Chapter 5

The Sensory Experience of Toilet Training and Its Implications for Autism Intervention

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Additional information is available at the end of the chapter

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1. Introduction

Individuals with autism spectrum disorders are often plagued with incontinence due to compromised sensory processing between the peripheral and central nervous system. Currently, a combination of the Azrin & Foxx method (1971) and operant conditioning are considered the standard protocol for toilet training children with developmental and intellectual disabilities including individuals with autism. Although programs that have been adapted to children with physical disabilities have resulted in successful toilet training in most cases, there is a considerable proportion of individuals with autism who have reached adulthood without being accomplished in bladder and bowel control. These individuals often reside in the spectrum of non-verbal with lower cognition levels (Dalrymple & Ruble, 1992) and exhibit not only incontinence but are challenged with abnormality in toileting such as encopresis, enuresis and fecal smearing. A lack of neurobiological data precluded conclusions regarding the development of, and abnormality in, toilet training individuals with autism. Existing literature is skewed towards treating the aforementioned issue as solely the domain of behavior. Whereas toilet training is both an inherently neurobiological and cultural phenomenon, society's failure to comprehend and address the problem of some of our most vulnerable members in the autism spectrum reflect a still "Victorian-albeit taboo" in this fundamentally important issue in self-care. This chapter reviews the importance of independent self-care skills in family routines, and proposes a putative sensory-neural understanding of the toilet training-resistant cohort, which is largely unknown. Case studies of two children with autism demonstrate how sensory experiences may affect toilet training success.

2. Toilet training in autism

Toilet training is commonly delayed in Autism spectrum disorders (ASD). Dalrymple and Ruble (1992) surveyed 100 parents of clients with ASD (mean age = 19.5 years) and reported that 22% of them did not have full success with toileting. Research studies on toileting in autism have been scarce and are mainly single case studies (Kroeger & Sorensen, 2010). In general, toilet training in autism included: the teaching of hand-washing techniques and cleaning up strategies (Rumfelt-Wright, 2001; Furman, 2001), positive motivational practice, habituation to the bathroom (Cicero & Pfadt, 2002; Rockville, 2008) and the utilization of communication training component to promote self-initiated toileting (LeBlanc, 2005).

3. Impact of lack of independence in toileting in family's life

Children with ASD exhibiting sensory processing issues often lack bladder and bowel control. This can impact family routines. Most notably, the families of children with ASD tended to avoid social participation more so than families with typically developing children (Bagby et al., 2012). Gray (1994) reports that social withdrawal is often a coping strategy for families with children on the autism spectrum who display inappropriate toileting behavior. Additionally, mothers of children with autism are less likely to work full-time than mothers of typically developing children (Porterfield, 2004). As schools and child-care facilities often reject children who are not independent with toileting, parental participation in activities outside of the homes may be further limited as a result of caregiving roles and extensive responsibilities.

4. Self-care skills in children with ASD: A brief overview

Most child care centers and inclusive preschools require children to be toilet trained before entering a certain grade level. For example, inclusive preschools in which prompted independent urination could occur during group lavatory trips at structured times. Children with ASD whom require diaper changes during the school days would be excluded from this classroom routine. As a longer period of seated time is expected for learning to occur, the children attending inclusive schools are required to maintain sufficient bladder and bowel control and to sustain basic self-care needs in order to adhere to environmental structures. Therefore, the ability of children to learn and refine performance of basic self-care tasks holds meaning not only for the children but also for their caregivers and teachers.

5. Neurobiology of toilet training

Without understanding how the body orchestrate the many events associated with going to the bathroom, it is not possible to progress in the field of intervention for individuals still

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struggling with containing themselves appropriately past the critical period for toilet training. This is because toilet training is a behavior that lies in the juncture between a biology that is involuntary and a biology governed by free will that is voluntary. In neurobiological terms, conscious control of urinary and anal continence requires an intact communication between the peripheral and central nervous system. Therefore, dysfunction of the nervous system would result in the loss of control of continence and could explain the prevalence of incontinence in individuals with compromised neurology such as autism. Micturition or the urge to urinate is dependent on the integrity of a center in the lumbo-sacral region of the cord with the bladder and urethra. Micturition takes place when the bladder and urethra sphincter hence stimulated transmits impulses via the ganglia to the cord. Whereas micturition can take place with the lower end of the cord alone, the voluntary control of micturition requires coordination with the central nervous system. Micturition reflex was evoked by filling the bladder and is mediated through sacral spinal region as illustrated in Figure 1. The micturition reflex arch involves the coordination from the spinal cord to the brainstem-cerebellum and back (Fowler et al., 2008). The micturition reflex arch composed of an afferent pathway from the urinary bladder to the lumbar and sacral region onto the spinal cord and to the pontine micturition center before connecting to higher centers in the brain. The afferent pathway is served by the pelvic nerve and hypogastric nerve which connects to the spinal cord before entering the brain. The efferent pathway, on the other hand, projects from the higher center of the brain through the periaqueductal gray area (PAG), travelling to the bladder, then to the lumbro-sacral parasympathetic center and finally to the sphincter muscle of the bladder via the pudendal nerve (Manto & Jissendi, 2012; see Figure 1). The pontine micturition center is thought to be the control center for micturition and is involuntary. The instinctual and involuntary aspects aside, there is a socio-cultural dimension of micturition and proceeds by conscious decision which develops through training. The voluntary center needs to recruit more elaborate coordination between the higher centers in the brain with the spinal cord. This conscious control of urination is thought to recruit higher cerebral centers including the medial prefrontal cortex, anterior cingulate cortex and insular cortex which will communicate with the pontine micturition center that mastermind toilet training. Figure 2 describes in detail the interplay of multiple systems that are involved in the conscious control of continence. As for for the control anal defecation: it is similar to the micturition reflex and work via the coordination of various anorectal physiology: action of sacral nerve stimulation, neurological control of the colon and anorectum and higher cerebral centers (Gourcerol et al., 2011).

Figure 2 illustrates the multi-level control systems that are required for the conscious control of bladder voiding. The PAG is recruited to connect lower spinal cord to the cerebral cortex. Since the cerebellum forms projections to the PAG via the pons, it is likely that sensory processing entering from the cerebellum convey information to the PAG and ultimately communicates with the cerebral cortex.

The neurobiology of continence control indicates that the frontal cortex and cerebellum is part of the essential circuit during the conscious control of continence. Successful toilet training should point toward the contribution of cognitive function and habituation that recruits the frontal cortex and the sensory components of the cerebellum. This paper strive to understand if the dual combination therapy targeting (i) cognitive and habituation training, and (ii) sensory modulation could result in positive outcomes for individuals resistant to traditional approaches to toilet training.

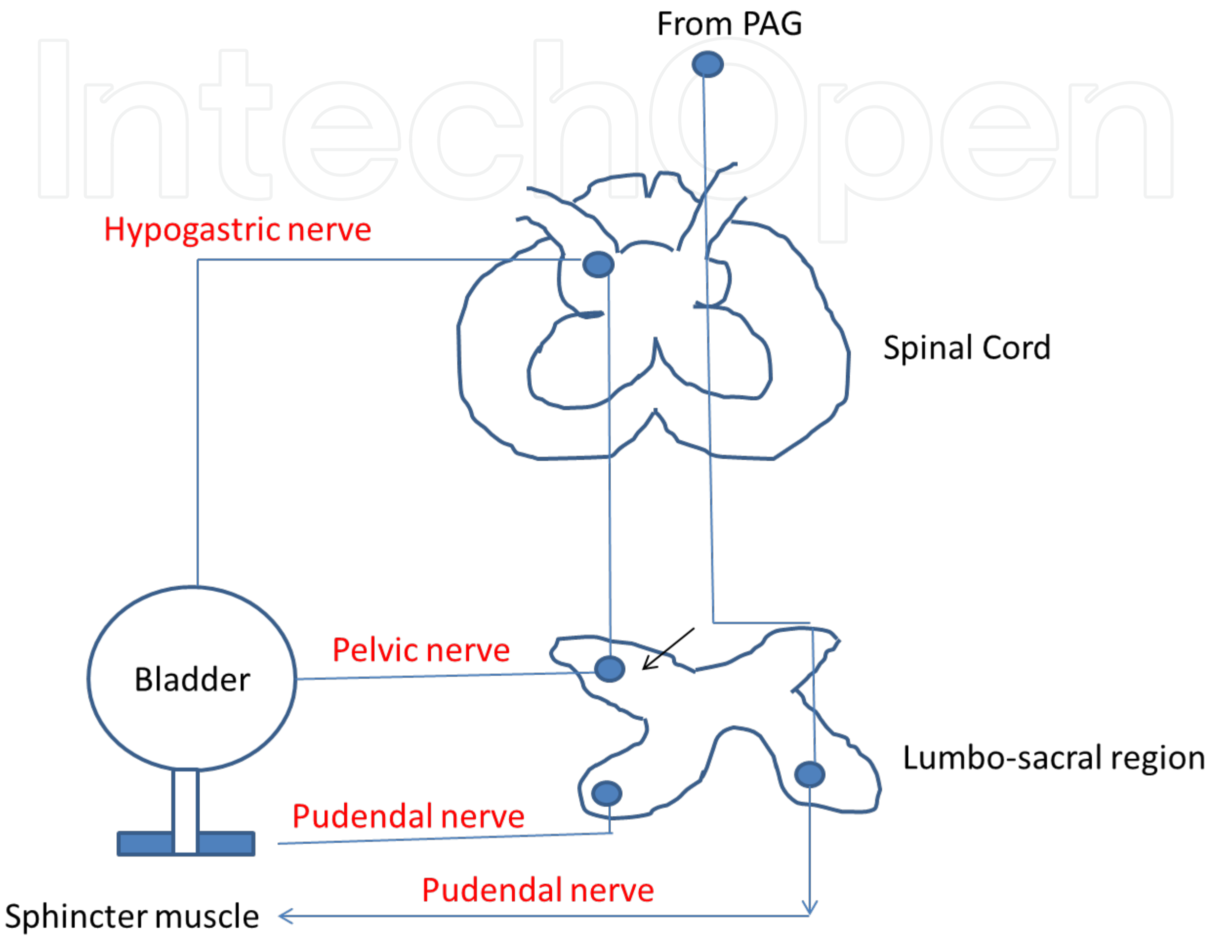

Figure 1. Connections between the afferent pathway (from the bladder to the lumbro-sacral region and the spinal cord via the hypogastric and pelvic nerve) and the efferent pathway (from the brain through the PAG, the spinal cord and onto the sphincter muscle and bladder via the pudendal nerve) that gives rise to the involuntary control of micturition or bladder voiding (Adapted from Manto and Jissendi, 2012).

During the maximal storage of urine, the pressure against the bladder stimulates nervous reflex to the lumbro-sacral region and the spinal cord. This in turn activates the pontine micturition center that communicates with the higher brain center consisting namely of the medial prefrontal cortex (mPFC), anterior cingulate cortex (ACC), and the insular cortex (insular Cx) that promote the guarding reflex for continence. In response, the PAG sends information back to the spinal cord, lumbro-sacral region, bladder to contract the detrusor muscle in the bladder and relax the sphincter muscle in the urethra for voiding. The conscious sensation of bladder pressure and voiding requires the decision of the frontal cortex and the motor learning coordinated through the cerebellum and brainstem. It is the link between the higher centers in the brain with the lower center in the bladder-lumbro-sacral region that constitute the

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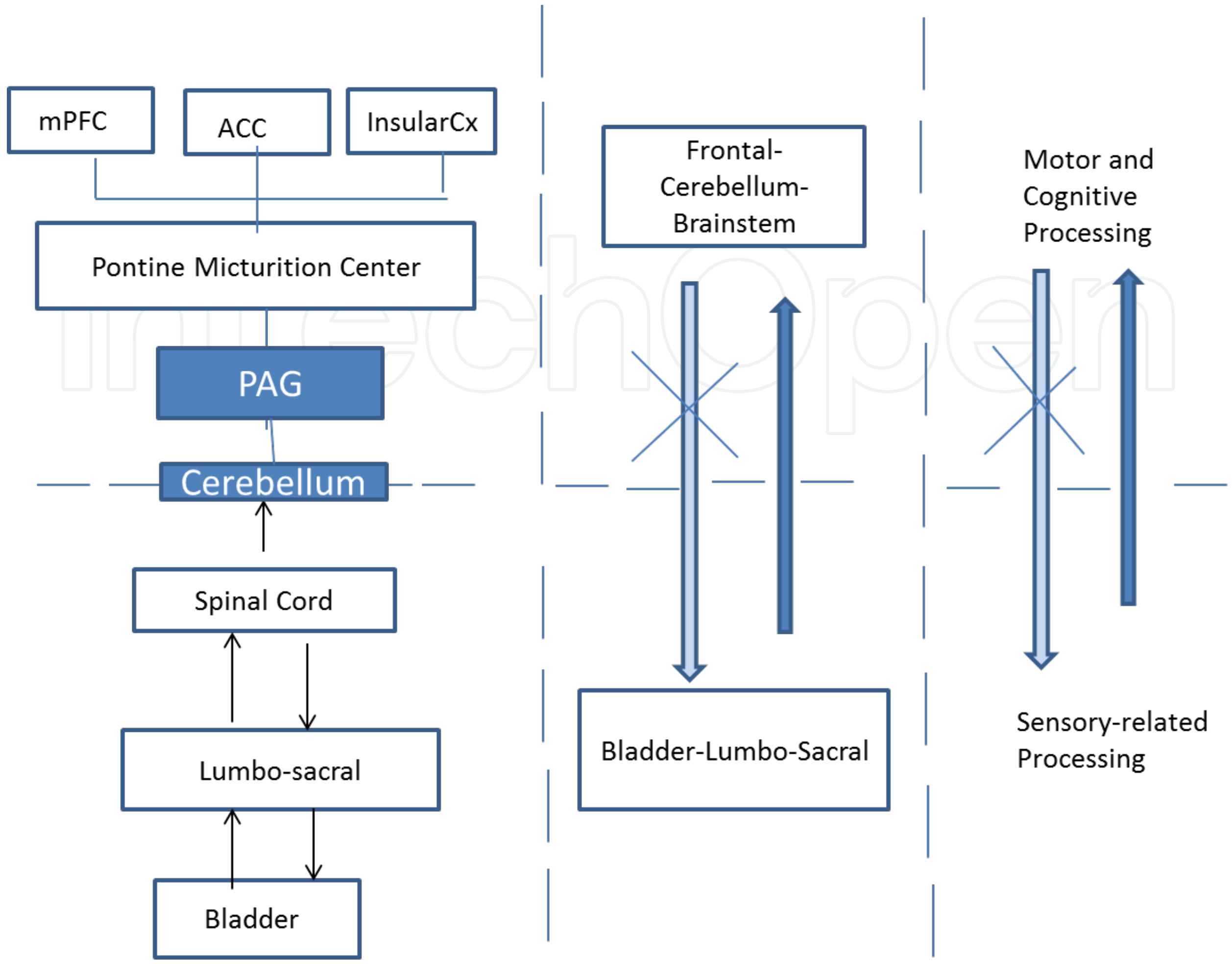

Figure 2. Neural circuits involving the brain that forms voluntary control of micturition.

conscious control necessary for toilet training. In behavior terms, the motor and cognitive learning sub-served by the higher brain centers talks to the lower sensory-related processing in the bladder region to allow the individual to decide whether or not to void. When there is neurological damage as in spinal cord injury or hypothetically in neurodevelopmental disorders such as autism, there is a lack of information flow between the higher (frontal-cerebellum-brainstem) and lower centers (bladder-lumbo-sacral); it may be likely that individuals resistant to toilet training belong to this cohort.

6. Sensory processing in autism

Sensory functions play an important role in young children's daily performance. As defined in the *Occupational Therapy Practice Framework: Domain and Process* (American Occupational Therapy Association [AOTA], 2008), the client factors of sensory functions include touch, smell, taste, hearing, seeing, temperature, pressure, proprioceptive processing and vestibular function. Professionals and parents are recognizing that when young children have poor sensory processing functions, it can affect their sensorimotor, cognitive, and social development (Sears, 1994). ASD are associated with differences in sensory functions and affective response to sensory stimuli. Studies have shown that 70%-100% children with ASD exhibit sensory processing difficulties (Adamson, O'Hare & Graham, 2006; Ben-Sasson et al., 2007; Tomchek & Dunn, 2007). Three sensory constructs (under-responsiveness, over-responsiveness, and sensation seeking) generally characterize the ASD population which are different than typically developing children (Ben-Sasson et al., 2009; Tomchek & Dunn, 2007). These sensory processing difficulties may further impact family routines and daily occupations, such as what a family chooses to do or not to do during *family time* and how the family prepares daily tasks (Bagby, Dickie & Baranek, 2012).

The cerebellum is strongly implicated in the control of continence by relaying sensory impulses from the sacral spinal regions to the higher centers. A dominant role of the cerebellum is the processing of sensory information through the cerebello-thalamo-cortical tract. Aberration in neuronal circuits of the cerebellum have been proposed (Yip et al., 2007, 2008, 2009) and could be an underlying factor for altered sensory sensitivity observed in individuals with ASD.

In addition, there is an association between the modes of sensory processing with temperament (Brock et al., 2012). The ASD population displays temperament scores distinct from typically developing children on most dimensions of temperament (such as activity, rhythmicity, adaptability, approach, distractibility, intensity, persistence, and threshold). Sensory under-responsiveness was associated with slowness to adapt, low reactivity, and low distractibility. Conversely, sensory over-responsiveness often accompanies hyperactivity, attention deficit and high distractability. A combination of increased sensory processing difficulties, especially in the areas of taste & smell sensitivity and movement-related sensory behavior, was associated with greater challenge in self-care skills, adaptive behaviors and emotional regulations (Lane, Young, Baker & Angley, 2010).

Successful integration of signals from various sensory systems is essential for daily functioning. Sensory processing powerfully influences the channel of information transfer necessary for the biology of continence. Sensory processing further contributes critical sensory integration and necessary motor skills for everyday activities and elaborates the temperament of the child, such as to dictate the affective and attentional capability, without which the behaviors associated with toileting could not be accomplished.

7. Analysis of sensory constructs related to toileting in children with ASD

- Under-responsiveness: not aware of wet or stool diapers, not notice when hands are dirty or messy
- Over-responsiveness or sensory sensitivity: overwhelmed by tactile inputs from underpants (or touch feelings of underwear edges), smell of urine, sight of fluorescent lights in bathroom, cold feel of toilet seat, loud noise associated with flushing, etc.

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- Sensation seeking: playing water, urine or stool in the toilet, playing water at the sink, turning on and off the lights in the bathroom, flushing toilet repeatedly

All of these sensory processing difficulties may make toilet training a challenge.

8. Analysis of motor and cognitive processing related to toileting in children with ASD

The cerebellum is a critical brain area for the relaying of sensory information to the cerebral cortex. Sensory information conveyed through motor movement is interpreted in the cerebral cortex, which eventually become stored as motor learning. The learning of motor skill is essential to daily self-help routine. In the cerebellum, the olivocerebellar pathway is a key pathway contributing to learning of motor skills. When the olivocerebellar circuit is deficient as reported in the autism literature (Blatt et al., 2010), it is expected that motor learning will correspondingly be impacted. The role of motor learning in neurodevelopmental disorders and its noticeable implications for the understanding and management of these patients has recently gained more attention (Manto & Jissendi, 2012).

It is common for children with ASD to exhibit deficits in sensory-motor processing such as apraxia. For example, complex motor planning and multiple sensory-motor steps are involved in self-care tasks such as undressing, toileting, cleaning up and hand-washing. The task of toileting requires children to utilize sufficient balance, trunk stability & gross motor skills to get on/off toilet seat and fine more coordination to dress & undress. Dressing or undressing is one specific activity within the self-care area commonly known as activity of daily living (ADL). Dressing independently as a child is important for demonstrating self-reliance (Christiansen & Matuska, 2004). Children with ASD often struggle completing these multiple sensory-motor steps related to toileting.

Independent toileting requires many motor skills that differ by gender, by the facility used, and by the type of clothing worn in different contexts followed by specific cultural norms. A child has to demonstrate his or her abilities to accomplish a series of sensory-motor activities. These activities often require a higher level of executive functioning to form an idea of motor sequences, and to perform a complex loop of motor planning & executions of movement patterns. The following paragraphs provide examples of motor and cognitive skills related to toileting:

- Motor skills related to toileting: moving on and off the toilet; sufficient balancing skills; muscle strength, postural control, and trunk stability to sit safely on the toilet; shifting weight to wipe and to undress then dress after toileting; active range of motion to reach for toilet paper, to wipe the perineal area and to flush the toilet; fine motor skills and bilateral coordination to grasp toilet paper; somatosensory and proprioceptive skills to feel the hold/ grasping of the toilet paper; directional movements to clean the perineal area; fine motor coordination to unfasten, remove, and refasten underwear and clothing. For boys who have insufficient gross motor skills and are lacking balancing skills or trunk stability may have a difficulty to stand in front of a urinal or direct urine into the toilet. Belts or additional accessories may also be worn, which would require additional eye-hand coordination and perceptual functions.

- Cognitive functions in toileting: familiarizing the child to the environment of the toilet so that it is perceived as being a friendly place where one uses the toilet for actions associated with voiding and evacuation; establishing a habit of sitting on the toilet for a length of time; succesfully voiding and evacuating in the toilet and being reinforced positively; forming a habit of going to the toilet to void and evacuate; realizing the urge to void and independently going to the toilet; feeling the pressure to the bowel and independently making the trip to the toilet; performing the steps of voiding, evacuation, cleaning up oneself, handwashing and drying the hands.

9. Task analysis of toileting in children with ASD

Toilet hygiene is an important activity of daily living task as it relates to independence in daily functioning, self-identity, and social acceptance. The following paragraphs provide examples of how toileting may impact routines and psychosocial aspects in children with ASD:

- Social Interaction and Imitation: interest in watching others perform certain tasks, then imitating "go potty", in children with ASD less responsive to social rewards such as praise of "good job" for successful toileting might be a challenge.
- Communication: ability to express a need to go to the bathroom. Boswell & Gray (2012) in TEACCH indicate the importance of having a communication system for children with ASD to initiate the toilet sequences, such as signaling that he needs to go to the bathroom; and have a back up plan in place when in a unfamiliar environment. Such plan may include an evaluation of the environmental contexts and incorporating "teachable moments" to teach the child how to use systematic communication tools, such as objects, pictures, or words to communicate in other settings.
- Tasks in bathroom include: obtaining and using supplies, clothing management – undressing and dressing, maintaining toileting position, transferring to & from toileting position, cleaning body & maintaining posture & balance during cleaning, caring for menstrual needs (Christiansen & Matuska, 2004).
- Teaching and practicing toilet hygiene: children with ASD who also exhibit tactile sensitivity may avoid hand-over-hand assistance to turn the water on and off at the sink during handwashing (Kern, Wakeford & Aldridge, 2007; Dunn, 1997). With compromised motor planning and eye-hand coordination, the movement of turning on and off of light and water, or holding on the handle to flush toilet would be daunting for the children with ASD.
- Change in routines associated with toileting: taking away diapers, wearing underpants.
- Caregiving: there are certain caregiving stresses associated with toileting (Dalrymple & Ruble, 1992). When a child is toilet trained, financial and time benefits arise, such as money

savings of diapers and wipes; available time from assisting toileting for caregivers to engage in other daily tasks (Lee, 2010).

The next paragraph implements, via case studies, the aforementioned task analysis involved in toilet training, including the motor skills and cgnitive domain. Case studies of two children who are siblings illustrate the success of toilet training in one child and a lack of independent toileting in another child; therefore, provide insight into factors that could hinder success.

10. Case studies utilizing the training protocol

The procedure is adapted from Azrin and Foxx (1971) and was carried out in the children's home during the evening 4 hours before bedtime. The participants' parents were interviewed prior to baseline collection and the habit journal was constructed based on the interview. In addition, the researcher compiled a journal recording the number and time of voids after mealtime and at each hour noting the baseline voiding pattern. The data was collected across two children, who are siblings, given the pseudo-name of Jim (10 year old male with a diagnosis of autism) and Bob (5 year old male also with autism) for anonymity. A schedule of reinforcers were noted and used for the protocol (see Table 1). Baseline data includes the frequency of voids per trip to the toilet. Both children were able to void, on occasion, upon verbal prompting but self-initiation was lacking. After baseline was taken, the toilet training program commenced. Unfortunately the training was not as intensive as would have been the ideal scenario. The training program was limited logistically by the children's schedule and school commitment, resulting in the time allocated for the toilet training programme to be 3 hours per evening for twice a week. After 4 weeks at this level of contact time, voiding was 100% for both children (Figures 1 and 2). Follow up after the intervention was maintained at 100%. However, self-initiation was only observed in Bob but not in Jim. While both children have autism, Bob's level of communication was superior to Jim in that Bob could independently express approximately 15 words. On the other hand, Jim was non-verbal and demonstrated less cognitive skills and receptive communication.

The protocol consists of first familiarizing the children to the toilet routine. Children were shown videos, pictures, songs of all aspects associated with toileting. After the multi-media exposure, children were encouraged to visit the bathroom, play with flushing the toilet, turn on and off the faucet, wash their hands with soap, dry with a towel and play with the toilet paper. The aim of the first stage is to allow the children to enjoy going to the bathroom. Stage 2 of the protocol is the child entering the bathroom in the presence of reinforcers so that the bathroom is viewed as a friendly place. Children sat on the toilet for 5 minutes with their favourite toy and activity. The time is increased to 10 minutes when children showed enthusiasm for the toilet sitting routine. When successful, implementation of the scheduled sitting begins. The routine of 15 minutes on the toilet followed by 15 minutes of break away from the toilet and bathroom was performed. To provide maximum opprtunity for voiding, children were given drinks every 15 minutes. In scheduled toilet sitting, the children were taught to undress by themselves from the waist down and continuously sit on the toilet without reinforcer. As they void, they were praised and reinforced with their favourite toy. As the percentage of voids increases, the children were given breaks even before the 15 minute-sitting time were up to instill the notion that once voiding has completed, it is time to leave the bathroom. Upon independent void, children were immediately rewarded with fun and interesting activities in another room.

• Stage 1: Introduction to toilet through multi-media education, such as Elmo potty video, toilet training songs, Elmo coloring book, toilet training stories
• Stage 2: 5 minutes on the toilet engaged in favourite activity, such as watching DVD, playing Lego®, or favourite toys
• Stage 3: Extend to 10 minutes on the toilet engaged in favourite activity
• Stage 4: 15 minutes uninterrupted toilet sitting while engaged in favourite activity
• Stage 5: Hydrate with water every 15 minutes followed by routine 15 minutes toilet sitting
• Stage 6: Toilet sitting for 15 minutes duration, without favourite activity, intervened with 15 minutes break. This is the scheduled 15 minutes on toilet and 15 minutes off toilet
• Stage 7: Toilet sitting for 15 minutes noting successful voids and reinforcing with praise and 2 minutes of favourite activity as reinforcer and a break
• Stage 8: When voiding is independent and successful, breaks are introduced into the 15 minutes toilet sitting and 15 minutes break routine extending the time of break

Table 1. Protocol for Voiding

Jim and Bob differed in their outcomes in toilet training. While both children could complete the steps associated with toileting as shown in Figures 3a and 4a, only Bob could initiate the process independently and did not need to wear a diaper following intervention since Bob could initiate independently (see Figure 4b). The other child, Jim, could only void when prompted and failed to achieve the independence (Figure 3b) necessary in order for him to graduate from the diaper. A sensory profile analysis (elaborated in succeeding paragraphs) using the Sensory Profile and the Sensory Processing Measure (SPM) illustrated the difference in sensory processing between Bob and Jim. Bob, not only has better cognitive ability but also has better sensory processing which may contribute to a more intact neural circuit between the higher brain centers with the lower bladder-lumbro-sacral and spinal region. It is likely that an intact circuit predicts better outcomes in toilet training. Nevertheless, further sensory and cognitive training for Jim could help him eventually develop independence.

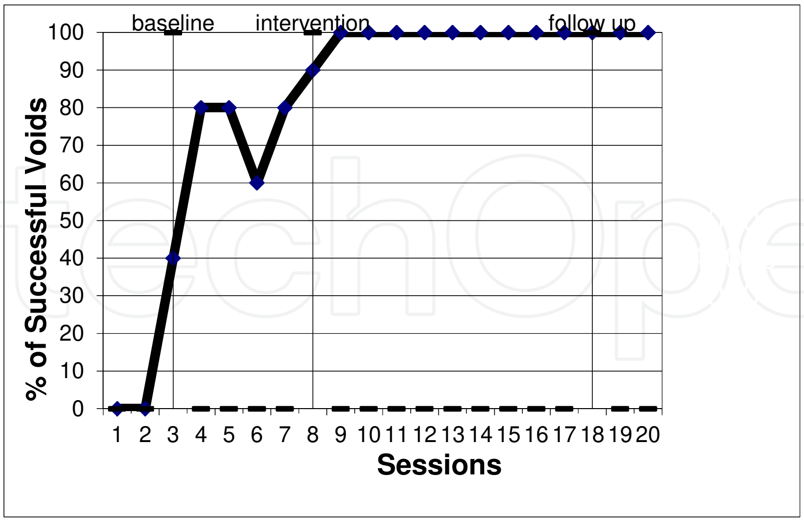
11. Evaluation Results and Summary Interpretation of Sensory Processing for the Case Studies

11.1. Sensory profile[1]

The Sensory Profile Caregiver Questionnaire (SP; Dunn, 1999) is a widely used pediatric assessment that provides a standard method for professionals and caregivers to measure

1 Dunn, W. (1999).Sensory Profile user’s manual.San Antonio, TX:Psychological Corporation.

a)



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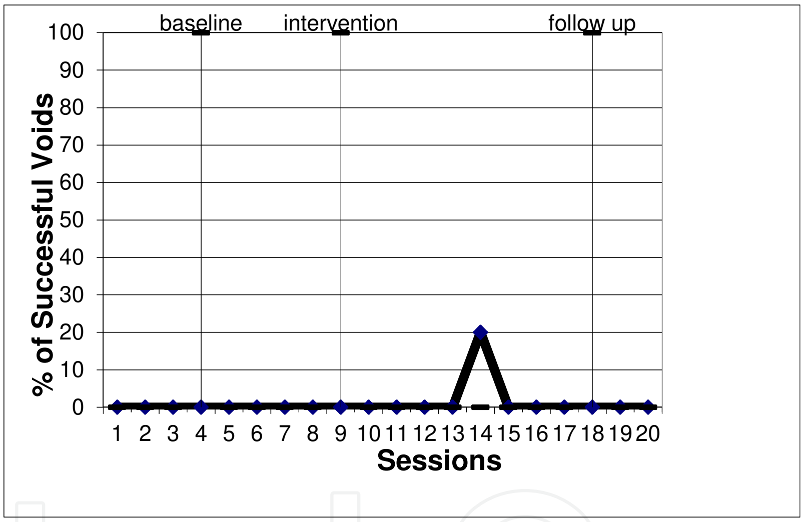
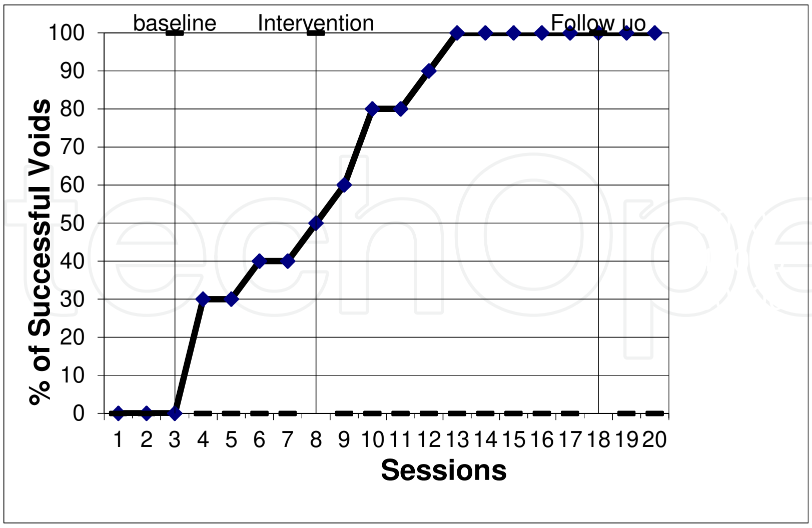


Figure 3. Percentage of successful voids (3a) and percentage successful void upon self-initiation (3b) for Jim.

children's (from 3-10 years of age) responses to sensory events in everyday experiences. Caregivers complete the questionnaire by reporting how frequently their children respond in the way described by each item, using a 5-point Likert scale (nearly never, seldom, occasionally, frequently, almost always). There are 125 items included in the profile[2], which are: (1) sensory processing, (2) modulation, and (3) behavioral & emotional responses. The sensory

2 Cut off scores were determined by preparing a cumulative frequency distribution with the national research sample of children without disabilities (n = 1,037) (Dunn & Westman, 1997) and computing the raw scored cut scores for -1 SD and -2 SD. This was done for the SSP total score and for each section. Refer to the Summary section for representation of the raw scores for 1 SD and 2 SD below the mean.

a)



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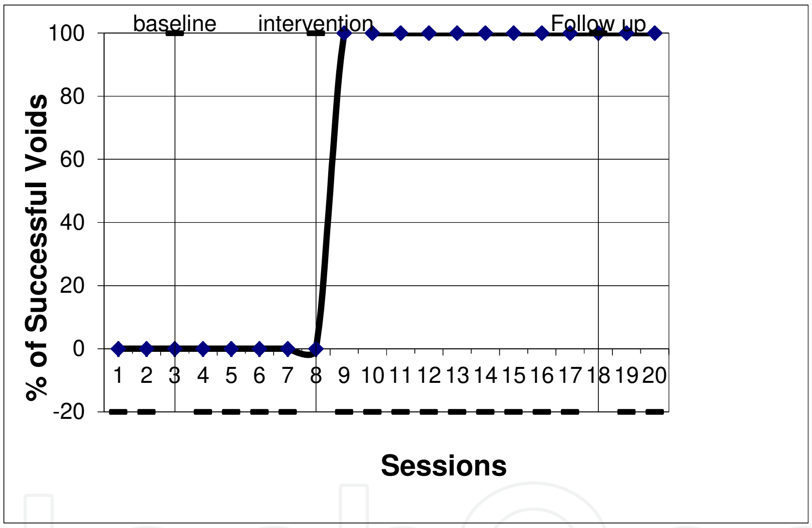

Figure 4. Percentage of successful voids (4a) and percentage successful void upon self-initiation (4b) for Bob.

processing section includes six sensory systems (e.g., auditory, visual, vestibular, tactile, oral). The modulation section contains five item categories that measure children's ability to regulate sensory inputs in order to produce an appropriate response to the context (Dunn, 1997). The summary scores are then classified as *Typical Performance*[3], *Probable Difference*[4], or *Definite Difference*[5] in each sensory processing system. The Sensory Profile was given to Jim and Bob's

3 Typical Performance is scores at or above the -1 SD point. This classification system is a statistical proportion usually represents about 84% of the norm. Section raw score totals that fall within this range indicate typical sensory processing abilities. This range indicates that the child performed no different than the 84% of the research sample of childrenwithout disabilities (n = 1,037).

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caregiver to reveal the possible contribution of his sensory processing patterns to daily performance and/or functional challenges. The following paragraphs summarize Jim and Bob's performance from the *Sensory Profile*.

11.2. Jim's section & factor summaries

Jim has Probable Difference scores in the following areas:

- Modulation Difficulty in *Visual Processing*: occasionally prefers to be in the dark; has difficulty putting puzzles together (as compared to same age children); has a hard time finding objects in competing backgrounds (for example, shoes in a messy room, favorite toy in the junk drawer); occasionally looks carefully or intensely at objects/people (such as stares); has trouble staying between the lines when coloring or when writing.
- Modulation Difficulty in *Touch Processing*: doesn't seem to notice when face or hands are messy (low registration); has difficulty standing in line or close to other people (tactile sensitivity); expresses discomfort at dental work or tooth brushing (for example, cries or fights); avoids getting messy (such as in paste, sand, finger paint, glue, tape).
- *Multisensory Processing*: has difficulty paying attention; walks on toes.
- Modulation Related to *Body Position and Movement*: fears falling or heights; seems accident-prone; hesitates going up or down curbs or steps (for example, in cautious, stops before moving).
- Modulation of *Movement* Affecting *Activity Level*: Low Endurance/Tone; spends most of the day in sedentary play (for example, does quiet things); becomes overly excited during movement activity.
- Modulation of *Visual Input* Affecting *Emotional Responses* & *Activity Level*: avoids eye contact; watches everyone when they move around the room; doesn't notice when people come into the room.
- Emotional/Social Responses: has trouble "growing up" (for example, reacts immaturely to situations); has definite fears; has difficulty making friends (for example, does not interact or participate in group play); doesn't have a sense of humor.
- Sensory Seeking: enjoys strange noises/seeks to make noise for noise's sake; seeks out all kinds of movement activities.

Jim has Definite Difference scores in the following areas:

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4 Probable Difference is scores at or above the -2 SD point below the mean, but lower than -1 SD point below the mean. This classification system is a statistical proportion usually represents about 14% of the norm. Section raw score totals that fall within this range indicate questionable areas of sensory processing abilities. This range indicates that the child's performance was between the 2nd and 16th percentile, representing 14% of the sample population.

5 Definite Difference is scores below the -2 SD point below the mean. This classification system is a statistical proportion usually represents about 2% of the sample population. Section raw score totals that fall within this range indicate sensory processing difficulties. This range indicates that the child is performing like a child in the lowest 2% of the sample, when compared to the research sample of 1,037 children without disabilities.

- *Auditory Hypersensitivity*: responses negatively to unexpected or loud noises (for example, cries or hides at noise from vacuum cleaner, dog barking, hair dryer); has trouble completing tasks when the radio is on.
- *Seeking Vestibular Inputs*: seeks all kinds of movement and this interferes with daily routines (for example, cannot sit still, fidgets); occasionally rocks in desk/chair/on floor.
- *Oral Motor Hypersensitivity* and *Dyspraxia*: avoids certain tastes or food smells that are typically part of children's diets; will only eat certain tastes (such as rice, fish & chicken); picky eater, especially regarding food textures.
- Modulation Related to *Endurance/Tone*: cannot lift heavy objects; shows poor endurance & tires easily.
- Modulation of Sensory Inputs Affecting *Emotional/Social Responses and Daily Performance*: such as *Poor Registration* and *Oral Sensory Sensitivity*; does perceive body language or facial expressions (for example, unable to interpret).
- Behavioral Outcomes due to Challenges in Sensory Processing: such as Emotionally Reactive and Inattention/Distractibility

11.3. Bob's section & factor summaries

Bob has Probable Difference scores in the following areas:

- Sensory Seeking in *Visual Processing*: seeks all kinds of movement and this interferes with daily routines (for example, can't sit still, fidgets, being whirled by adult, merry-go-rounds, playground equipment, moving toys, etc.).
- *Oral Motor Hypersensitivity* and *Dyspraxia*: gags easily with food textures or food utensils in mouth; avoids certain tastes or food smells that are typically part of children's diets; will only eat certain tastes (such as rice, fish, chicken & noodle); picky eater, especially regarding food textures.
- Modulation Related to *Body Position and Movement*: seems accident-prone; hesitates going up or down curbs or steps (for example, in cautious, stops before moving); fears falling or heights; takes movement or climbing risks during play that compromise personal safety.
- Sensory Seeking: enjoys strange noises/seeks to make noise for noise's sake; seeks out all kinds of movement activities; becomes overly excited during movement activity; "on the go".

Bob has Definite Difference scores in the following areas:

- Modulation of *Auditory Processing*: holds hands over ears to protect ears from sound; responses negatively to unexpected or loud noises (for example, cries or hides at noise from vacuum cleaner, dog barking, hair dryer); has trouble completing tasks when the radio is on; appears to not hear what you say (for example, does not "tune-in" to what you say, appears to ignore you).

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- *Multisensory Processing*: has difficulty paying attention; looks away from tasks to notice all actions in the room.
- Modulation of *Movement* Affecting *Activity Level*: spends most of the day in sedentary play (for example, does quiet things); becomes overly excited during movement activity; frequently "on the go".
- Modulation of *Sensory Inputs* Affecting *Emotional/Social Responses* and *Daily Performance*: express discomfort at dental work or tooth brushing; don't seem to notice when face or hands are messy; has difficulty making friends (for example, does not interact or participate in group play); talks self through tasks; has trouble staying between the lines when coloring or when writing; has difficulty tolerating changes in routines.
- *Inattention/Distractibility*: contributed by poor modulation of *Auditory Processing*
- *Low Registration*: high pain tolerance; lack of temperature awareness; don't seem to notice when face or hands are messy.

12. Sensory profile results

In comparison of Jim & Bob's Sensory Profile results, Jim demonstrated multifaceted sensory processing and modulation difficulties in several areas, including: *Low Endurance/Tone, Oral Sensory Sensitivity, Fine Motor/Perceptual Skills, Visual Processing, Vestibular Processing,* and *Modulation of Visual Input Affecting Emotional Responses and Activity Level*. Despite showing a more organized sensory processing profile, Bob displays problems in *Modulation of Movement Affecting Activity Level* and *Emotional/Social Responses*. Through sensory motor activities, he demonstrates ideational dyspraxia and problems with motor planning, which are validated through his Sensory Profile by engaging in sedentary play. In comparison to Jim, who displays complex multi-sensory processing deficits, including somatodyspraxia, tactile, vestibular & proprioceptive among other sensorimotor deficits. This may help explaining Jim's higher level of difficulties with activities of daily living (ADLs), including toileting.

13. Sensory Processing Measure (SPM)[6]

The Sensory Processing Measure (SPM) is an integrated system of rating scales that is used to assess children's response to sensory stimuli in various environments. The SPM consists of three forms: the Home Form, the Main Classroom Form, and the School Environments Form. The SPM is based on sensory integration theory (Ayres, 1972[7], 1979[8], 2005[9]), which proposes that the integration and regulation of everyday sensory experiences is critical neurobehavioral

6 Parham, L. D., Ecker, C., Miller Kuhaneck, H., Henry, D. A., & Glennon, T. J. (2007). Sensory Processing Measure (SPM): Manual. Los Angeles, CA: Western Psychological Services.

7Ayres, A. J. (1972). Sensory integration and learning disorders. Los Angeles, CA: Western Psychological Services.

Factor Summary		
Category	**Raw Score - Jim**	**Raw Score - Bob**
Sensory Seeking	61/85*	58/85*
Emotional Reactive	46/80**	34/80**
Low Endurance/Tone	37/45*	44/45
Oral Sensory Sensitivity	24/45**	32/45*
Inattention/Distractibility	16/35**	15/35**
Poor Registration	24/40**	27/40**
Sensory Sensitivity	15/20*	16/20
Sedentary	10/20*	8/20**
Fine Motor/Perceptual	8/15*	12/15
Section Summary		
Sensory Processing		
Category	**Raw Score - Jim**	**Raw Score - Bob**
Auditory Processing	19/40**	16/40**
Visual Processing	30/45*	35/45
Vestibular Processing	43/55**	47/55*
Touch Processing	73/90	75/90
Multisensory Processing	24/35*	22/35**
Oral Sensory Processing	34/60**	41/60*
Modulation		
Category	Raw Score - Jim	Raw Score - Bob
Sensory Processing Related to Endurance/Tone	32/45**	44/45
Modulation Related to Body Positioning Movement	40/50*	40/50*
Modulation of Movement Affecting Activity Level	19/35*	14/35**
Modulation of Sensory Input Affecting Emotional Responses	10/20**	11/20**
Modulation of Visual Input Affecting Emotional Responses and Activity Level	13/20*	16/20
Behavior and Emotional Responses		
Category	Raw Score - Jim	Raw Score - Bob
Emotional/Social Responses	55/85*	43/85**
Behavioral Outcomes of Sensory Processing	15/30**	15/30**
Items Indicating Thresholds for Response	13/15	13/15

No indication: Typical Performance

* Indicates *Probable Difference*

** Indicates *Definite Difference*

Table 2. Comparison of Jim & Bob's Sensory Profile results (comparing to children aged 3-10 years old):

8Ayres, A. J. (1979). Sensory integration and the child. Los Angeles, CA: Western Psychological Services.

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process that affects development and function. Reponses of "never", "occasionally", "frequently", or "always" are given in answer to questions regarding areas of *Social Participation*, *Vision*, *Hearing*, *Touch*, *Taste & Smell*, *Body Awareness*, *Balance & Motion*, and *Planning & Ideas*. Results are converted to T scores, and compared to responses of typically developing children aged 3 to 12 years old. Scores are interpreted within ranges described as "typical" (within normal limits), "some problems" (*T score of 60-69), and "definite dysfunction" (**T score of 70-80). In addition to the Sensory Profile, Jim and Bob's caregiver also completed Sensory Processing Measure (SPM) – Home Form[10]. This assessment is similar to the Sensory Profile, with additional information on *Social Participation* and *Praxis* (the ability to plan and organize movement).

Results of the SPM (Table 3) indicate Jim is experiencing definite dysfunction in the areas of *Hearing, Motor Planning,* and *Social Participation*. Some sensory problems are also indicated, including: *Vision, Touch, Body Awareness,* and *Balance & Motion*. Bob's SPM results show fewer deficits in multi-sensory processing, with definite dysfunction in *Motor Planning & Ideas*. Some sensory problems are indicated, including: *Vision, Hearing, Touch, Motor Planning,* and *Social Participation*. In comparison of Jim & Bob's Sensory Processing Measure results, Jim demonstrates more sensory deficits in multiple categories, especially in the areas of *Social Participation, Hearing,* and *Body Awareness*.

	Raw Score		T-Score		Percentile	
Area of Assessment	**Jim**	**Bob**	**Jim**	**Bob**	**Jim**	**Bob**
Social Participation	38	25	80**	65*	"/>99	93
Vision	23	21	69*	68*	97	96
Hearing	20	18	71**	69*	98	97
Touch	17	21	61*	66*	86	95
Body Awareness	17	14	61*	57	86	76
Balance & Motion	19	20	64*	65*	92	93
Planning/Ideas	35	25	80**	70**	"/>99	97.5
Total	104	103	67*	67*	95.5	95.5

T-Score of 40-59 indicates *"typical performance"*

*T-Score of 60-69 indicates *"some problems"*

**T-Score of 70-80 indicates *"definite dysfunction"*

Table 3. Comparison of Jim & Bob's Sensory Processing Measure (SPM): Home Report Results

9Ayres, A. J. (2005). Sensory integration and the child, 25th anniversary edition. Los Angeles, CA: Western Psychological Services.

10Parham, L. D., & Ecker, C. (2007). Sensory Processing Measure (SPM) Home Form. Los Angeles, CA: Western Psychological Services.

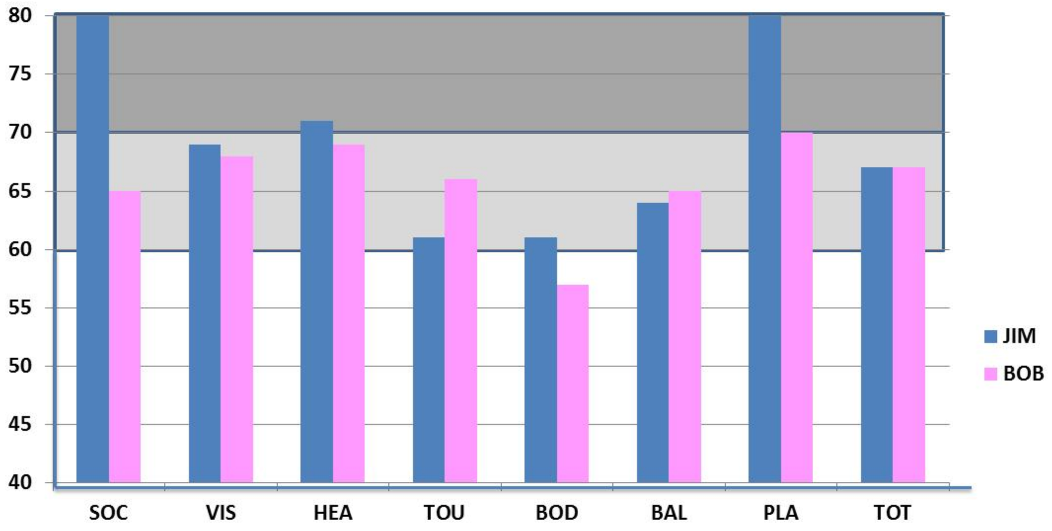

Figure 5. A summary T-Scores of Sensory Processing Measure (SPM) for Jim and Bob. Sensory processing areas are represented on the x-axis and T-Scores are indicated on the y-axis. The darkest shaded zone for the T-Scores between 70 and 80 represent *definite dysfunction*. Correspondingly, the lighter shaded zone between T-Scores of 60 and 70 indicate *some problems*. Note that although the total T-Scores for Jim and Bob is the same and fell under "some problems", Jim has a more complex sensory processing profile and somatosensory processing deficits as indicated on the above-mentioned Sensory Profile results.

14. Summary interpretation of Jim and Bob's sensory processing

When a child has difficulty in a particular sensory system, it means that this form of sensory input would be confusing or upsetting to the child. As a result, the child may avoid situations that overload him with specific types of sensory stimuli or acting inappropriately when such stimuli are unavoidable. Problems in multisensory processing could cause a child to become easily agitated or distracted around busy environments & while experiencing new sensations. At times, the child may show emotional distresses and seem disorganized in their movement patterns or social interactions. In any case, difficulty with sensory inputs can interfere with the child's ability to modulate emotions, behavior, and/or activity level appropriately in response to sensory stimuli in contexts and to complete important activities successfully.

The Sensory Profile & the Sensory Processing Measure scores reveal Jim and Bob's sensory processing and modulation difficulties in multiple areas. Jim's sensory modulation difficulties are more profound and complex than Bob (Table 2, Table 3 and Figure 5). For example, Jim demonstrates several sensory-based motor deficits and somatodyspraxia, including tactile defensiveness, poor endurance, low muscle tone, and lack of body awareness. His proximal joint instability, poor posture control & lack of trunk stability add to his uncoordinated movements & fatigue during gross motor tasks. In order to make sense of his body positions in space, Jim may exhibit excessive movements, grasp objects too tightly, or push too hard when engaging with everyday objects. In comparison, Bob's ideational dyspraxia may contribute to his needs of repeating movement patterns to make sense of movement patterns.

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These sensory processing deficits would affect their attention to tasks, social participation and functional performance in daily routines, such as toileting.

Future directions

Much of the research studies on toilet training in autism has centered on operant conditioning, especially training protocols. Toilet training develops as a result of culture and is a condition of civilized living, but there may be reasons for examining an even earlier process. This process speaks of the inherent biological drive which communicates between lower and higher centers and is shaped by learning. In the population of ASD who may be cognitively impacted to a severe degree, independence in toileting is inhibited by the lack of sensory-neural integration. This chapter attempts to address the issue of sensory processing challenges in toilet training for the intervention of the resistant group. Toileting is an essential daily living skill which typically developing individuals often take for granted. It is in the lack of its skill acquisition that profoundly impacts the children with ASD, their families, caregivers and society as a whole.

Abbreviations

SOC = Social Participation

VIS = Vision

HEA = Hearing

TOU = Touch

BOD = Body Awareness

BAL = Balance and Motion

PLA = Motor Planning and Ideas

TOT = Total T-Scores

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