Autism Spectrum Disorder: Neuromodulation, Neurofeedback and Sensory Integration Approaches to Research and Treatment

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Berard Auditory Integration Training

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Guy Berard, MD developed a method of using uniquely modulated music to stimulate the auditory system. His goal was to enhance auditory processing to be more efficient (Berard, 1993). Berard believed "everything happens as if human behavior were largely conditioned by the manner in which one hears" (Berard, 1993). Berard's work focused on the concept that *how* we hear plays a very significant role in *how* we behave and learn. He felt that when the auditory system functioned effectively, it would manifest in improved behaviors, as well as improvements in language, social, motor, and academic performance. Unfortunately, even today, there are professionals who are not aware that many individuals who are struggling with academics and behavioral problems have an inefficient auditory system. This interferes with effective listening and processing, which puts the individual at a great disadvantage in the classroom and workplace.

As an ear, nose, and throat (ENT) physician, Berard's primary focus during his earliest years of practice with AIT was on middle ear function and the cochlea. His AIT program was used primarily to assist in certain types of hearing impairment. However, he observed that learning-related skills and abilities, such as attentive listening, concentration, auditory discrimination, and memory skills, often improved following his AIT program. The Berard program is now noted for its use as an educationally-related intervention (Berard & Brockett, 2011). In recent years, as understanding of sensory processing has increased, it has become evident that Berard AIT also significantly impacts sensory modulation and the visual system (Brockett, Lawton-Shirley, & Kimball, 2014; Brockett, 2015).

Ayres identified the brain's processing of sound as an essential form of sensory integration and proposed that vestibular-auditory processing influences both survival and discriminative functions. The information provided through this system helps sort out what is safe versus not safe, an understanding that can be critical to survival. It also guides us about our position in space, and can stimulate movement responses. During early development, the system also helps direct the infant/toddler to caregivers for engagement that facilitates opportunities to thrive (Ayres, 1972).

Various theories gradually emerged to explain how AIT produced the observed results, including biochemical changes (Edelson, 1995), improved ability to shift attention and "tune in" (Edelson, 1996), and improved function in the middle ear (Edelson, 1994). The cerebellar-vestibular theory proposed that the results of Berard AIT were associated with the unique effect of the auditory vibrational stimulation produced by the specific type of modulation used for this method. The random modulation may create changes in the vibrational patterns perceived by the ear, which then, stimulates the vestibular connection to the cerebellum more intensely (Lawton-Shirley, N. personal communication, May 20, 2018). During Berard AIT, the average maximum listen volume is below 85 dB, a safe level for the 30-minute sessions (OSHA, 1981). Another aspect of the intensity is the frequency of the sessions, (2) 30-minute sessions each day for 10 days (Brockett, 1994). This unique vibrational stimulation could potentially impact auditory and vestibular-cerebellar connections, which could result in improvements in functions regulated by these structures (Brown, 1999; Frick & Hacker, 2001; Netter, 1986; Rimland & Edelson, 1994). Specific facilitation of auditory/vestibular processing has been associated with changes in sensory processing and modulation, arousal, attention and focus, postural control, social emotional development, auditory filtering, and visual-motor performance (Ayres, 1972; Frick & Hacker, 2001; Hall & Case-Smith, 2007; Rimland & Edelson, 2004).

Auditory Processing Deficits in Autism

One of the characteristics of autism is difficulty with communication and social interactions. An underlying cause may be the challenges with auditory processing experienced by those on the autism spectrum. Auditory processing must be efficient in order to communicate and engage in social interactions, but it is now recognized that the auditory system, and auditory processing, are often not working effectively for those on the spectrum (Grandin & Panek, 2013). There may be difficulties in various areas of the auditory system, all of which compound the significance of the challenge faced by those with autism.

Hypersensitivity to sound is one problem that is often easy to recognize. Sounds that are tolerat-ed comfortably by most people can be painful, irritating, and frightening when the auditory sys-tem is not functioning as it should. Behaviors such as covering the ears, startling to sounds that don't bother others, and hearing sounds, such as an approaching airplane, before others can hear it, are often signs of hypersensitive hearing. Those on the spectrum may be in constant fear of when the next assault from sound will occur. Sudden, loud sounds may be very troublesome, but even sounds at a low volume can be a problem depending upon the frequencies involved and how the individual hears those particular frequencies.

Receptive language or language input problems can also interfere with communication. One could ask, "Do you hear what I hear?" and for many on the spectrum, the answer is "no", they do not hear the same sounds as we hear them. For example, Temple Grandin explains that the fast transition consonants, such as /b/, /t/, /f/, etc., are pronounced very quickly and in a conso-nant/vowel combination such as *ball, tall, fall*; it may be difficult to distinguish the differences. When the words sound the same, the listener may need to rely on content to figure out what word was spoken (Grandin & Panek, 2013). By the time this is done, the speaker has often al-ready said another sentence, or more, causing even more confusion for an individual with autism. Other language input problems can occur if the listener does not hear the space between the words, causing all the words to run together as they do when we listen to a foreign language. Or, the listener may not be able to attach meaning to the words they hear, even when they hear them clearly and correctly, so the verbal information does not make sense to them.

Just as language input can be a problem, language output, or expressive language can also be dif-ficult for those on the spectrum. Some may never become verbal, while others may require in-tense therapy in order to develop spoken language. When auditory processing is faulty, it can take a lot of time to organize a thought and then verbalize it. When distractions occur, such as the person repeating the question, or someone else making a comment, it disrupts the processing and the person with autism may need to start over again. They often need quiet time, without inter-ruptions, to process their response.

Some individuals on the autism spectrum are able to become verbal with assistance from audio scripts such as TV commercials or video shows. When they listen and hear the words from the audio scripts, the pronunciation, intonation, rhythm, and timing, are always exactly the same. The accompanying video also provides meaning to what they hear. This may make it easier for them to eventually make sense out of the words. During life experiences, the video, or visual component, is often not a part of the activity, so the person with autism is dependent solely on the audi-tory message. Some memorize scripts and, over time, begin to use them to communicate. Provid-ing visual support for the auditory message can enhance processing, for both receptive and ex-pressive language.

Alfred Tomatis, Guy Berard, and Stephen Porges were interested in the function of the middle ear, and in particular, the parasympathetic nervous system's effect on the tensor tympani and sta-pedius muscles. When these muscles are working properly, the person can tune into the higher frequencies of human speech. However, stress, anxiety, and fear, trigger the fight-or-flight reac-tion, which shuts down the appropriate function of the tympani and stapedius muscles, limiting the individual's ability to process the human speech frequencies properly. The ability to listen, communicate, and connect to another person is reduced, until the situation resolves so the indi-vidual can feel safe. Feeling safe enables the parasympathetic system to switch off the stress re-action, and according to Porges, turns on a "social engagement system" and the middle ear mus-cles. Once the individual feels secure, he can connect better and listen to the human voice more efficiently because higher frequencies of human speech can now be processed more effectively (Doidge, 2015). This is one reason why talking to a person who is in a state of high stress and anxiety may have poor results. Using visual supports and other calming strategies to reduce the stress may be more productive than language.

Procedure

The standard protocol for Berard AIT provides two 30-minute sessions of listening each day for 10 days within a 12 day period. A break of at least 3 hours between the listening sessions allows for a rest from the auditory stimulation. Music for Berard AIT is typically a mixture of lively reggae, light rock, and jazz, with a wide range of frequencies from 20 Hz to 20 kHz. The music is processed, or modulated by the Berard AIT device, the Earducator/6F™ (Hollagen Designs CC, Western Cape, South Africa). The Audiokinetron is still in use by some Berard practitioners. The Earducator/6FTM alternately suppresses and emphasizes low and high frequencies on a random basis through the use of a broadband filter, and the music does not exceed an average output of 85 dB. Closed headphones (Beyerdynamic CT250-80) are recommended by Hollagen Designs CC (Brockett et al., 2014; Brockett, 2015).

According to Berard, narrow-band filters allow specific frequencies, that the listener hears too well, to be filtered, and is another feature in his method of processing the sounds (Berard, 1993). A listening test to show minimum hearing levels at 11 frequencies is administered to the individual. The tester repeats frequencies to establish reliability. The results are analyzed using a computer program, available to all Berard practitioners, based on Berard's protocol for selecting filters (Berard, Edelson, & Brockett, 2000). The protocol identifies the relative peaks in the listening profile and prioritizes the activation of narrow-band filters. No narrow-band filters are used when a reliable test is not available, or when the analysis indicates no filters are needed.

The protocol for Berard AIT recommends quiet listening without engagement in cognitive activities. Most participants are able to listen quietly, though some may require a passive sensory fidget toy to keep their hands away from the headphone cord and to help them cooperate with the listening process. Activities such as reading, assembling puzzles, writing, and other cognitively stimulating tasks are distracting and not recommended (Brockett et al., 2014).

After 10 half-hour listening sessions have been completed (the mid-point in training), some adjustments may be made in the use of narrow-band filters, depending on reassessment of the listening profile. The volume may also be reduced in the left ear if the individual has difficulties with speech-language development. The theory behind this is to stimulate language growth in the left hemisphere (Berard, 1993).

Studies

A variety of studies began in the early 1990s in order to learn more about how effective the AIT program could be, what types of changes resulted, and who might be good candidates. The first study was a placebo-controlled pilot study conducted by Rimland and Edelson with 19 individuals with autism. Results indicated statistically significant improvements in behaviors, sound sensitivity, and hyperactivity after AIT (Rimland & Edelson, 1995). Following the encouraging results of this pilot study, these researchers undertook a second, comprehensive study from 1991-1993 with 445 participants who were on the autism spectrum. This study involved an open-clinical research design which included several experimental control measures. After the 10 hours of listening sessions, sound sensitivity, a common finding with those on the autism spectrum, was significantly reduced. Hearing acuity improved slightly, and variability within the audiogram was reduced, indicating that the listener heard frequencies at a more consistent level across the frequency range. Behavior rating forms were used to measure changes in problem behaviors. Starting at 1 month after the AIT sessions, there was a sharp reduction in challenging behaviors and this reduction was maintained through the 9 months of monitoring. Contrary to expectations, lower functioning subjects with autism showed the most benefits. This method of intervention was found to be appropriate for a broad range of individuals, not just higher functioning people (Rimland & Edelson, 1994).

A placebo-controlled third study investigated electrophysiological and audiometric effects of AIT, including the auditory P300 event-related potential (ERP). The P300 is an important indicator of attention and working memory (Linden, 2005). It is most commonly elicited in an "oddball" paradigm when a subject detects an occasional "target" stimulus in a regular train of standard stimuli. The P300 wave only occurs if the subject is actively engaged in the task of detecting the targets. The P300 wave may represent the transfer of information to consciousness, a process that involves many different regions of the brain (Picton, 1992). Three months after the completion of AIT, the three subjects in the experimental group showed dramatic improvement in the auditory P300 ERP, while no changes were measured in the control group. The results of this AIT study showed normalization of brain wave activity, and behavioral changes were consistent with the previous two studies (Edelson et al., 1999).

Changes in Sensory Modulation and Behaviors

Most of the studies during the 1990s concentrated on monitoring behavioral changes and decreases in sound sensitivity. However, Berard practitioners gradually began to hear more and more reports from parents and therapists about improvements in sensory challenges after clients completed the Berard training program. This raised the consideration that perhaps AIT created changes in sensory modulation that facilitated the progress in behavioral changes, especially if the behaviors exhibited were compensations for faulty sensory experiences. It is recognized that sensory modulation helps the individual manage the changes that occur in their living environment throughout the day. When modulation is working efficiently, the individual is able to adjust to the changes and demands of their experiences in order to achieve success (Bundy, Lane, & Murry, 2002; McIntosh, Miller, Shyu, & Hagerman, 1999; Miller, 2006).

There are a variety of abilities that appear to be impacted by Berard AIT, including movement and gravity awareness (functions of the vestibular system), and hearing, which is critical for language development, attention, and learning (Oetter, 2009). When novel sound is provided with intensity and repetition, the neuroplasticity of the brain is stimulated, allowing growth and change to occur (Cool, 2004; Frick & Lawton-Shirley, 1994; Netter, 1986). The elements necessary for neuroplasticity to be activated are contained in the Berard AIT experience. The modulated music that shifts rapidly and randomly from treble to bass is novel stimulation to the brain because the musical frequencies are typically blended together. The schedule of the listening sessions also provides the intensity and repetition that is important.

Brockett, Lawton-Shirley, and Kimball (2014) completed a case review of 54 clients to identify changes in sensory modulation and behaviors after completing the Berard AIT program. The purpose of this case review was to determine if behaviors specifically related to sensory modulation showed positive changes following 10 hours of Berard AIT. Sensory modulation was identified, for the purposes of this study, as a neurophysiological process reflected in the individual's ability to regulate and organize behavioral, motor, emotional, and anticipatory reactions to sensory information and events (Brockett et al., 2014).

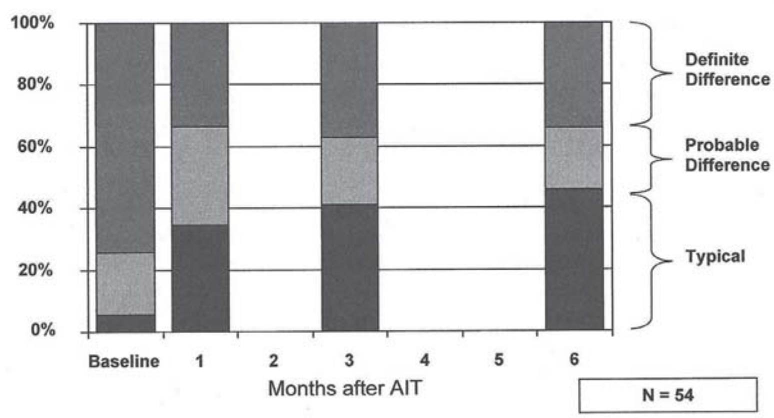

Figure 13.1. SSP-short form, changes during 6 months after AIT.

The Short Sensory Profile (SSP) measures behaviors reflecting sensory modulation during daily life activities. Brockett used the SSP to measure sensory modulation responses such as behaviors reflective of sensory defensiveness, vestibular processing, and behavior outcomes of sensory modulation before and after AIT. During the case review, the SSP total test scores and individual factor sections improved from pre-test to post-test ($p < 0.01$). As the SSP was designed to measure the components of sensory modulation, the statistical results appear to support clinical observations that Berard AIT can result in improved abilities in those sensory modulation components and these changes were maintained through the 1, 3 and 6 month post testing (Figure13.1; Brockett et al., 2014).

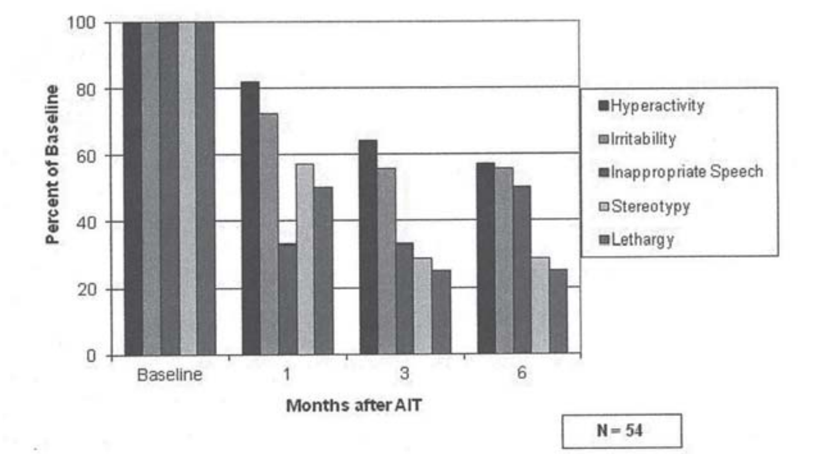

Figure 13.2. ABC-median change from baseline to six months post-Berard AIT.

The Aberrant Behavior Checklist (ABC) has been used to measure behavioral outcomes of AIT in studies looking at response to treatment for children with a diagnosis of autism or attention deficit disorder (Edelson et al., 1999; Rimland & Edelson, 1994). Behaviors assessed by the ABC (such as irritability, lethargy, stereotypy, and hyperactivity) have also been identified as behavioral reflections of poor sensory modulation (Aman & Singh, 1986; Dunn, 1999; Hall & Case-Smith, 2007). The case review study showed that behavioral difficulties reduced on all five factors of the ABC ($p < 0.01$). It is important to note that most changes occurred within 1 month of the intervention and maintained at three and six months (Figure. 13.2).

The case review included a correlational analysis between the ABC and SSP factors to help determine if sensory modulation, as measured by the SSP, is a significant contributor to the behavioral factors measured by the ABC (Brockett et al., 2014). Review of the data showed that correlations were significant for four of the five factors ($p<0.05$): Irritability (-0.531, $p < 0.01$), Stereo¬typy (-0.410, $p < 0.01$), Hyperactivity (-0.399, $p < 0.01$), Inappropriate Speech (-0.288, $p < 0.05$). Sensory modulation appears to be a component of these behaviors. Data also indicated that the changes were not affected by the age of the subject.

Berard practitioners report that clinical, parental, and teacher observations often show the challenging behaviors reduce or resolve after the AIT program. If sensory modulation is more efficient for the individuals after AIT, the compensating behaviors, which are often be disruptive to daily living experiences, may not be needed.

Berard AIT Impacts Visual System

Berard practitioners, and parents of children who have received Berard AIT, have reported changes in various aspects of vision, including skills and abilities such as acuity, depth perception, spatial awareness, and so forth (Brockett, 2015). At first thought, it may seem unlikely that listening to processed music would cause a change in the visual system. However, if one considers the connections between the auditory system and the visual system, and also the functions of the cerebellar-vestibular system, it is easier to understand that specific, intense auditory stimulation could impact on visual functions.

Optometrists have a long history of interest in auditory and visual processing, and recognize the importance of integrating these systems in order for the struggling learner to achieve success. In the 1970s, Rosner introduced the Visual Analysis Test (VAT) and the Auditory Analysis Test (AAT) to be used in conjunction with his perceptual skills curriculum (Press, 2012a). Therapy activities that focus on processing within many domains, including visual and auditory, were introduced in *Thinking Goes to School* by Hans Furth and Harry Wachs (1975).

Dyslexia is often considered to be a visual disorder and is a concern for those involved with children who are struggling with academics, particularly reading. Intervention is often focused on treatments related to vision. However, Griffin and Walton suggest there are two forms of dyslexia. Dyseidetic is the visual form, while dysphonetic is the auditory form. Both forms involve visual and auditory processing difficulties (Walton & Griffin, 2006). Studies by both Solan and Birch found that weaknesses in auditory/visual integration are factors in reading disabilities (Solan, 2004; Birch, 1964).

When those who have participated in Berard AIT begin to read more efficiently, one or both forms of dyslexia may have been contributing factors to the reading problems. After completing Berard AIT, a client was asked why she was now able to read twice as long compared to before the training program. She replied that she no longer got tired when reading because she knew what the words were when she saw them, and she understood what they meant. She no longer needed to "sound out" the word and figure out what it meant in the context of the story. The AIT stimulation may have triggered reorganization and integration of the auditory/visual connections, allowing development of the skills needed to become a proficient reader.

The important relationship of auditory and visual processing through the vestibular system is noted by Solan and his colleagues to be a dominant factor in primary learning processes. They state "since vestibular responses are associated with eye movements and hearing, they contribute to visual and auditory processing" (Solan, Shelley-Tremblay, & Larson, 2007). These observations provide further support for the cerebellar-vestibular system theory about Berard AIT.

The book, *Parallels between Auditory and Visual Processing,* describes the similarities between the auditory and visual systems (Press, 2012b), which is supported by Holland. Holland states that every function in the visual system has an equivalent in the auditory system (Holland, 2006). Professionals in the field of special education are quite familiar with evaluations of figure-ground, discrimination, memory, closure, and sequencing in both the domain of audition as well as that of vision. Holland makes a significant point that there is a top-down and bottom-up interaction of auditory processing in the inferior colliculus for sound as there is in the superior colliculus for vision. In other words, auditory perception mirrors visual perception (Press, 2012b).

An important outcome of research at the Ruhr University-Bochum, in Germany, also supports the concept that neural pathways simultaneously process information from different senses. These researchers discovered that patients who are blind in one side of their visual field can benefit from listening to sounds on the affected side. After passively listening for an hour, the patients' ability to detect light stimuli in the blind half of their visual field improved significantly. Lewald states "there is increasing evidence that processing of incoming sensory information is not strictly separated in the brain" (Lewald, Tegenthoff, Peters, &Hausmann, 2012).

Lewald reports that nerve cells in the superior colliculus process auditory and visual information simultaneously, and this area is not usually affected by visual field defects. So there are some dormant capabilities in the blind half of the visual field. Because these same nerve cells also receive auditory information, the researchers tried acoustic stimuli to increase sensitivity to light stimuli, and it was successful, though the effect lasted 1.5 hours. The researchers are now focused on gaining more sustained improvement in visual abilities and use of sound stimulation for more complex visual functions (Lewald et al., 2012).

There have been some individual reports from parents and optometrists of enhancements in functional visual skills after participation in a Berard AIT program, though no clinical studies have been published. Wendy Garson, OD, presented a case study at the Berard Auditory Integration Training & Developmental Optometry Conference which was co-sponsored by the Optometric Extension Program Foundation and the Berard AIT International Society, on April, 2015 in Falls Church, VA. Garson reports that, after completing a visual evaluation, her patient, a young adult who experienced difficulty with functional visual skills, was immediately referred for Berard AIT. Upon completion of the 10-day AIT program, Garson re-assessed the patient's visual skills and found significant improvement in several areas, even without any type of visual intervention having been provided at that point. Similar reports have been made by parents, but no research is available at this time. Because AIT only requires a short time of listening, and some changes do seem to occur during that period, this is an area that could benefit from further study.

There is ample evidence of the connection or integration between the auditory and visual systems, and there is evidence that when the integration of these systems is faulty, there can be significant breakdowns in the learning process. Retraining the auditory system, which seems to carry over to retraining of at least some visual functions, may enhance the learning process (Brockett, 2015).

Case Studies

Two case studies will be presented here to demonstrate the process and results of the Berard AIT method. Names have been changed to respect confidentiality, but ages and other data are accurately presented. These cases represent typical responses to the Berard method, but it is important to recognize that each individual is unique and may respond differently. There is a range of results from highly successful to mildly responsive, and a few may not show noticeable change. Some individuals show obvious change quickly, while others may respond gradually. Many will demonstrate a mixture of positive behavioral changes with some challenging transition behaviors until the person adjusts and stabilizes, while others exhibit only positive progression.

Case 1

Background. Diego is a 5 year, 3 month old boy with a diagnosis of autism. His parents choose to provide Berard AIT due to his hypersensitivity to sound and his failure to develop any language. His mother states that he reacts with signs of distress and discomfort to loud speakers, screaming, music, hair dryer and the vacuum cleaner. She reports a history of some sinusitis which has been treated with antibiotics as needed, and a few ear infections.

Procedure. Diego participated in a standard program of Berard AIT with two 30-minute listening sessions each day for 10 days. Diego's mother was asked to complete the Aberrant Behavior Checklist (ABC) and The Sensory Profile (Short Form—SSP) to obtain baseline data that would be used to monitor his progress. He accepted the headphones for the sessions but needed some encouragement to cooperate for the 30 minutes.

Results. After his first 30-minute session of listening in the morning, Diego took a nap. This is very unusual for him to do and his mother felt he had to have been very tired to sleep in the morning. During the second day of training, Diego reportedly demonstrated increased pointing to objects while making verbal approximations, and increased his imitation of words. His mother noted that he was drinking with better oral motor control and continuous swallowing. Socially, Diego showed increased social initiation with his brother, and more awareness of his environment. On day 3, Diego was able to catch a ball six times and also threw the ball back to his mom. He continued to try to imitate speech and motor activities. On day 4, his mother reported that he was now able to chew gum and not swallow it. His constant jumping was also decreasing. On day 5, he was tolerating brushing his front teeth and was trying to dress himself. He also walked more independently with his mother without needing his hand held. On day 7, he called his mother "mama" for the first time ever. On day 8, he said "eat" spontaneously.

After the 10 days of listening were completed, Diego's progress was monitored by having his mother complete the rating forms at 1, 3, and 6 months post-AIT to show his behaviors at those intervals. The following data indicates the changes in his scores during this time period.

Table 13.1
Improvement on the Aberrant Behavior Checklist (ABC)

Category	% Improvement
Irritability	80
Lethargy	60
Stereotypy	60
Hyperactivity	60
Inappropriate speech	75

The ABC is designed to measure changes in behaviors due to interventions that may be implemented.

Table 13.2
Improvement on the Short Sensory Profile (SSP)

Baseline total score: 93/190	Range: Definite Difference
Post-AIT total score: 162/190	Range: Typical Range

Note. Higher scores indicate more typical behavior and performance.

The Sensory Profile measures a child's sensory processing abilities and its effect on daily functional performance. Typical performance indicates that the 84% of children meet or exceed this threshold. Probable difference indicates that 14% of the children fall within this category. Definite difference indicates that 2% of the children fall within this category.

Observations from parents and others involved with the child can be helpful when monitoring progress.

Comments from mother:

> *Diego's awareness has improved so much. When riding a merry-go-round, he became aware of the other rides and wanted to go on them. He did and enjoyed it. At a birthday party he would put his hands on his ears and get away when people sang "Happy Birthday". This time he came and joined the group, listened to the song, and at the end he clapped his hands and vocalized "ehhh."*
>
> *Diego is also much more independent. He now serves himself food and drinks more often. He wants to walk without me holding his hands. At the pool, he is aware of the depth and wants to get to the deeper area by himself. We supervise and he is trying to float now. Before he was really afraid (panicked) to get water up to his chest.*
>
> *Social relations with his brother are improved now. They share games and ride tricycles together. Diego is pedaling his bike a lot more. Diego pays attention to his cousins and what they are doing. I encourage him to join them and he does it with no problem. Now when we go to family reunions for picnics and birthdays, he stays with the group all the time. Before, he used to look for a way out after he spent a while with others.*

Diego's communication is getting better because he understands much more. When he gets mad about some things, I call it to his attention and he pays attention and I talk to him so he calms and waits. I am stimulating him to talk and he is willing and tries to repeat. His attention span is much longer.

Diego tolerates the toothbrush, hair brush and nail cutting now. At the end of 6 months, Diego is no longer covering his ears due to noise. He does not cry or do anything that would show discomfort.

Diego's improvement is noticeable, even my family members have noticed.

Case 2

Background. Tim is a 3 year, 11 month old boy diagnosed with autism. His parents chose to do Berard AIT due to his hypersensitivity to sound, and significant delay in language. He is just beginning to speak a few single words. He has had a history of ear infections which were treated with amoxicillin, Augmentin, and Zithromax. Tim participates in a 30 hour/week applied behavior analysis program and a sensory diet is implemented. Medications include Zyrtec daily for allergies and Trazadone for sleep. Tim's auditory sensitivities interfere with daily activities. He hears sounds before others can hear them, is very stressed by sirens, fire alarms, and hair clippers. He could not tolerate haircuts or having his ears examined. He was not able to cooperate with the Berard audio test protocol. He did pass a prior sound field test that indicated his hearing was adequate for speech/language development.

Results. Tim accepted the headphones without difficulty and his cooperation with the process was excellent. After 4 days of AIT, his mother noted that he crossed the midline, demonstrating ability to reach across the middle of his body with his arm to pick up his cup. This was a first for him and represents important developmental progress. On day 5, Tim was very active, with lots of spinning and stimulatory activities. During the last 5 days, Tim was calmer. His mother reported that on day 6, Tim heard a seagull in the sky and looked up at it. This was the first time he had been seen observing a bird in the sky.

After the 10 days of listening were completed, Tim's progress was monitored by having his mother complete the rating forms at 1, 3, and 6 months post-AIT to show his behaviors at those intervals. The following data indicates the changes in his scores during this time period.

Table 13.3
Improvement on the Aberrant Behavior Checklist (ABC)

Category	% Improvement
Irritability	50
Lethargy	53
Stereotypy	no significant change
Hyperactivity	23
Inappropriate speech	not a problem

The ABC is designed to measure changes in behaviors due to interventions that may be implemented.

Table 13.4
Improvement on the Short Sensory Profile (SSP)

Baseline total score: 110/190	Range: Definite Difference
Post-AIT total score: 145/190	Range: Probable Range

Note. Higher scores indicate more typical behavior and performance.

Improvement was also seen in the Autism Treatment Effectiveness Checklist (ATEC), improving from a baseline total score of 73 to a 6-month total score of 60. The ATEC is designed to measure change in an individual due to various interventions. Areas scored include communication, sociability, sensory/cognitive awareness, and health/physical/behavior.

Written communication from Tim's mother included the following comments:

> *Tim is doing well. The first two weeks after AIT, Tim was doing a lot of spinning, hand flapping, and jumping off the furniture. He was also agitated and uncooperative during that time period. All these behaviors stopped the first month just as you said they would. Tim was also refusing to make eye contact with his teachers at school. This has also stopped.*
>
> *As you know, one of the major reasons for doing AIT with Tim was his extreme hearing sensitivity and sensory issues. We have seen excellent results in these areas. Two weeks after completing AIT, Tim had his first hair cut by someone other than myself, and he hardly put up a fuss! Even more amazing is the fact that Tim let the doctor check his ears when he did not feel well. He did not cry or fight. Until now, Tim would have to be physically restrained, including having his arms, legs, and head held down while he screamed hysterically.*
>
> *Tim also seems to be more aware of his environment. He is more interested in people and animals. He pets the dog for the first time and laughed. He is also very interested in other boys and men. He attempted to climb a tree with some other kids his age. He has also been able to play outside without a hat on. Usually the sun is too bright for him.*

Conclusion

This chapter provides information about auditory deficits in autism, an introduction to the Berard AIT method, its impact on sensory modulation including the visual system, and some cases studies as examples individual responses. More details are available at the official Berard AIT website at BerardAITwebsite.com, or on the Berard AIT Channel on YouTube. The book, *Hearing Equals Behavior: Updated and Expanded*, by Guy Berard and Sally Brockett offers more comprehensive information.

During the early 1990s, when Bernard Rimland, the late director of the Autism Research Institute, was asked if Berard AIT did work, he responded, “Yes”,” I am reasonably certain that it does work.” At that time, he reported in the preface to *Hearing Equals Behavior: Updated and Expanded*, that although there was still insufficient scientific evidence to permit categorical statements to be made, he felt that many, if not most, parents of autistic children who try the Berard method, will be justifiably pleased with the results (Berard & Brockett, 2011). Since that time, scientific study has been undertaken to examine more details about the impact of the training on the individual. The following chapter will present information about this newer research.

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