

A case study of a five-year-old child with pervasive developmental disorder-not otherwise specified using sound-based interventions

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ABSTRACT: *The aim of this study was to determine the efficacy of The Listening Program (TLP) in treating a child with pervasive developmental disorder-not otherwise specified (PDD-NOS). Using a single-subject case study design, one child with PDD-NOS was administered a 20-week TLP intervention focused on improving sensory processing and language function. Data collection included pre- and post-evaluations using video footage, and Sensory Profile and Listening Checklist questionnaires. Results of the study indicated improved behaviour and sensory tolerance in the post-intervention video footage, including active participation in singing and movements to song. Sensory Profile and Listening Checklist questionnaires indicated significant improvements in sensory processing, receptive/expressive listening and language, motor skills, and behavioural/social adjustment at the post-intervention assessment. Although small in scope, this study highlights the need for continued research by occupational therapists into sound-based interventions. Particularly, occupational therapists need to perform larger-scale studies utilizing TLP to verify the efficacy of this alternative treatment method. Copyright © 2009 John Wiley & Sons, Ltd.*

Key words: autism, case study, developmental disability, pediatric occupational therapy, The Listening Program

Introduction

Over the years, people have used music in various forms in an attempt to increase socialization and aid in healing in people with autism spectrum

disorders (ASD) (Gerber, 1998; Cook and Hayashi, 2008). Research dating back several decades indicated that the use of music with people diagnosed with ASD has been successful in assisting these individuals to participate in activities of daily living that are enjoyed by typical individuals, including dance, socialization and even conversational communication (Clarkson, 1994; Wimpory et al., 1995; Orr et al., 1998; Duffy and Fuller, 2000; Boso et al., 2007).

The field of sound-based interventions originated in France in the early 1950s by Alfred Tomatis (1991), an ear, nose and throat physician. Tomatis developed his method initially to assist vocal performers but then expanded to functional and developmental difficulties (Tomatis, 1991). Guy Berard, a student of Tomatis, built upon the method and coined his treatment as auditory integration training (AIT) (American Academy of Pediatrics [AAP], 1998), which has been shown, both anecdotally and in small-scale empirical studies, to be effective in improving attention to task, communication and behaviour (Stehli, 1991; Rimland and Edelson, 1995; AAP, 1998; Madell, 2001).

Following in the footsteps of Berard and Tomatis, The Listening Program (TLP), developed by Advanced Brain Technologies (ABT), utilizes psycho-acoustically modified music as a means of treatment (ABT, 2008). However, TLP differs from AIT and the Tomatis Method in the frequency, intensity and duration. Additionally, TLP is delivered in the client's home on compact discs (CDs) and commercially bought CD players and headphones, as opposed to a clinic setting using specialized audio equipment (i.e. Tomatis's Electronic Ear [Tomatis, 1991] and AIT's AudioKinetron and Earducator [Berard, 1993]). TLP has support within the community of participants including clinicians and clients, but has limited scientific support due to the lack of published empirical evidence of the technique and its relative newness.

The purpose of this case study was to explore the use of sound-based intervention with a child diagnosed with an ASD, specifically pervasive developmental disorder-not otherwise specified (PDD-NOS). Using TLP as an intervention, this research sought to determine if a sound-based intervention improved overall sensory processing and receptive/expressive language skills in a child diagnosed with PDD-NOS.

Incidence and prevalence of ASDs

Pervasive developmental disorders, or ASDs, are disorders characterized by a hallmark symptom of impaired social interaction (Paul et al., 2007). Among these disorders are autistic disorder, Rett's disorder, Asperger syndrome, childhood disintegrative disorder and PDD-NOS. According to both the Centers for Disease Control (2008) and the National Institute of Mental Health (2007), the rates of ASDs are dramatically higher than earlier estimates derived during the 1980s and 1990s. These estimates indicated the prevalence of autism to be roughly 1 in every 10 000 children aged 3–10 years. Current findings from a

2007 government survey regarding prevalence of ASDs indicate the prevalence to be 2–6 of every 1000 8-year-old children (from 1 in 500 to 1 in 150). It is important to note that these statistics do not represent data from a national study, but rather reflect data from key cities across the country. One of the main reasons identified for the increase in prevalence of ASDs is the use of more inclusive diagnostic criteria and increased physician awareness of the disorders falling into the ASD category (Frombonne, 2003; Muhle et al., 2004). Although data do not specifically pinpoint PDD-NOS, the alarming number of ASDs overall warrants extensive research into any potential treatment.

PDD-NOS

The Diagnostic and Statistical Manual of Mental Disorders: Fourth Edition Text Revision (DSM-IV-TR) (American Psychiatric Association [APA], 2000) identifies PDD-NOS as 'a severe and pervasive impairment in the development of reciprocal social interaction associated with impairment in either verbal or nonverbal communication skills or with the presence of stereotyped behavior, interests, and activities' (p. 84). In order to meet the diagnostic criteria of PDD-NOS, a child generally demonstrates impairment in the above areas, but the impairment is not severe or specific enough to be characterized either as autistic disorder or as one of the other defined ASDs. As it has no specific diagnostic criteria (rather, psychologists/psychiatrists diagnose by ruling out other ASDs), PDD-NOS is often identified as *atypical autism*.

While considered to be less severe than other ASDs in terms of functional and communication impairment (Mesibov, 1997; Serra et al., 1999), PDD-NOS shares many characteristics with other impairments on the autism spectrum. Although not specifically identified in the DSM-IV-TR, many children with ASDs, including PDD-NOS, demonstrate difficulty with sensory processing (Bettison, 1996; Case-Smith and Bryan, 1999; Dawson and Watling, 2000; Boddaert et al., 2003; Saulnier, 2003; Alcantara et al., 2004; Paul et al., 2007). In many cases of children with ASDs, vestibular, proprioceptive and tactile sensations are incorrectly processed in the brain. These difficulties in sensory processing often lead to hyper- or hyporeactivity to sensory stimuli. The high prevalence of sensory disturbance in children with ASDs has led some researchers to theorize that sensory modulation is actually the primary impairment in children with autism, while social interaction, communication and language difficulties are actually sequelae of the sensory impairment (Ornitz, 1974).

Another common characteristic of children with ASDs (including PDD-NOS) is difficulty with auditory processing and/or auditory perception (Bettison, 1996; Muller et al., 1999; Boddaert et al., 2003, 2004; Alcantara et al., 2004). Children with ASDs tend to be highly sensitive to auditory stimuli, demonstrating hyperacusis that can be disabling, particularly in the classroom environment, as it is filled with conflicting sounds (Bettison, 1996; Alcantara et al.,

2004). PET (Positron Emission Tomography) studies by Muller et al. (1999) revealed that people with autism have 'reduced or reversed dominance for language perception' and 'a trend towards reduced activation of auditory cortex during acoustic stimulation' (p. 28). It is as a result of these common auditory processing/perceptual problems that children diagnosed with ASDs are eligible candidates for sound-based interventions.

AIT

According to the AAP (1998), AIT is a treatment technique that uses psycho-acoustically modified music in an attempt to 're-train' a person's auditory processing. Utilizing results from an audiogram, the treating practitioner determines frequencies that the individual is not hypersensitive to. Music is then computer-modified so that the individual receiving the treatment listens to music at optimal frequencies. The original AIT programmes generally consisted of two half-hour sessions of listening per day for 10 days (Bettison, 1996). The Tomatis approach to AIT recommends repeating the 10-day cycle several times over a 4- to 12-month period (AAP, 1998).

It was originally proposed that AIT was beneficial for children with listening and attentional difficulties because AIT programmes helped to strengthen middle ear muscles, improving the ability to tolerate sound (Berard, 1993). While this theory does not seem feasible when considering our understanding of the auditory system, other theories are gaining in popularity. One such theory is that AIT stimulates the reticular activating system. The reticular system, which plays a role in neuroplasticity, receives input from the vestibular system and can respond by releasing neurotransmitters that aid in arousal, emotion and learning (Madell, 1999). According to Boddaert et al. (2003), scientific evidence has also been found, through the use of PET scans, that the brains of people with autism activate differently than typical brains during auditory tasks. During such tasks in individuals with autism, the right middle frontal cortex was activated. This area of the brain is considered a cortical attention centre, and may be responsible for abnormal behaviour responses often associated with people on the autism spectrum. This atypical physiology may help explain why AIT is considered by many to be an alternative approach to controlling behaviour in people with autism.

Although AIT is gaining recognition as a viable treatment approach for autism, it remains extremely controversial (Bettison, 1996; Tharpe, 1999; Dawson and Watling, 2000). The major concern with the treatment technique is the lack of empirical support for its efficacy. Although anecdotal support of effectiveness is abundantly available, the empirical data that are available often refute efficacy, rather than supporting it (Bettison, 1996; Tharpe, 1999; Dawson and Watling, 2000). Another concern is in the fact that AIT is used on children without first accurately assessing the presence of an auditory processing/perceptual problem (Madell, 1999). Opponents of AIT challenge the validity of

auditory training on people with behavioural problems, as behaviours can cause false positives on behavioural audiograms, which are typically used in determining auditory processing problems (Tharpe, 1999). In order to determine if AIT is appropriate for children with ASDs, more evidence must be obtained on all AIT programmes.

The listening program (TLP)

According to ABT (2008), TLP builds on the work of Tomatis by utilizing psychoacoustically modified music in certain frequency zones. These frequency zones have been hypothesized to impact functional capabilities. Zone one has been identified as containing lower-frequency sounds (0–750 Hz) that assist with sensory integration including balance, rhythm, coordination, muscle tone, body awareness, sense of direction, laterality and right/left discrimination. Zone two focuses on midrange frequency sounds (750–4000 Hz) that have been linked to speech and language development. Skills in this zone include memory, concentration, attention, speech, language and vocal control. Zone three of TLP correlated to high-frequency sounds (4000 Hz and above) meant to improve skills such as energy, intuition, ideas, ideals, spirituality, creativity and auditory cohesion.

When constructing TLP, ABT (2008) utilized each zone to provide music to aid the listener in developing needed skills. The music itself is designed to have listening sessions that include a warm-up, training and integration (ABT, 2008). These modules allow the listener to become accustomed to the music before the optimal sensory stimulation frequencies are achieved. Following optimal stimulation, the listener is returned to a relaxed state as their daily listening programme ends. The listening schedule is determined by the treating practitioner, usually with listening occurring one to two times per day for 5 days, followed by a 2-day break.

The evidence supporting the TLP method with children diagnosed with ASD is anecdotal and unpublished. Additional research is warranted utilizing more rigorous research designs, methods of measurements and homogenous populations in order to determine more meaningful correlations between TLP and functional outcomes. By investigating sound-based intervention and its effect on occupational goals, therapists can broaden their knowledge bases and potentially improve therapeutic outcomes.

Method

Study design

This study used a single-subject case study design to determine the efficacy of TLP on overall sensory performance and receptive/expressive language. As sound-based intervention's effects on sensory processing have only been

minimally investigated from an occupational therapy (OT) standpoint, it was determined that a single case could be broken down to determine both the efficacy and the need for future research.

Participant

The participant (pseudo-named John) was a five-year-old male with a reported diagnosis of PDD-NOS. John lives with his mother, father and two younger siblings. According to parental report, he was born at 40 weeks gestation and obtained his motor milestones within normal limits. His first word was spoken at approximately 8 months, followed by three to four word phrases at 36 months, sentences at 40 months and emergent conversational language at 42 months. John has a history of middle ear infections that resulted in a tympanostomy (placement of ear tubes) at 24 months.

At 54 months of age, John was referred for OT due to concerns regarding his aggressive tendency towards others (siblings and classmates) and intolerance to sensory input (touch and sound). The referral also indicated decreased attention to structured and unstructured tasks and impulsivity.

In terms of occupational performance, John presented as a very bright and creative child who demonstrated strengths in rote cognitive skills, creativity, fine/gross motor skills and caregiver involvement. His performance in valued daily occupations, such as play, social and activities of daily living, was negatively impacted by his inability to successfully process and use sensory information from his environment.

Procedure

Initially, John was receiving OT two times per month in an outpatient rehabilitation setting. Therapy focused on a sensory diet activity programme developed to aid in managing his behaviours at home and within the community. This programme consisted of heavy work, deep pressure and slow vestibular activities. After 2 months of the sensory diet intervention, it was determined that John would be a good candidate for TLP. The caregiver and treating therapist mutually agreed to begin John on TLP in order to improve his ability to self-regulate and engage in sensory-based activities that he typically found to be noxious. In addition to OT, John was receiving speech therapy two times per month to improve the following areas: vocabulary; understanding and use of questions; and ability to follow multi-step directions.

John was placed on a base schedule of TLP consisting of two 15-minute sessions per day due to his history of middle ear infections and auditory defensiveness. The equipment used for the TLP sessions included a personal CD player with Sennhieser HD 515 headphones (Sennheiser Electronic Corporation, Connecticut). John completed a total of 20 weeks of structured listening. His programme consisted of TLP's Level One Kit, which included the treatment categories of low-, mid- and high-frequency stimulation.

Data collection

Data were collected via video footage, caregiver questionnaires and clinical observations both prior to and after completion of the TLP programme. In order to view John in his natural school environment, his caregiver submitted home video footage of a school music programme. This video footage showed John and his classmates prior to the inception of TLP. Although the full music program consisted of five songs and lasted approximately 45 minutes, only the first, third, and fifth songs performed were included in the pre-programme video footage. Following the TLP programme, footage taken by the caregiver from another school music programme was submitted, focusing on the first, fifth and eighth songs of eight total songs in the programme, which was 60 minutes in duration. Two researchers (the authors) independently viewed these videotapes at the time of their submission (the first video prior to the programme, the second video after completion of the programme). The researchers analysed each video with the intent to identify any behaviours that were not viewed in the other children participating in the programme. Specifically, the researchers sought to identify behaviours commonly associated with children on the autism spectrum including inattention, distractibility, self-stimulating behaviours (such as rocking, spinning or hand flapping) and diminished social interaction. Once both researchers had viewed the videos, the data collected were compared for similarities and differences to establish inter-rater reliability. Both parties agreed upon the resultant data.

Along with the video footage, the caregivers also completed two standardized questionnaires: the Listening Checklist and the Sensory Profile. These questionnaires were completed pre- and post-intervention. Adapted by ABT from Madaule (1994) to be used in conjunction with TLP, the Listening Checklist is a judgment-based questionnaire that documents caregiver's perceptions of a child's listening capabilities and behaviours (ABT, 2008). The first portion of the questionnaire is comprised of a series of questions related to receptive and expressive listening and language. This portion allows parents to rate their child on a 4-point scale (*rarely, sometimes, often or always*). The wording of the checklist is done in such a way that behaviours appear progressively worse as you move along the scale from *rarely* to *always*. Sample statements from this section include 'difficulty staying focused' and 'flat and monotonous voice quality' (ABT, 2008). The second portion of the questionnaire investigates motor skills, behavioural and social adjustment, level of energy, developmental history, environmental history, and foreign languages as they apply to listening and language. In this section, a number of statements are listed, and the caregiver simply checks any statement that applies to his/her child. The Listening Checklist is not norm-referenced, nor does it offer information regarding what constitutes typical or atypical behaviour in the overall schema. As such, the Listening Checklist was used as a screening tool to allow the researchers to gather subjective information from the caregiver's point of view.

The Sensory Profile, developed by Dunn (1999), is also a judgment-based questionnaire that is completed by the caregiver. This questionnaire evaluates a child's sensory processing capabilities. The questionnaire is comprised of 125 statements rated on a 5-point scale (*always, frequently, occasionally, seldom and never*). These items are specifically broken down to determine sensory processing skills, modulation, and behavioural and emotional responses of the child. Responses obtained from the Sensory Profile can help identify a child's sensory processing abilities as typical, showing a probable difference or showing a definite difference.

Results

Baseline data

Using the pre-intervention video and questionnaires, a baseline level of functioning was determined for John. The video footage indicated that John was having noticeable difficulties performing with his peers in the music programme. The programme combined singing songs with props and movements. John's response to activity around him was to rock, cover his eyes and cover his ears. Overall, it was noted that John did not actively participate in the singing or movements associated with the music programme.

The pre-intervention Listening Checklist indicated that in receptive listening and language, John's caregiver selected *often* for the following characteristics: 'difficulty staying focused'; 'short attention span'; 'easily distracted, especially by noises'; 'over sensitivity to sounds'; 'misinterprets requests or questions'; 'confuses similarly sounding words'; 'needs repetition and clarification more than usual'; 'following only one or two instructions in sequence'; and 'difficulty understanding discussions'. In the expressive listening and language section of the Listening Checklist, John's caregiver indicated *always* for 'difficulty summarizing a story' and 'difficulty relating isolated facts'.

Baseline functioning for John on the motor skills, behavioural and social adjustment, and level of energy scales of the Listening Checklist indicated multiple areas of difficulty. As per caregiver report regarding motor skills, John had poor posture, inadequate sense of personal space, atypical drive for movement/touch, fidgeting, messy handwriting and difficulty with organization/structure. In the behavioural and social adjustment section, John demonstrated low frustration tolerance, difficulty beginning/completing projects, difficulty with time/punctuality, difficulty making judgments and generalizing to new situations, did not complete assignments, lacked tactfulness, acted immaturely and did not tolerate stress well. On the level of energy measure on the Listening Checklist, John was rated as having a habit of procrastinating and being hyperactive.

On the Sensory Profile section summary, results of the pre-intervention questionnaire indicated that John demonstrated a *definite difference* in 'auditory

processing', 'vestibular processing', 'touch processing', 'multisensory processing', 'modulation of visual input affecting emotional responses and activity level', 'emotional/social responses' and 'behavioural outcomes of sensory processing'. According to the Sensory Profile section summary, John demonstrated near global dysfunction in sensory processing, with only 'sensory processing related to endurance/tone', 'modulation related to body position and movement' and 'items indicating thresholds for response' scoring in the *typical performance* range.

In the factor summary of the Sensory Profile, John again demonstrated near global dysfunction. The only factor assessed in the *typical performance* range was 'fine motor/perceptual'. All other factors ('sensory seeking', 'emotionally reactive', 'low endurance/tone', 'oral sensory sensitivity', 'inattention/distractibility', 'poor registration', 'sensory sensitivity' and 'sedentary') were rated in the *definite difference* or *probable difference* ranges.

Overall, sensory processing and listening were below normal limits for John in the baseline assessment. These sensory processing impairments made it difficult for him to participate in classroom and home activities.

Post-intervention findings

Post-intervention video footage showed a marked improvement from the previous music programme. After completing 20 weeks of TLP, John was able to tolerate multistimuli (auditory, touch and visual) accompanying the school music programme including songs, props and movement. This ability to handle stimuli made it possible for John to sing, work with the various prop items, such as hats, and participate in the choreography of the songs. He demonstrated increased eye contact with his teacher/music leader, caregivers (smiling and waving) and improved interactions with peers. John demonstrated improvement with the coordination of his movement, bilateral coordination, sequencing and timing that was in near synch with the music and his peers. At several points during the music programme, John actually seemed to attend better than many of the students around him, watching the teacher and performing instructed movements ahead of the other children.

On the post-intervention Listening Checklist, John showed improvement in every receptive area that previously had a deficit. In most cases, the improvement was from a report of *often*, to a report of *sometimes*. In terms of understanding discussions, John demonstrated significant improvements, from a report of often having 'difficulty understanding discussions' to a report of rarely having such difficulty. Figures 1 and 2 indicate results of the Listening Checklist Receptive Listening and Language both pre- and post-intervention with TLP.

In the Expressive Listening and Language section of the Listening Checklist, John also showed improvement in several areas. He improved from a rating of *sometimes* to *rarely* in 'speech lacks fluency/rhythm is hesitant' and 'difficulty recalling exact word usage'. Scores on 'difficulty summarizing a story' and

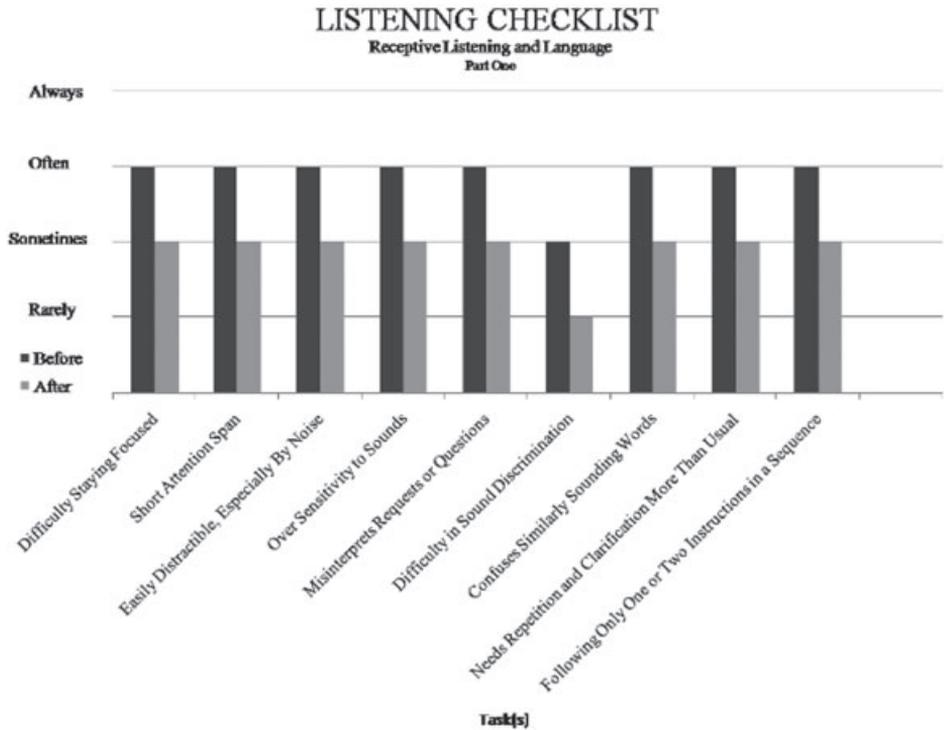


FIGURE 1: Listening Checklist. Receptive listening and language. Part one.

'difficulty relating isolated facts' improved from a report of *always* pre-intervention to a report of *sometimes* post-intervention. Figure 3 highlights findings from the Expressive Listening and Language section of the Listening Checklist.

On the motor skills, behavioural and social adjustment, and level of energy scales of the Listening Checklist, John also demonstrated improvement from pre- to post-intervention of TLP. Following intervention, John no longer demonstrated poor posture, atypical drive for touch, messy handwriting or difficulty with organization/structure. In the behavioural and social adjustment area, John no longer demonstrated low frustration tolerance, difficulty with time/punctuality, difficulty making judgments and generalizing to new situations, lack of tactfulness or inability to tolerate stress. The level of energy scale showed no change from pre- to post-intervention with TLP.

Results of the Sensory Profile section summary also indicate marked improvement in function from pre- to post-intervention. Most noticeable improvements were seen in 'touch processing' and 'multisensory processing', which improved from a categorization of *definite difference* to a categorization of *typical performance*. 'Auditory processing', 'modulation of visual input affecting emotional

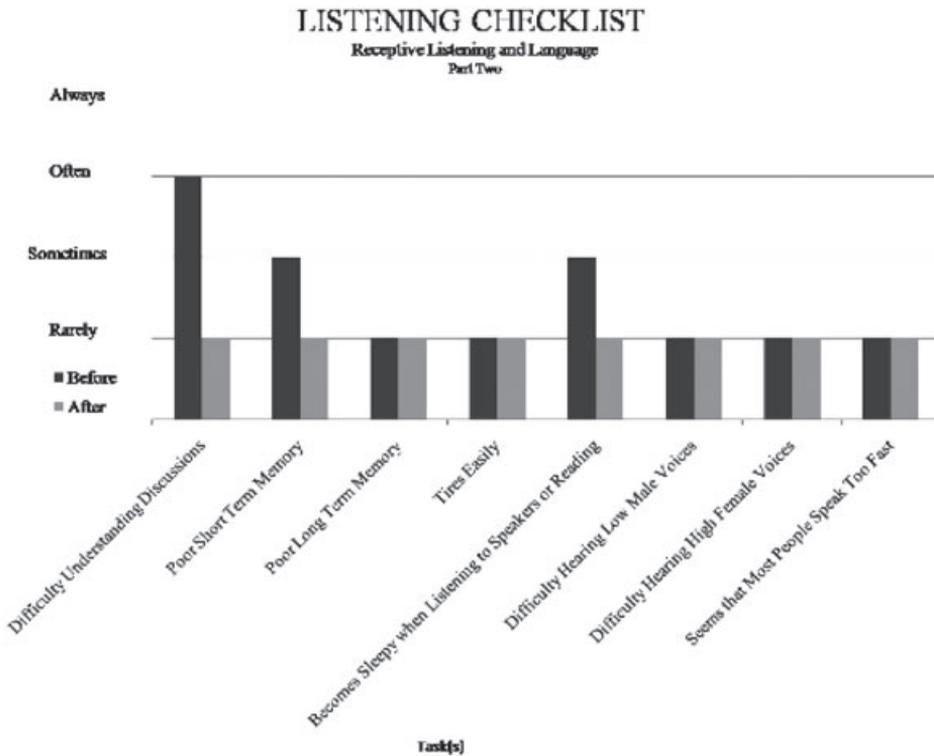


FIGURE 2: Listening Checklist. Receptive listening and language. Part two.

responses/activity level', 'emotional/social responses' and 'behavioural outcomes of sensory processing' all improved from the category of *definite difference* to *probable difference*. There was also a shift from *probable difference* to *typical performance* in the areas of 'oral sensory processing', 'modulation of movement affecting activity level' and 'modulation of sensory input affecting emotional responses'. Figures 4 and 5 represent pre- and post-intervention categories of function in the sections of the sensory profile.

Results of the Sensory Profile factor summary revealed improvements in all areas from pre- to post-intervention except 'sensory seeking' and 'fine motor/perceptual', both of which remained static. The most significant change was found in the emotional reactive factor, which improved from the *definite difference* category to the *typical performance* category. Low endurance/tone, oral sensory sensitivity, poor registration, sensory sensitivity, and sedentary scores all improved from scores in the *probable difference* range to scores in the *typical performance* range. Pre- and post-intervention categorical scores can be seen in Figure 6.

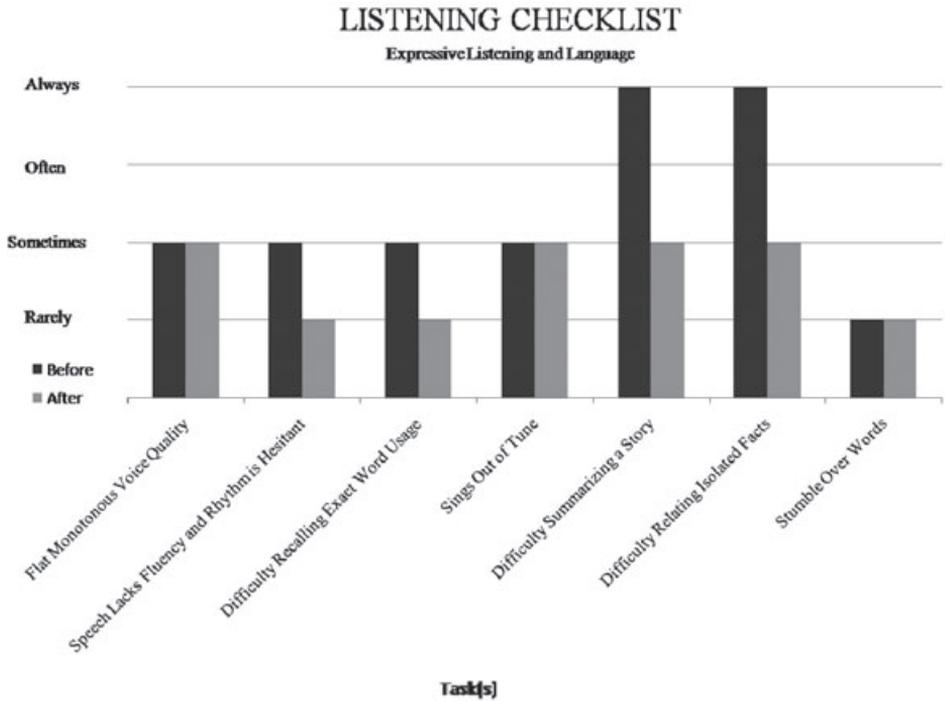


FIGURE 3: Listening Checklist. Expressive listening and language.

Discussion

Historically, studies indicate that occupational therapists have utilized sensory integration/modulation as the primary intervention technique when working with children with ASD (Case-Smith and Bryan, 1999; Watling et al., 1999). When questioning therapists about the intervention techniques they used on the autistic population, Watling et al. (1999) found that 23% of therapists used *other intervention techniques*, which included AIT, oral motor techniques, Project TEACCH (Treatment and Education of Autistic and related communication handicapped children) and craniosacral methods. Some therapists appear to be recognizing that alternative treatments, such as AIT (sound-based intervention), have a place in the treatment of children with ASD.

While there are no published studies regarding TLP specifically, research into sound-based therapy for ASD is beginning to emerge regarding similar programmes. The Tomatis Method has had several published studies regarding efficacy (Gilmor, 1999; Neysmith-Roy, 2001; Ross-Swain, 2007). The Gilmor (1999) meta-analysis of the Tomatis Method research indicated that studies have found the treatment to have favorable outcomes regarding behaviour. Neysmith-Roy (2001) and Ross-Swain (2007) echo this sentiment, indicating that, for the

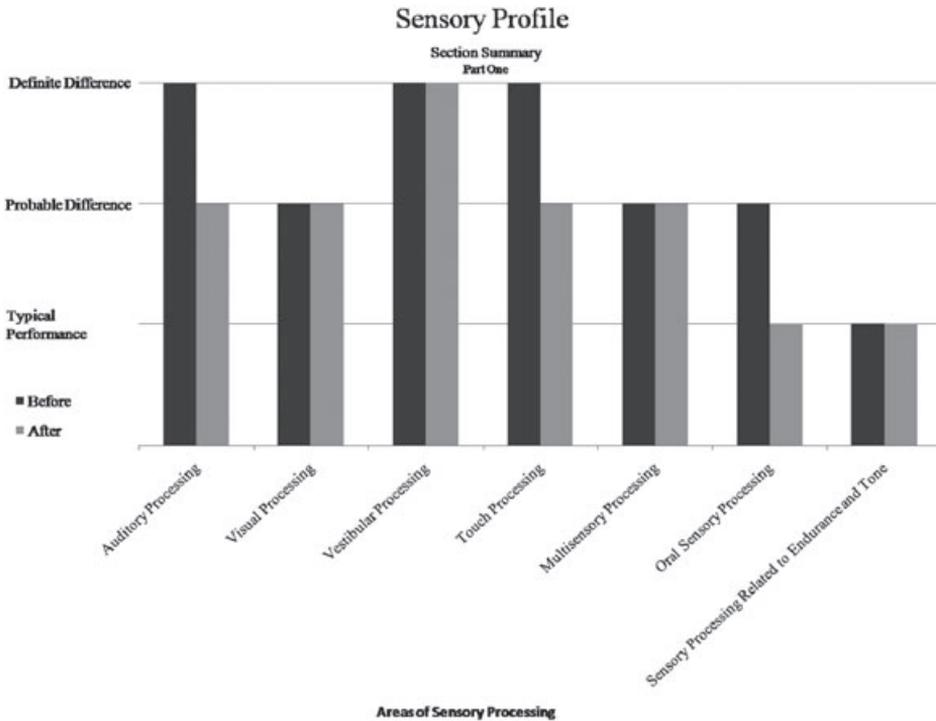


FIGURE 4: Sensory profile. Section summary. Part one.

majority of study participants, there were positive behavioural outcomes associated with the Tomatis Method. While this research indicates efficacy of sound-based interventions, the subtle programmatic differences associated with TLP have yet to be verified scientifically.

The purpose of the present study was to determine the efficacy of a sound-based intervention on a child with PDD-NOS. In the case of John, TLP as an intervention appeared to assist in reducing sensory sensitivity, enhancing expressive and receptive language, and improving functional behaviour.

Pre-intervention video footage showed a young boy with increased anxiety and acting-out behaviours probably associated with low sensory thresholds. As previous research indicated, these sensory problems are commonly associated with ASDs, including PDD-NOS (Bettison, 1996; Case-Smith and Bryan, 1999; Dawson and Watling, 2000; Boddaert et al., 2003; Saulnier, 2003; Alcantara et al., 2004; Paul et al., 2007). During the first recorded music programme, John was unable to attend to the teacher, and was noted on several occasions to cover his eyes or ears. Although occasionally singing or performing actions associated with the songs, he was never seen to do both at the same time. At the beginning of the programme, John was far more interested

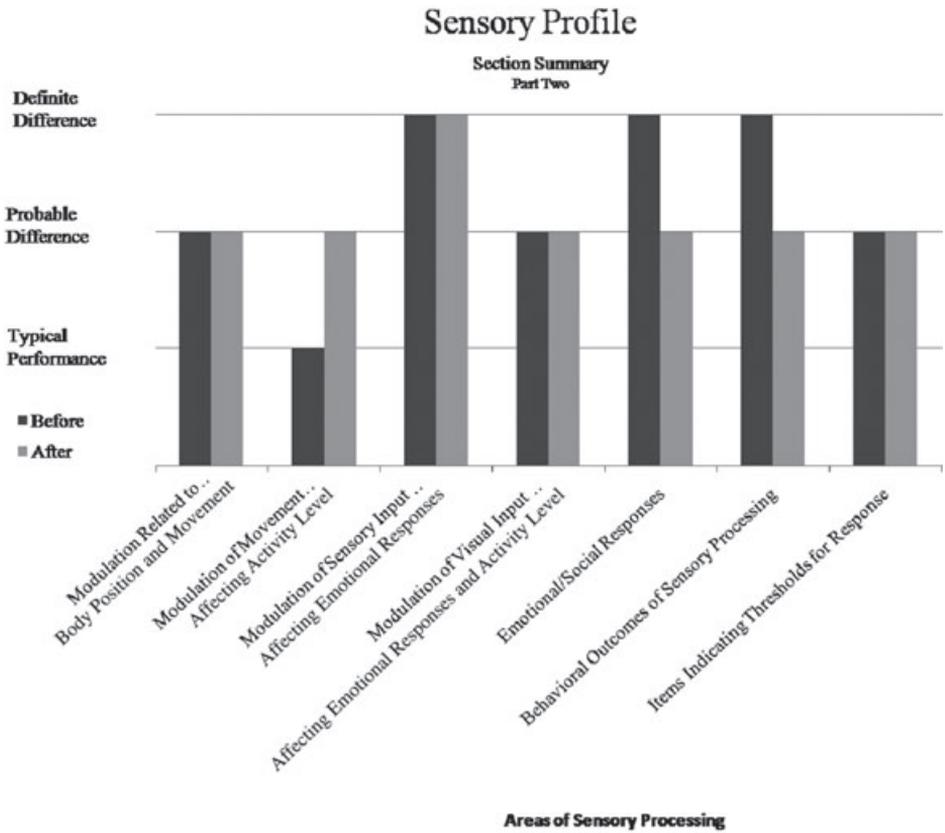


FIGURE 5: Sensory Profile. Section summary. Part two.

in song props than he was in participating, and as the programme progressed, he became more agitated and non-participatory, increasing episodes of rocking and covering his eyes/ears.

Sensory Profile scores pre-intervention confirmed John’s sensory impairments. The section summary indicated difficulties across the board, with the exception of ‘sensory processing related to endurance/tone’. Factor summaries indicated that John demonstrated sensory avoiding, was emotionally over-reactive, demonstrated high levels of inattention/distractibility, and had poor registration of sensory stimuli.

Utilizing TLP method, which focuses on sensory integration using low-, mid- and high-frequency modulated music, John was able to improve his ability to accommodate to sensory stimuli that he had previously found to be noxious. This increased tolerance was noted in both the post-intervention video and the Sensory Profile. The post-intervention video footage showed John readily participating in an activity in which he was previously unsuccessful. Not only was

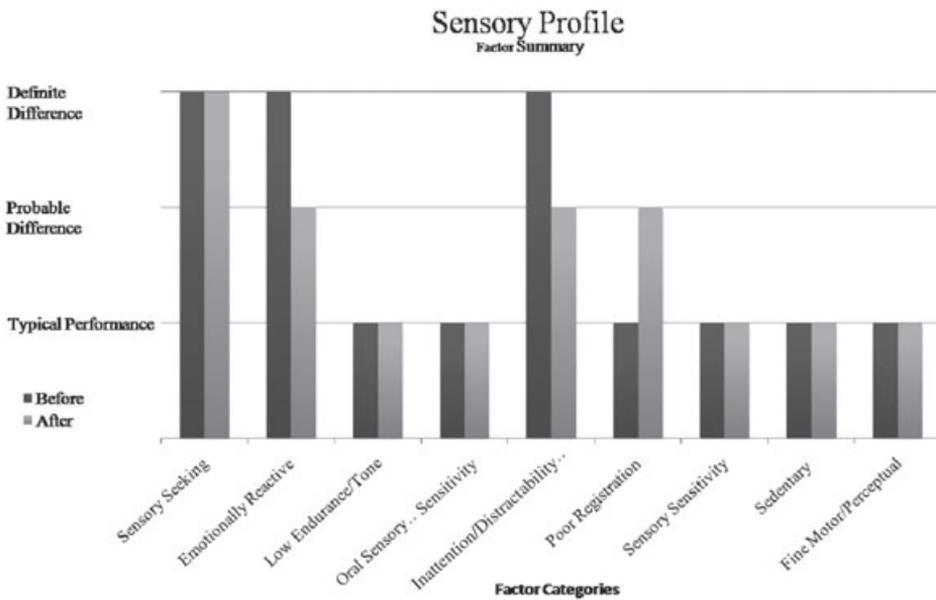


FIGURE 6: Sensory Profile. Factor summary.

he able to tolerate the atmosphere of increased visual, auditory and tactile stimuli, but also he was able, and willing, to perform as an active participant. To spectators at the post-intervention music programme, John appeared to be a typical five-year-old participant.

The post-intervention Sensory Profile echoed this success. Scores in both the sections and factors improved dramatically from previous testing. Although the majority of scores remained in the *probable difference* category of the Sensory Profile, many had dropped from the *definite difference* category. The oral sensory processing section and the poor registration factor of the Sensory Profile actually dropped into the *typical performance* category. The TLP method seemed to assist John in increasing his sensory threshold, making it possible for him to tolerate stimuli throughout the day. In simpler terms, his 'sensory cup', which previously overflowed, readily causing behavioural outbursts, was enlarged to enable him to take in and effectively process more sensations successfully. John's dramatic improvements in behaviour associated with sensory processing improvements in the post-intervention lend credence to the theory by Ornitz (1974) that sensory processing disturbance may be the primary impairment in children with ASDs, while behaviour and social deficits are secondary.

John's expressive/receptive listening and language skills were also significantly improved through the use of TLP, as evidenced in the Listening Checklist. All receptive/expressive problem areas noted in the pre-intervention assessment were found to occur only sometimes or rarely in the post-intervention assessment. Largest improvements receptively were noted in his ability to

understand discussions, while expressively, the post-intervention assessment found John's greatest improvements to be in summarizing a story and relating isolated facts. His improvements in listening and language were evident in his ability to follow directions in the post-intervention video, and his ability to sing and move along appropriately with his peers.

The use of TLP to improve receptive/expressive listening and language in John highlights the fact that many children with ASDs do demonstrate auditory processing/perceptual problems that impact their communication skills and behaviour. Although auditory impairments are not considered to be a part of the diagnostic criteria for ASDs (APA, 2000), difficulties in auditory processing and perception are considered to be common among children with these disorders (Bettison, 1996; Madell, 1999; Muller et al., 1999; Boddaert et al., 2003, 2004; Alcantara et al., 2004).

One critique of using AIT with children with ASDs is that behaviours can cause false positives on audiograms, leading to auditory training on children with no auditory impairments (Tharpe, 1999). The case of John illustrates that auditory perception is also a critical component of auditory processing that can benefit from AIT. Although John had no diagnosed auditory processing disorder, the results of both the pre-intervention Sensory Profile and the Listening Checklist indicated sensitivity to sound and difficulty processing auditory stimuli. These findings were part of the initial prompt to try TLP as an intervention. The success of TLP in remediating auditory perceptual issues, particularly sound sensitivity, support the use of AIT in children with ASDs who demonstrate these problems, whether diagnosed as an auditory processing disorder or not.

The improvements in John's motor skills and behavioural/social adjustment, as reported in the post-intervention section two of the Listening Checklist, emphasize his overall improvement in skills. Often, sensory and auditory processing difficulties present as behavioural problems (Bettison, 1996) that draw attention from peers and others. Before TLP, John's behaviours were taxing on his parents, siblings, peers, and school personnel. His low frustration tolerance, inability to make appropriate judgments and inability to tolerate stress led to a number of acting out behaviours, including aggression towards his siblings and peers. Post-TLP saw John handling auditory input and other sensations more successfully, which led to improved behaviours, enhanced motor skills, and increased participation in school and home activities. Additionally, both the SLP and the OT providing services reduced their service level in order to consult and monitor instead of more direct intervention.

Conclusion

Exploring new intervention techniques in OT is imperative for the success of treating the varied presentations of ASDs. Sound-based interventions have

gained popularity over the past 20 years, particularly with the work by Alfred Tomatis (Hall and Case-Smith, 2007; Corbett et al., 2008; Williams, 2008). The theories and techniques originated by Alfred Tomatis and Guy Berard and furthered by other professionals are being utilized by a number of clinicians, particularly those in OT (Hall and Case-Smith, 2007) and in speech/language therapy. Although sound-based interventions have been proposed to work well with those with sensory processing, auditory processing and behaviour deficits, there has been minimal research validating this hypothesis. By using the TLP method in conjunction with OT using sensory processing strategies, and sensory processing as the outcome, this study serves to open up the field of sound-based interventions to practicing occupational therapists and facilitate further efficacy research. Although the case study has clear limitations regarding size, scope and generalizability, it offers itself as a stepping stone for continued research into sound-based interventions, sensory processing and OT.

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