIT) and related sensory-based interventions places the role of these therapies in question for children with ASD (Odom et al, 2003; Prior et al, 2011; National Standards Project, 2009; Leong & Carter, 2008).

Despite the lack of evidence supporting the efficacy of SIT and related interventions, it remains a popular treatment and is still being incorporated into children's education plans. In a US survey conducted in 1999, a high percentage (82%) of occupational therapists surveyed reported using sensory integration as a frame of reference as well as sensory integration techniques when

working with children with ASD (Watling et al, 1999). This trend was later substantiated in a 2006 survey of 552 parents. In this survey SIT was reported as the third most commonly implemented treatment for ASD, ahead of interventions with solid empirical support such as applied behaviour analysis (Green et al, 2006).

This continued support and utilization of sensory integration techniques may in part be explained by the somewhat contradictory positions of organizations that establish the scope of practice for occupational therapists. The American Occupational Therapy Association (AOTA) is explicit in its position on sensory integration and related practices, “AOTA recognizes SI as one of several theories and methods used by occupational therapists and occupational therapy assistants working with children in public and private schools” (American Journal of Occupational Therapy, Nov/Dec, 2009, Volume 63, Number 6; pg. 838). The Canadian Association of Occupational Therapists (CAOT) in a 2006 position statement specifies individuals with ASD and their families should have access to “evidence-based, interprofessional and collaborative health services” throughout their lifespan. The paper supports the view that children with ASD process sensory information differently, but indicates the research related to the effectiveness of interventions is challenged by the complexity and variability of the disorder.

Implications for Practice

In light of the controversy as to the efficacy of sensory-based interventions, what are the “best practice” guidelines for educators in addressing sensory difficulties in children with ASD?

Based on the current research it cannot be said with any degree of certainty that sensory integration-based techniques facilitate educational goals or have any long-term effect on the core symptoms of autism. Although many of the sensory-based practices recommended to address sensory difficulties in children with ASD may not be harmful, and indeed may be pleasurable, they may interfere or delay the implementation of proven and more effective interventions. Others caution that the inappropriate implementation of these approaches (e.g., contingent use of sensory input following disruptive behaviour) may inadvertently reinforce and strengthen challenging behaviours over time (Devlin et al, 2011).

Without sufficient empirical evidence of effectiveness of SIT/sensory based therapies, educators are encouraged to utilize interventions with a stronger evidence base. There are empirically supported alternative interventions for the types of functional problems and behaviours that sensory based therapies claim to address (National Standards Project, 2009; Prior et al, 2011; Odom et al, 2010; Leong & Carter, 2008). Please refer to the Information Paper; *Evidence-Based Practice* (Autism in Education, 2012) which summarizes the results of four comprehensive autism research reviews and identifies those practices classified as having sufficient empirical evidence of effectiveness. Additionally, the paper considers the requirements necessary for schools to implement evidence-based practice system-wide. The paper highlights the importance of selecting interventions based upon an understanding of the empirical evidence. Further, it states this understanding should be integrated with knowledge about the student and related circumstances, the expertise and experience of the educators and

professionals involved, and by the ongoing collection and analysis of data as an intervention is implemented.

“Best practice” guidelines indicate educational programs for children with autism need to incorporate appropriately structured physical environments that take into account individual differences. Specific task/environmental modifications to support student outcomes identified through the program planning process are practical in many educational programs and can be used in conjunction with other interventions to promote fuller participation in the learning environment.

Comprehensive educational programs benefit from consultation with professionals (e.g., autism consultants, occupational therapists, psychologists, physiotherapists, etc.) to provide guidance about potential interventions for children whose sensory difficulties interfere with educational performance. The services these professionals can provide go well beyond SIT and can assist educators to integrate functional activities (self-care, play, leisure and learning) into daily routines and natural environments (Sahagian, 2003; Law, 2006; CAOT, 2006; Baranek, 2002). These practices are based upon a developmental and/or behavioural frame of reference and aim to maximize the child's participation and reduce behavioural difficulties by adapting the environment and teaching new skills (i.e., they do not try to remediate the child's underlying neurological functioning). Such strategies may include modifying clothing, room design, noise and/or light levels, experimenting with food textures, adapting tools and/or materials, and changing and structuring activity demands to maintain a state of calmness and readiness for learning (Pollock, 2009; CAOT, 2006; Perry & Condillac, 2003).

The following **GUIDING QUESTIONS** can be used to assist educators in making decisions concerning the need for and type of intervention to address specific behaviours.

1) What is the specific behaviour of interest (BOI)? (What can be observed?)

2) How does the behaviour impact the child in school? At home? In community?

3) Is an intervention required?

- Does the behaviour interfere with learning?
- Does the behaviour interfere with health or safety?
- How often does the behaviour occur?
- Is the behaviour itself stigmatizing for the child?
- Does the behaviour interfere with peer relationships?
- Is it a priority for the family? student? school? community?
- Will successful intervention have a direct positive effect for the child or family?

4) What is the possible communicative function of the behaviour for the child?

- What factors or situations are associated with occurrence or non-occurrence of the behaviour?
- What happens prior to the behaviour and following the behaviour?

- How do people react when the behaviour occurs?
- Does it occur without social input (e.g., when other people are not interacting with the child)?

5) What are possible intervention options?

- What is the evidence to support the intervention?
- Is the intervention considered evidence-based with this population (e.g., accepted as evidence-based in systematic reviews such as the National Standards Project and comparable reviews)?
- Is the intervention itself exclusionary? Stigmatizing?
- Is the intervention a good fit for use in the school environment (appropriate personnel resources and adheres to school or board policies)?
- Does staff have adequate training and/or supervision to implement intervention?
- Is there adequate time allotted and are procedures in place to monitor the intervention?
- Are there risks associated with implementing the intervention? Are there risks in not implementing the intervention?

6) How is the intervention to be applied?

- What do we want to teach the child to do instead of the targeted behaviour?
- How will we teach and reinforce this?
- Can effectiveness of the intervention be measured?
- How will we monitor progress in an objective way?
- Is there a plan to help the learner generalize the skills outside the teaching situation or learning environment?
- When will the intervention be reviewed?

(Note: It should be recognized that problem behaviours, especially those representing a significant change from the child's typical behaviour, may indicate an underlying medical condition. The individualized educational plan or behaviour support plan can be developed in collaboration with the medical professionals).

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This paper is produced by the Interprovincial Autism Advisory Committee. It will be amended as new information comes to light through relevant research and literature. If you would like to make a comment or provide additional information related to this topic area, please forward to: Sheila_Bulmer@apsea.ca

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Table 1 (adapted from Leekam et al. 2007)

Sensory items used in the Diagnostic Interview for Social and Communication Disorders (DISCO) (Wing & Gould 1970).

Category	Sensory Items from DISCO (9th Version)
Auditory	<ol style="list-style-type: none">1. Distressed by sounds that do not affect others Responds negatively to unexpected/loud noises Holds hands over ears2. Unusual fascination with certain sounds Enjoys strange noises/makes noise for noise sake3. Unusually acute hearing
Visual	<ol style="list-style-type: none">1. Unusually interested in bright lights and shiny things2. Gets unusually excited at seeing things spin3. Twists or flicks hands or objects near eyes4. Looks at object from many different angles for no apparent reason
Proximal/Touch	<ol style="list-style-type: none">1. Unusual interest in the feel of certain surfaces2. Scratches or taps on different surfaces3. Negative reaction to touch5. Aimless manipulation of objects6. Dislikes being washed, having hair washed, nails cut, hair cut, teeth brushed
Smell/Taste	<ol style="list-style-type: none">1. Unusual tendency to explore objects or people by smelling them2. Has very unusual food preferences3. Eats a very small range of foods; refuses food that is lumpy or needs chewing
Other oral	<ol style="list-style-type: none">1. Tends to put everything into his/her mouth Mouths objects frequently
Kinaesthetic	<ol style="list-style-type: none">1. Enjoys being spun round more than age peers2. Spins round or runs round in circles more than age peers
Pain	<ol style="list-style-type: none">1. Indifference to pain, heat and cold Decreased awareness of pain and temperature
Mixed	<ol style="list-style-type: none">1. Plays with saliva, urinates to make puddles, smears feces2. Self-injures if not prevented3. Stimulates self (e.g., taps chin, regurgitates food) without injury4. Destructive activities involving repeated tearing or breaking of things5. Over breathing