Effectiveness of Listening (Auditory) Therapies

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Abstract

Therapeutic interventions that employ listening have been used to treat children and adults with a variety of diagnoses since the middle of the last century. The theoretical foundations for listening therapy have been developed by such great thinkers as Alfred Tomatis, Guy Berard, and Jean Ayres, and there is much anecdotal support documenting the effectiveness of auditory training to address a wide range of impairments. The empirical evidence supporting the effectiveness of listening therapy, however, has not been very strong. The majority of studies annotated in this review have looked at the effectiveness of auditory training in the treatment of children with autism. Although many children with a diagnosis of autism also carry a diagnosis of sensory processing disorder, it is not possible to make conclusions about the effectiveness of listening therapy on SPD based solely on the autism work. A small study published in the last year shows that listening therapy may be a promising intervention option for children with SPD.

Introduction

The notion that listening to music may have healing powers is as old as the ancient Greek philosophers (Thompson & Andrews, 2000), and its proponents have been many through the centuries and up to the present day (Sacks, 2007). The scientific application of this very old philosophical concept was developed in the mid-twentieth century in France by Dr. Alfred Tomatis. Dr. Tomatis found similarities in the audiograms of vocally-impaired professional opera singers and hearing-impaired ammunition factory workers that led him to postulate the intimate neurological and functional links between listening and voice production. (Thompson & Andrews, 2000). Tomatis developed a method of modifying music via gating and frequency filtering with the object of enhancing and integrating the interconnections at multiple levels within the nervous system. His driving principle was that the ear's unique neuroanatomical position and function allowed it to serve as one of the primary integrators for the development of language, balance, posture, movement, and vision. Tomatis posited that his specialized listening training program could be effectively used to address a wide range of impairments.

Listening, or auditory, therapy was further refined in the early 1980's by a French otolaryngologist named Guy Berard who theorized that auditory processing abnormalities, evidenced in audiogram distortions, might account for behavioral and learning problems (ASHA position paper, 2004). Berard developed a treatment called Auditory Integration Training (AIT) that involves 10 hours of listening (20 half-hour sessions) to music that has been electronically modified based on the child's identified acoustic sensitivities. The Berard method has been used to treat impairments in the areas of attention, reading, and auditory processing, but it has been studied most extensively in autism.

There are other auditory training programs that have been developed based on the principles of Tomatis and Berard as well. These include the Samonas Sound Therapy (www.samonas.com), the Porges' Acoustic Intervention

(Baranek, 2002), Integrated Listening Systems (www.integratedlistening.com), and home listening programs, such as that described by Frick & Hacker in 2001.

The purpose of this review is to examine the most recent evidence regarding the effectiveness of listening-based therapies in children with autism or sensory processing disorders. The search strategy employed the following engines: 1) OVID portal for All EBM Reviews (Cochrane DSR, etc), Medline 1996-2007, CINAHL, PsychInfo, 2) PubMed Clinical Queries, 3) PEDro, 4) OT Seeker, and 5) APTA's Hooked on Evidence. Google Scholar was also helpful, in addition to related links and reference lists. Several searches were run using combinations of the keywords auditory, listening, training, sound, neurophysiology, sensory integration, and sensory processing. The results were filtered based on the principles of the evidence hierarchy, beginning with the highest level of evidence, systematic reviews of randomized controlled trials (RCTs), followed by the RCTs themselves, case reports, and commentary in refereed journals ("expert opinion").

The scope of this review is limited to those articles that have the most relevance for children with sensory processing disorders. Only one study was retrieved that examined this population specifically. In accordance with the principles of evidence-based practice, web-based testimonials and studies published in non-refereed journals have been excluded from consideration.

The review begins with a commentary by Thompson and Andrews (2000) as it provides a summary of the theoretical foundations upon which auditory training programs are based. Two systematic reviews of the studies that have investigated the effectiveness of auditory training follow. The first looks at studies that have been done with children who have learning and communication problems, and the second, at randomized controlled trials that have been done in autism. Two of the larger RCT studies, appraised in the latter, have been annotated to provide a closer examination of some of the original work. Position papers of two national professional organizations follow. Given the influence that these prestigious groups may have on our patients and families, it is important for us as clinicians to be aware of their official positions on treatments that we may be providing. The review closes with a study published last year that holds promise for the use of listening therapy in the treatment of children with SPD.

Annotations

Commentary

Thompson B., & Andrews, S. (2000). An historical commentary on the physiological effects of music: Tomatis, Mozart, and neuropsychology. *Integrative Physiological and Behavioral Science,* 35, 174-188.

The authors of this article are Tomatis practitioners who provide here an insightful and concise summary of the history and neurophysiological principles of listening therapy. They relate the contributions of Dr. Alfred Tomatis's work to our understanding of the importance of the ear to the entire nervous system. Dr. Tomatis was an innovative scientist who studied the ear structure and its abundant connections to all parts of the brain, the cerebellum, the pons and medulla, the thalamus, and the cerebral cortex. He believed that the ear was one of the primary "Integrators" of the entire nervous system stating that the ear is primary in the regulation of movement, balance, and posture, in addition to hearing, language, and voice production. For Tomatis, who was one of the first to recognize and explore fetal hearing, auditory stimulation was the most significant of the senses because he believed that sound organizes neural function. He developed his listening therapy program based on these neurophysiological assumptions:

1) the human nervous system is responsive to sensory stimulation

2) sensory input stimulates growth in the nervous system (increased circulation, increased dendritic branching, etc.)

3) early intervention is better than later intervention since the developing brain is more plastic and thus has more potential for change, and

4) positive changes in the brain are not made quickly, it may take months or even years to effect desired ends.

The Tomatis Method employs periods of intensive listening interspersed with periods of rest. Traditionally, the listening phase requires that the child listen for 80 minutes per day for 30 days. The "Electronic Ear" (EE) is the name of the sound stimulation system that Tomatis developed to deliver the altered music, via specialized headphones. The system has four key features. One, the sound is filtered and modified to deliver the band range frequencies appropriate for the particular client, based on pre-testing. Two, the sound stimulation is electronically gated to achieve alternating contraction and relaxation of the stapedius muscles.

This provides the exercise purported to be critical for the Tomatis method's success. Three, there is a progressive reduction of sound intensity to the left ear in order to facilitate the establishment of right ear dominance. And four, there is a gradual manipulation in the timing between bone and air conduction in order to train for more rapid response. Thompson and Andrews suggest that the Tomatis method, by the careful distortion of sound, opens "new pathways in the brain" (p.185).

Systematic Reviews

Gilmor, T. (1999). The efficacy of the Tomatis Method for children with learning and communication disorders: a meta-analysis. *International Journal of Listening.* 13, 12-23.

The author has collected and combined the data from five small research studies performed in Canada in the 1980's by trained Tomatis practitioners. His purpose was to see if statistically significant trends could be identified by meta-analysis of the combined data. Only one of the studies, the single negative trial, has been published in a peer-reviewed journal; the other four have been presented as conference papers and/or as self-publications.

The combined N for the five studies is 231 children, with an age range of pre-schoolers (no specific age reported) to fifteen years. The children all had learning and communication issues of one sort or another (again, not specifically identified here), and those in the treatment groups received the standard Tomatis protocol of ~100 hours of structured listening. The use of control groups was inconsistent between studies, and other potential threats to validity, such as blinding of assessors and concealing of group allocation, were not reported by Gilmor. A total of seventy-five outcome measures were collapsed into five general domains: auditory, cognition, language, social, and psychomotor for combined analysis. The d effect size was calculated using the Cohen formula for comparing changes in the pre- and post- treatment means. Table 2 summarizes the compiled data: effect sizes in four of the five domains are in the .30 to .41 range; the smallest mean effect size is in the auditory domain at .04.

Although in Gilmor's discussion he remarks that effect sizes of .30 to .41 are significant, the more standard interpretation (Portney & Watkins, 2000, p.357) would be that these are small to low-medium effects. It is a limitation of this meta-analysis that on Table 2 of this article, the 95% confidence intervals are listed as negligible since Gilmor writes within the body of the paper that the variances in the group populations were large. He concludes rightly that the results must be interpreted with caution, nonetheless, it is his opinion that they support the effectiveness of auditory training with this population. The results of a meta-analysis can only be as strong as the strength of the contributing studies, however, and in light of the many threats to validity in the studies reviewed, this opinion appears to be overstated. In particular, the lack of homogeneity of sample selection, and the potential lack of randomization and blinding of examiners and of group allocation suggest biased results. Thus, the conclusion that can be drawn by an informed reader is that the data look promising and suggest further study;

however, the effectiveness of the approach is not confirmed by the study due to methodological compromises in study design.

Sinha Y., Wheeler D., & Williams K. (2006). Auditory integration training and other sound therapies for autism spectrum disorders: a systematic review. *Archives of Disease in Childhood,* 91, 1018-1022.

This article is a recent review made available through the Cochrane Database in which the authors systematically searched the literature for randomized controlled trials that investigated the effectiveness of listening-based therapies in autism. As such, it is the highest level of evidence found for this annotation. The authors' search strategy was clearly described and their process of selecting and grading the quality of the research was delineated according to accepted evidence-based practices. Of the 377 articles found, they identified 6 RCTs that included work done with both adults and children, who carry the diagnosis of autistic spectrum disorder, and had received auditory training. (The complete references for all six RCTs can be found in the Reference section at the end of this paper.) Information such as number of subjects, trial type, randomization, blinding, follow-up duration, inclusions and exclusions, patient demographics, and control conditions were summarized and compared for the six studies. Although the authors did not provide "grades" based on their appraisals, methodological weaknesses were identified. These included: inadequate information about methods of randomization and allocation concealment, lack of intention-to-treat analysis, and questionable length of follow-up (14 months was maximum). The size of N varied from a low of 10 (Veale, 1993) to a high of 80 (Bettison, 1996), for a combined N of 171, with ages ranging from 3 years to 39 years. The intervention in all 6 RCTs was termed AIT, based on the work of Berard, however, equipment and sound modifications were not consistent between studies. Control conditions were essentially the same for all: unmodified listening, with the same frequency and length as the treatment condition, two 30-minute sessions for 10 consecutive days. This duration is much less than other programs such as the Tomatis-based programs.

Outcome measures were not consistent between studies. The two largest studies (Bettison, 2000, and Zollweg, Palm, & Vance, 1997) did not find a difference between treatment and control conditions. Three of the smaller trials reported some benefit following AIT based on improved scores on the Aberrant Behavior Checklist, however, the authors question the validity of this interpretation since according to the test developer, it is the subtest scores, not the total score, that has clinical relevance. The authors were not able to complete a meta-analysis of the data due to heterogeneity of data, but they conclude that the evidence at this time does not support widespread use of AIT in the treatment of autism, and that it is in their words, "experimental at best" (p.1021). Though the questions about methodology are valid and important, the conclusions of these authors seems unduly harsh. It is difficult to disprove effectiveness and thus a more justified conclusion would be that due to methodological issues, the previous studies neither confirm nor refute the effectiveness of AIT.

Randomized Control Trials

Bettison S. (1996). The long-term effects of auditory training on children with autism. *Journal of Autism and Developmental Disorders,* 26, 361-374.

This study is one of the RCTs reviewed in the preceding annotation. Bettison's research was conducted for the purpose of correcting some of the shortcomings that had been identified in prior studies of auditory training for children with autism. Eighty children between the ages of 3 and 17 years with a diagnosis of autism or Asperger syndrome were randomly assigned to either a treatment group or a non-treatment group. Allocation was concealed from parents, teachers, and test administrators. The treatment consisted of the Berard-type auditory training (AT) in which the children listened to modified music through headphones twice a day for 30 minutes, on ten consecutive days. The control group listened to unmodified music on the same schedule (structured listening, or SL). Dependent variables included the following standardized tests: Autism Behavior Checklist, the Developmental Behavior Checklist, parent and teacher versions, the Peabody Picture Vocabulary test, and the Leiter International Performance Scale. Non-validated instruments were used to measure sensory problems: the Sensory Problems checklist and the Sound Sensitivity Questionnaire. Audiograms were also done on all subjects. Measurements were taken 5 times: at baseline, and at one, three, six, and twelve months following the intervention period for all dependent variables with the exception of some omissions at the one-month post test (audiograms and verbal performance tests). T-test comparisons at baseline confirmed that the random group assignment was successful, and the groups were equivalent at the outset.

Pretest scores for each of the behavioral tests were compared with scores at each of the post-test intervals for both groups using T-tests. While there were some variations in the pattern of improvement, the general finding was that both groups significantly improved on the behavior measures at one month post, and that this improvement was sustained to the 12-month post-test. Interestingly, some improvements were maintained better in the placebo/control group than in the AT (treated) group. For example, the scores for the children in both groups improved significantly on the teacher version of the DBC between the 3-month and the 6-month tests in both groups. This improvement was maintained at the 12-month test in the control group but not in the treatment group. The parents' feedback from both groups was generally positive; they observed in their children increased interaction and spontaneous speech, less opposition, and more appropriate responses in social situations. Some adverse reactions were also noted in both groups: temporary sleep disturbances were most common, but there were also some reports of earaches, headaches, and stomach aches. No frequency numbers or duration of symptoms were recorded.

This is a fundamentally sound study in that the N is large, the subjects are diagnostically homogeneous, the group assignment is random, and the assessors are blinded. Its major flaw, acknowledged by the author, is the lack of a true control group. In the author's discussion of her findings she suggests that some feature of listening, shared by both the AT and the SL group protocols, probably accounts for the observed improvements in the children's behavior. She recognizes that the lack of an untreated group (true control) in this study's design makes it impossible to rule out the possibility that the observed beneficial effects were due to practice, ongoing schooling, or chance, but she contends that the large effect size and the pattern of greatest change at one month argues in favor of treatment effect. This seems to be a fair conclusion, although it has limited value without further investigation regarding source of the effect. The fact that both groups improved means that it is not possible to ascribe the effects to the training per se; it may be that simply listening to music on a regular schedule is beneficial.

Rimland B., & Edelson S. (1995). Brief report: a pilot study of auditory integration training in autism. *Journal of Autism and Developmental Disorders,* 25, 61-70.

The stated purpose of this study, selected from the Sinha, Wheeler, and Williams review (2006), was to examine the effectiveness of AIT on adaptive behaviors in autistic children. The 18 subjects were recruited from an independent agency in Oregon. There was one drop-out. The remaining 17 were matched on the basis of age, gender, hearing sensitivity, and ear infections, with random assignment of pairs to either the treatment or the non-treatment group. The parents and the testers were blind to group assignment. The Berard protocol, two

30-minute sessions per day for 10 days, listening to electronically modified music through headphones, was used in the treatment group. The untreated group listened to the same music on the same schedule, but the music was non-modified. The dependent variables included: air and bone conduction audiometry, pure tone sensitivity, and three parent questionnaires to measure adaptive behaviors, the Aberrant Behavior Checklist (ABC), Fisher's Auditory Problems Checklist (FAPC), and the Hearing Sensitivity Questionnaire (HSQ). Measurements were taken six times during the study period: at baseline, at the midway point of the listening phase, at two weeks following conclusion of listening, then at 1, 2, and 3 months post-treatment. The matched pairs were not found to be equivalent on the behavior variables at baseline (the subjects in the non-treatment group were more significantly impaired than those in the treatment group), therefore, post hoc adjustments had to be done to correct for this difference. The authors found a statistically significant improvement in the treatment group on the ABC and the FAPC over the three month testing period, whereas there was little or no change in the untreated group. An unexpected finding was that there were no changes in sound sensitivity in either group of subjects.

The investigators concluded that AIT is a potentially valuable treatment option for autistic children. Inasmuch as the positive changes in adaptive behaviors are not accompanied by any related changes in hypersensitivity to sound, the mechanism of improvement is unclear, but further study is warranted in their view.

The results of this study need to be interpreted cautiously because of the small number of subjects, and the failure of random assignment to create equivalent groups at baseline, the latter being a probable result of the former. The failure of the control group to make changes may have had more to do with the severity of their disease than to their group assignment.

Position Papers

American Academy of Pediatrics, Committee on Children With Disabilities. (1998). Auditory integration training and facilitated communication for autism. *Pediatrics*, 102, 431-433.

The American Academy of Pediatrics published this paper in response to parents' growing interest in alternative, non-traditional interventions for their children with autism. The Academy's stated concern is to ensure the health and safety of the children they serve, and they assume the responsibility of providing guidance to families in their search for treatments that have been shown to work. They briefly summarize the research, annotated above, by Rimland & Edelson (1995), and Bettison (1996), and conclude that the results insufficiently support this intervention. They question the assumption made by Berard practitioners that it is possible to accurately identify children with sound hypersensitivities in this population based on audiogram data. They further raise concerns about the safety of sound levels used in the technique, and they are skeptical of the array of benefits to which AIT proponents lay claim.

American Speech-Language-Hearing Association. (2004). *Auditory integration training.* Retrieved 12/30/07, from www.ashaorg/policy.

This is a more recent review of the literature than the one published by the AAP, and it includes four additional studies in its consideration, but the conclusions are the same: it is the position of the ASHA that the effectiveness of auditory integration training has not been demonstrated by rigorous, scientific study. They too, raise concerns about the safety for children of repeated exposure to high decibel sounds during the auditory training. They suggest that the decibel levels may be dangerously high for a child's small ear canals and could lead to hearing loss. Like the pediatricians, they express concern about parents' vulnerability to alternative therapies that are enthusiastically promoted, but not well supported by hard data, and they do not recommend that auditory training be used clinically at this time.

Auditory training in other diagnostic groups

Hall L., & Case-Smith J. (2007). The effect of sound-based intervention on children with sensory processing disorders and visual-motor delays. *American Journal of Occupational Therapy,* 61, 209-215.

The purpose of this study was to examine the effects of a therapeutic-listening program as an adjunctive treatment for children diagnosed with SPD and visual-motor impairment who are receiving sensory-based OT. Twelve children, aged 5 to 11 years old, recruited by convenience, were eligible because they scored one or more standard deviations below the mean on the VMI and had at least three scores of “definite difference” on Dunn’s 1999 version of the Sensory Profile. Exclusions were children with diagnosis of MR, CP, DS, visual or hearing impairment, severe autism, and children on medication. There were two drop-outs, leaving an N of 10. No intention to treat analysis was reported. Nine of 10 participants were male, with a wide variety of medical diagnoses: Asperger syndrome, hypotonia, ADHD, developmental delay, coordination disorder, Arnold-Chiari malformation, high-functioning autism, etc.

The trial was conducted in two phases, with each child acting as his own control. In the first phase, lasting four weeks, the children received a sensory diet that was individually tailored based on the results of the Sensory Profile at baseline. The first author, a registered OT, designed the diets, but the specific recommendations were implemented by each child’s parents. In the second phase, which lasted 8 weeks, daily therapeutic listening was added to the sensory diet. Two to three music CDs, selected according to the preferences of the individual child, were modified by altering high and low frequencies at random intervals. This protocol was derived from the program described by Frick and Hacker (2001) in their book entitle, *Listening With the Whole Body.* The parents were instructed to have their children listen to the CDs for 20 to 30 minutes, twice a day, with listening sessions spaced at least 3 hours apart. Parents were asked to keep a log, noting frequency and response to listening.

Outcome measures were taken at baseline, at the end of the four week sensory diet (control) phase, and finally at the end of the 8 week experimental (diet and listening) phase. Measures included the Sensory Profile, the Draw-A-Person (DAP) test, the VMI, the Evaluation Tool of Children's Handwriting (ETCH), and parents' subjective reports. Paired t-tests, comparing Sensory Profile scores at baseline and post-phase two, show statistically significant improvement in 9 of the 14 sub-scales. (Raw scores were used for this analysis.) A post hoc analysis using Tukey's test determined that this change was associated with phase two, and not phase one. For the VMI and the ETCH test data, the mean scores were compared between pre-test and post phases one and two, using the Scheffe procedure. Significant improvement was found in the visual subtest of the VMI, and the letter and number legibility scores on the ETCH following phase two. The DAP scores did not show a significant change following treatment. Subjective reports from the parents were generally positive following the listening program phase. Many parents reported improvements such as greater noise tolerance, reduced tantrums, and improved school performance. The authors conclude that therapeutic listening may be effective in improving behavior, visual perception, and handwriting, for a child with a diagnosis of SPD and visual-motor impairment.

The results of this small study should be interpreted with extreme caution for a number of reasons. It is not an RCT, and the study design does not control for interaction effects or maturation. Nor is it clear why the authors chose to make the two intervention phases different lengths; this weakens the comparisons that can be made between the two treatments. Further, the N is small and only includes one female. All the same, even with these caveats, it is an interesting study since it looks specifically at the population of children with identified sensory processing issues as a cohort group. As the new nosology of SPD (Miller, Anzalone, & Lane, 2007) becomes more widely applied in clinical practice, we may be able to identify more precisely how children in each of the subgroups respond differentially to auditory training.

Summary

It may be tempting to conclude from the systematic review of Sinha, Wheeler, and Williams (2006) taken together with the positions of the American Academy of Pediatrics (1998) and the American Speech and Hearing Association (2004), and the equivocal findings of Bettison's relatively large study (1996) that listening therapy has not been shown to be an effective intervention. While I concede that it is unwarranted at this point to conclude with confidence that auditory training is effective, it is equally unwarranted in my view to decide that it is ineffective. The problem with making inferences about the effectiveness of listening therapy for children with SPD on the basis of earlier studies of autism is that clinically important changes may have been washed out due to heterogeneity of the subjects. Dawson and Watling (2002) make the relevant point that within the autism spectrum there may be both hypo- and hyper- responders. As we gain a better understanding of the subtypes of sensory dysfunction, based on the new nosology of SPD (Miller, 2006), we will be better able to identify those children who might benefit from this form of intervention. Listening therapy may not be effective in all the SPD subgroups, we would not necessarily expect it to be, but the work of Hall and Case-Smith (2007) suggests that we can do a better job distinguishing those children who will probably benefit from those who probably will not. More research is needed to investigate the response patterns to various listening programs for each of the SPD sub-groups across co-morbid diagnoses in order to explore their potential therapeutic value.

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