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ReviewArticle

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Does Evidence Inform Intervention by Professionals? Reporting on Research into Auditory Stimulation for Auditory Processing Disorders in Children with ASD and Related Disorders

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Abstract

Since the 1980's there has been an acceleration of interest by neuroscientists in the Auditory Problems of Children with Autism Spectrum Disorder (ASD). The focus of study has largely shifted from attempting a differential diagnosis between the symptoms of ASD and of Auditory Processing Disorder (APD), towards an improved understanding of APD and its impact on the lives and wellness of people with this disorder. A large amount of research data has accumulated, and sheds light on the manner in which auditory brain potentials of children with ASD differ from those of the neurotypical learner. This article will offer a summarised overview of this data, and will discuss how this body of evidence is informing and directing our intervention strategies, both clinical and educational. The author will further summarise the most recently published research papers on the impact of Auditory Integration Training (AIT)– the Bérard Method (also named Filtered Sound Training - FST), The statistical significance and implications of this data for the planning of intervention programmes to remediate auditory problems of children with ASD will be discussed. In conclusion some new insights into the breadth of the impact of auditory processing problems on the social, emotional, learning, language and well-being of children with ASD will be mentioned.

(208 words)

Biography

As a Speech and Language Therapist and Audiologist, Rosalie spent most of her working career in the field of ASD. She has travelled to various countries to study many approaches that parents reported to be effective, compiling a desk directory of this information entitled *'Autism, Options Galore'*. She developed a Whole-Person approach to intervention named *Neuro-Cognitive Mobilisation*. She is an international trainer of practitioners in the Bérard Method of AIT, having developed several devices for AIT including the computer-based and tablet-based systems called Filtered Sound Training. She has presented on CAPD, AIT and Autism at conferences in the UK, Ireland, Hungary and South Africa. (104 words)

Introduction

The use of event related potentials (ERP) to study the auditory system has been discussed as a valuable tool to discover the way the brain deals with sound at a primitive, pre-attentive level: that is, without requiring the voluntary response of the hearer. As early as 1939 P. A. Davis demonstrated that after an auditory event the brain showed a response linked to this event as a change in potential which could be measured without the subject's conscious response [1].

In 1950 Mykelbust wrote of the probability that children with Specific Language Impairment (SLI) could have listening problems in the absence of a physical hearing loss. These comments were largely ignored, but in the 1970's there was a resurgence of interest in this concept.

1978 P. Tallal and M. Piercy demonstrated that children with SLI performed more poorly than the controls in an Auditory Repetition Test when the stimulus intervals were smaller than 250 ms [2]. They concluded that the auditory processing of these children was 'sluggish' compared to the control group. The study of the auditory processing problems of children with developmental difficulties such as Dyslexia and Autism Spectrum Disorder has increasingly

included research into the long-latency Event Related Potentials (ERP), particularly the ERP's related to pre-attentive processing of complex sounds, such as speech.

In 2005 D.V. Bishop and colleagues studied the ERP's of a group of children with SLI during a frequency discrimination task [3]. In several cases, brainwave - forms of individuals in the SLI group resembled those of younger typically-developing children (immaturity), though in other cases the waveform was deviant - unlike that of control cases at any age.

Since there is growing scientific evidence of differences in the pre-attentive processing of sound – particularly speech sounds – in children with ASD and Dyslexia, it is necessary to take the time to understand the implications of this accumulating data on the remediation and intervention – planning for these children.

Discussion of ERP's

When a complex signal such as speech or music is processed the activation travels along the sensory pathways , from cochlea to primary auditory cortex and on to associative cortices. As it does so the sound is acted on in increasingly detailed and complex analyses.While the physical features of the sound act upon perception (frequency, intensity, location) in a primitive, 'bottom-up' action, we are also able to moderate the processing of the incoming signals according to our interest, familiarity, context and preferences (i.e. 'top-down' actions).

It is evident in research design that in order to investigate the 'bottom-up' processes we need to avoid 'top-down' contamination in which the subject makes voluntary responses. The use of ERP's in the study of primitive, pre-attentive processing offers a useful tool with which to gain this kind of insight.

ERP's are divided into Early, Middle and Late Latency responses, according to the time when they occur: "early" ERP's occur 1 – 10 ms after the sound; "middle" ERP's occur 10 – 50 ms, and "long" latency ERP's occur more than 50 ms after the sound stimulus. These ERP's are also assigned a letter to denote whether they have a positive (P) or a negative (N) displacement. Thus the P50 ERP is a positive displacement occurring at 50 ms.

Auditory ERP's are thought to denote differing aspects of processing

The P50 reflects sensory gating, which is linked to protection from stimulus overload [4, 5].

The P1-N1-P2 reflects the detection of the sound signal [6]. It occurs at 100 ms. This measurement is used to determine hearing threshold. It has been shown to have a stronger response in the left hemisphere for speech as compared to non-speech sound [7].

The MisMatch Negativity response is a pre-attentive response by the brain to a deviant stimulus in a sequence of stimuli. The MMN is a negative wave that is elicited between 150 and 300 ms after the signal. The presentation of an *oddball or deviant* event, embedded in a stream of repeated or familiar events, the *standards*, results in an evoked response that can be recorded non-invasively. It is equally elicited by changes in frequency, duration and intensity. MMN is thought to reflect an automatic neuronal response to a change in auditory input and has been linked to auditory discrimination and auditory sensory memory [8].

The P300 response appears about 300ms after the auditory stimulus and is moderated by attention [9]. In research it is investigated using the *oddball* paradigm. The P300 shows habituation in less than 10 seconds [10, 11].

Auditory Processing in Autism Spectrum Disorder

Unusual sensory experiences are increasingly identified as a key characteristic of individuals with Autism Spectrum Disorder (ASD), [12, 13]. This characteristic has been included in the diagnostic criteria for the disorder in the Diagnostic and Statistical Manual V [14].

Problems of auditory modulation have been linked to behavioural and attention problems, to speech and language difficulties and to dyslexia [15, 16]. Katz & Kusnierczyk have described auditory modulation disorders according to their effect on processing speed, speech-in-noise processing, hypersensitivity, poor attention, auditory-visual integration, sequencing and auditory memory problems [17]. They demonstrate that such auditory processing problems will hamper reading, spelling, and comprehension.

It is estimated that nearly 90% of all children with autism suffer from sensory abnormalities, *'often hypersensitivities, to stimuli that neuro-typical individuals could easily ignore'* [18]. They often demonstrate poor auditory processing in contrast to their significantly more efficient visual-spatial processing [19-21]. Rimland reported that 40% of people with autism suffer from hyper-processing of auditory stimuli, or 'hyperacusis' [22]. It is frequently reported that this hyper-hearing leads to social withdrawal, speech problems and overload behaviour in the form of tantrums and aggression [23].

The auditory processing speed appears slower in children with ASD. Wong and Wong, Courchesne, and Condon have described longer transmission time in the brainstem, resulting in slow processing of sound [24-26]. It has been found that children with language-based learning impairments had major difficulties with 'temporal processing' at brainstem level. Thus the brainstem cannot adequately process rapidly-changing sounds, as in speech. This would negatively affect comprehension, as well as cognitive auditory functions, leading to learning difficulties [11, 27, 28].

ERP's in ASD

P300 has been investigated in children with Central Auditory Processing Disorders (CAPD). A significant relationship has been

demonstrated between P300 (amplitude and latency) and deficits in selective attention, short-term memory and auditory discrimination ability in children with confirmed CAPD [29].

Dunn M.A et al investigated the MMN in Children with ASD, and reported that the amplitude of the MMN in this population was significantly smaller than in typically-developing children [30].

In 2013 Brandwein et al reported impairments in the processing of audiovisual input at 100ms in high-functioning children with ASD.

Stroganova et al reported abnormal P100 auditory ERPs, stating that the pre-attentive arousal in young children with ASD contributes to their atypical auditory behaviour [31]." Ruiz-Martinez et al (2019) reported on the impairment of both P1 habituation and in MMN in children with ASD, for both electronic and speech sounds [32]. They emphasise that impaired sensory behaviour leads to impaired learning. Kolesnik et al found increased cortical reactivity to repeated tones in 8-month old infants who were later diagnosed with ASD [33]. They state that this was "The first human evidence that elevated cortical reactivity is present in infants with a later diagnosis of ASD prior to the emergence of behavioural symptoms". Jamal et al reported at the INSAR conference that 'impaired auditory habituation correlates with symptom severity in children with ASD [34].

To summarise, the research into the auditory ERP's of children with ASD shows that the primitive, pre-attentive level of processing auditory signals (both speech and non-speech sounds) is unusual, and that there are abnormal responses of the kind that lead to disruption of sensory behaviours and may severely impair learning.

In the light of this growing body of evidence it can be concluded that it is counter-productive to provide top-down assessments and top-down interventions to remediate the auditory processing problems of children with ASD. As the data shows, the learning difficulties of these children originate at a primitive, pre-cognitive level. This suggests that an appropriate intervention should match this condition, to address the problem in the most 'primitive, bottom-up" manner at our disposal.

Therefore a closer investigation should be made of interventions that address auditory processing at such a 'primitive, bottom-up' level. There have been some attempts to devise 'auditory training' programmes to activate and stimulate these primitive processes in order to enhance their functioning. In 1996 Paula Tallal and associates launched the Fast ForWord programme. In the 1950's Dr Alfred de Tomatis presented his Audio-Psycho-Phonologie programme using music to awaken the mother-ear and the father-ear in a psycho-dynamic enhancement with the goal of improving general development, speech and learning.

An auditory retraining programme that has been the subject of much research, is the Bérard method of Auditory Integration Training (AIT). There is a large body of scientific research, studies, and anecdotal reports about this method of auditory training. Despite this, professional opinion in the past has been divided and largely antagonistic. Since this method is often labelled 'unscientific', it would be of interest to examine the research that has been undertaken, specifically on Bérard AIT, to see what evidence has accumulated, in the interest of maintaining a 'scientific' approach in our professional pursuit of 'evidence-based ' decision-making. For ease of display the reports have been divided into pre-2000 and post-2000.

The Efficacy of Auditory Integration Training: Summaries and Critiques: 28 Clinical Studies Pre-2000. (for more detail see https://www.aitinstitute.org/ait_clinical_studies.htm)

Number Of AIT Studies 1993 to 2000				
Disorders	**Positive Findings**	**Ambiguous, Controversial, &/or Contradictory**	**Results Unclear/ Questionable**	**No Effects**
Autism	13	1 (Bettison) 1 (Gillberg)	1 (Mudford et al.)	0
ADHD	4	0	0	0
CAPD	2	0	1 (Yencer)	0
Several Populations	2	0	1 (Zollweg et al.)	0
Animals (chicks)	2	0	0	0

All of the studies show discernible benefits.
The authors of 23 (i.e. 82%) studies concluded that their data supported the efficacy of AIT,
3 (i.e. 11%) claimed to have found no evidence of efficacy,
2 (i.e. 7%) report ambiguous, contradictory results.

A list in table form summarising some of the results and comments follows.

Key to abbreviations used in the table:

- Aberrant Behaviour Checklist (ABC-1),
- Autism Behaviour Checklist (ABC-2),
- Behaviour Summarized Evaluation (BSE),
- Childhood Autism Rating Scale (CARS),
- Clinical Evaluation of Language Fundamentals--Revised (CELF-R),
- Conner's Parent Rating Scales (CPRS),
- Fisher's Auditory Problems Checklist (FAPC),
- Screening Test for Auditory Processing Disorders (SCAN),
- Self-Injurious Behaviour Questionnaire (SIBQ),
- Staggered Spondaic Word (SSW), and the
- Test of Nonverbal Intelligence (TONI).

TOPIC	YEAR	AUTHORS	SUBJECTS	DESIGN	COMMENTS/ RESULTS
Ocular Movements Among Individuals with Autism Pre- and Post-Auditory Integration Training	1993	Margaret P. Creedon in collaboration with Stephen M. Edelson and Janice E. Scharre	22 ASD subjects No control group	open-clinical study, visual tracking movements and optokinetic nystagmus (a visual reflex) were assessed. Parents completed the FAPC and the ABC-1.	Significant improvements were seen in horizontal tracking immediately following AIT and in both horizontal and vertical tracking three months post-AIT . No changes were seen in optokinetic nystagmus. The FAPC indicated significant improvement at 3 months post-AIT, and the ABC-1 indicated significant improvement both immediately following and 3 months post-AIT.
Study of the Effects of Auditory Integration Training in Autism	1993	Dawn Cortez-McKee and Jaak Panksepp	33 ASD No control group	open-trial clinical study. Participants were assessed using multiple measures prior to, at 1-week, 1-month, and 3 months following AIT. The measures included: ABC-1, BSE, CARS, CPRS, FAPC, and SIBQ.	Significant improvement was seen on all of the measures, except the FAPC, at the one- and three-month follow-up assessment periods Critique:- FAPC is a survey tool, not a suitable instrument to measure change after AIT.

Study 1 of the Effects of AIT in Autism	1993	Tina K. Veale	5 ASD 5 controls, matched according to check-lists right	In a double-blind placebo pilot study. Parents complet-ed the ABC-1, the CPRC, and the FAPC. These instruments were completed prior to, one month fol-lowing, and three months following AIT.	Positive trends indi-cating improvement in the experimental group were seen at three months following AIT for all three evaluation forms.
Study 2 of the Effects of AIT in Autism	1993	Tina K. Veale	46 ASD No controls	An open clinical study	Parents completed the ABC-1, CPRS, FAPC as well as the Autistic Behaviour Composite Check-list and Profile. Significant im-provements were observed at one month and six months following AIT.. Some of the behavioural changes included: reductions in hyperactivity, social withdrawal, auditory problems, restlessness, and anxiety.
Non-Pharma-co-logical Tech-niques in the Treatment of Brain Dysfunction	1994	Jeffrey M. Gerth, Steve A. Barton, Harold F. Engler, Alyne C. Heller, David Freides, and Jane Blalock	10 children with auditory-based learning deficits Eight of the ten had also been diagnosed as having Attention Deficit Disorder.	Subjects were given a series of diagnos-tic tests, and par-ents were requested to complete several questionnaires. Two subscales from the Wood-cock-Johnson Psycho-Educational Battery test were used to evaluate changes in auditory processing.	The Sound Blend-ing scale and the Incomplete Words scale, indicated an improvement of one standard deviation or more in 4 of the 10 subjects, and moderate improve-ment in two other subjects.

Auditory Processing Skills and Auditory Integration Training in Children with ADD	1994	Donna Geffner, Jay R. Lucker, Ann Gordon and Dolores A. DiStasio	16 children with ADD/H.	This study investigated changes in audition and language. A large number of tests were employed to evaluate possible changes as a result of AIT. The measures included: standard audiometric threshold testing, tolerance for tones and speech, speech recognition in quiet and noise conditions, and the Goldman-Fristoe-Woodcock (GFW) Test of Auditory Selective Attention. Post-assessments were conducted within 3 months following AIT.	Significant improvement was observed in the subjects' tolerance to tones and speech, speech recognition in the noise condition, and in listening skills as measured by the GFW Auditory Selective Attention Test and several subscales from the Detroit Test of Learning Aptitude (oral commissions, attention span for unrelated words, and attention span for related words.)
Positron Emission Tomography Measure of Modified Auditory Integration Therapy: A Case Study	1994	Jacqueline M. Cimorelli and Melanie K. Highfill	A single-subject The research subject was an 8-year old male with mental retardation and autism	Investigated changes in brain functioning following AIT using Positron Emissions Test (PET) Scan technology. PET scans were conducted prior to a second set f AIT listening sessions (baseline), one day after and again six months after AIT.	The results at both the one-day and six-month follow-up evaluations indicated a normalization of brain wave activity, including a decrease in hyper-metabolism in the frontal lobe and an increase in activity in the occipital lobe.
Changes in Unilateral and Bilateral Sound Sensitivity as a Result of Auditory Integration Training	1994	Deborah Woodward	60 ASD No controls	Uncomfortable loudness level (UCL) measurements were performed prior to and immediately following AIT.	Following AIT, the monaural tolerance level to each ear increased 13 to 15 dBHTL, This increased tolerance to speech noise was statistically significant. In addition, the binaural tolerance level indicated a more normal response.

Parental Perceptions of Change Following Auditory Integration Training for Autism	1994	Dana Monville and Nickola Nelson	40 surveyed parents	Parent Survey	25 (63%) reported an increase in attention span; 25 (63%) reported a decrease in sound sensitivity; 12 (30%) reported an increase in language. 4 parents (10%) reported an increase in tantrums and aggression.
Auditory Integration Training	1994	Dr. Jane R. Madell and Darrell E. Rose	4 children, ASD/ PDD/ Learning Disabilities	Audiological and behavioural assessments were used.	Audiograms of all four children showed improvement following AIT (i.e., a decrease in variability). Behavioural improvement was observed in three of the four children: • increased calmness, • decreased sound sensitivity, • improvements in speech/language • improved word recognition in noise.
The Effects of Auditory Integration Therapy on Central Auditory Processing	1994	B Huskey, K Barnett, and J M. Cimorelli	6 exp 6 controls	An experimental study of 2 auditory processing tasks, . the SSW test and the Phonemic Synthesis Test (PST).	Pre- and post-tests were given prior to, and at 4 to 6 weeks, and at 8 to 12 weeks following AIT. For the SSW test, there were no improvements in the subjects 4 to 6 weeks following AIT, but there were improvements on the total score and on the left competing condition at 8 to 12 weeks following AIT. There were no changes in the results from the PST.

Clinical Outcome Evaluation: Auditory Integration Training	1994	Jane H. Rudy, Sharon S. Morgan, and Marianne Shepard	13 No controls	An open-clinical study, 13 subjects diagnosed with attention deficit/hyperactivity disorder (ADHD) and/or central auditory processing dysfunction (CAPD) were given a variety of assessments prior to, immediately following, and three months post-AIT. These tests examined hearing acuity, central auditory processing (SSW, SCAN), auditory evoked potentials (i.e., brain waveforms--P200 and P300), language function (CELF-R), and intelligence (TONI) immediately following AIT,	There were significant improvements in the SSW, SCAN, and CELF-R, and no change in the TONI. Three-months post-AIT, there was additional improvements in the SSW and CELF-R, but no further change in the SCAN. There was also a significant improvement in the TONI. An analysis of the P200 waveform indicated a significant change in amplitude but no change in the P300 waveform latency.
A Pilot Study of AIT in Autism	1995	Rimland B., Edelson S.	18 children and adolescents with ASD	Follow-up after 3 months.	Diminished aberrant behaviour but no change in Sound Sensitivity.
Long-Term Effects of Auditory Integration Training Comparing Treated and Non-Treated Children	1996	Donna Geffner, Jay R. Lucker, and Ann Gordon	10 with AIT 10 controls	The study involved a one-year follow-up evaluation of children with Attention Deficit Disorder. A tolerance testing procedure for 'uncomfortable' listening levels was used.	Improvement was observed for the AIT group, but no change in the control group. Additionally, tests evaluating speech recognition in noise and auditory-language processing showed improvement for those in the AIT group but not for those in the control group.

ANIMAL STUDIES	1995 1996	M. Waldhoer, J. Panksepp, D. Pruitt, M. Vaningan, D. McKee, J. Rossi III, and J. Lindsey Jaak Panksepp, J. Ross III, & T.K. Narayanan	Newborn chicks and AIT		The data suggests that AIT may modify serotonergic tone in the brain. Panksepp suggests such music arouses and activates attentional circuits in the brain *These findings indicate that listening to music produced neurochemical changes.*
The Effects of Auditory Integration Training for Children with Central Auditory Processing Disorder (CAPD)	1996	Karen A. Yencer	36 exp and controls	36 children diagnosed with central auditory processing disorder. Children with autism, pervasive developmental disorder (PDD), and multiple-handicaps were excluded from the study.	Testing prior and 1 month after AIT. Standard audiometric testing, the SSW test, the Phonemic Synthesis test, the Standard Progressive Matrices test, FAPC, auditory brainstem response (ABR), event-related potential (P300), and a speech-in-noise test. The P300 analyses indicated some improvement in the AIT condition (mean latency from 366.2 msec. to 348.5 msec.) versus a slight worsening in the placebo condition (mean latency from 400.8 msec. to 402.2 msec.). Critique – *post-AIT testing at 4 weeks instead of the required 3 to 6 months!*

The Long-Term Effects of Auditory Training on Children with Autism	1996	Sue Bettison	80 in 2 groups, exp / control, 3-17 years of age, with autism or Asperger syndrome and mild to severe distress in the presence of some sounds.	Measures used were the Hearing Sensitivity questionnaire (HSQ) – an informal survey devised by Bernard Rimland but not validated nor scorable. Also used the Developmental Behavior Checklist.	No difference between AIT and normal music. Improvement in both conditions, Improvements in sensitivity as well as IQ. Critique: *severe shortcomings, The HSQ was designed only as a survey of sound sensitivity in the autism population and not an instrument to evaluate treatment effectiveness. Is unstandardized , lacking even face validity*
Epileptic Activity in Autism and Acquired Aphasia: A Study Using Magneto-Encephalography	1997	Jeffrey D. Lewine, Sherri L. Provencal, John T. Davis, and William W. Orrison,	2 subjects	Magnetoencephalography and EEG recordings were used to measure electrical activity in the brain in one child with dyslexia and one high-functioning autistic adult.	Baseline recordings demonstrated larger than normal responses in the areas associated with hyperacusis. Following AIT, a more normalized balance or symmetry in electrical activity was observed
The Efficacy of Auditory Integration Training: A Double Blind Study	1997	William Zollweg, Vere Vance, and David Palm	30 participants assigned at random to either an experimental AIT group or a placebo-control group. Mild to profound Mental handicap , some with ASD.	A double-blind research design, Evaluations were conducted using audiometric tests, a Loudness Discomfort Level test, and the ABC-1 at 3, 6, and 9 months following AIT.	No differences were found between the AIT and control groups. Critique:- *AIT not recommended for MD* *Loudness incorrectly set as high as 122 dB SPL* *27% were given wrong narrow-band filters.*

Auditory Integration Training in Children with Autism: Brief Report of an Open Pilot Study	1997	C. Gillberg, M. Johansson, S. Steffenberg, and O. Berlin	9 pupils with ASD No controls	9-month follow-up period, using ABC and the ABC Sensory Subscale.	8 of the 9 children showed improvement on the Autism Behaviour Checklist (ABC) total score, And 7 of 9 children showed improvement on the ABC sensory subscale.
Auditory Integration Training: A Double-Blind Study of Behavioral, Electro-Physciological, and Audiometic Effects in Autistic Subjects	1999	Stephen M. Edelson, Deborah Arin, Margaret Bauman, Scott E. Lukas, Jane H. Rudy, Michelle Sholar, and Bernard Rimland	19 ASD assigned at random to exp/ control	All evaluations were 'blind' to group assignment. Behavioral, electro-physiological, and audiometric measures were assessed prior to and following AIT(Used the ABC-1) in the experimental group at the 3-month follow-up assessment.	A significant improvement was observed in behavioral problems . Electrophysiological: Of the 19 subjects, three experimental group and two placebo group subjects were able to cooperate with the auditory P300 Event Related Potential (ERP) task. All five subjects showed abnormal P300 ERPs prior to the AIT listening sessions. Three months following AIT, all three subjects showed a dramatic improvement in their auditory P300 ERP. No improvement was seen in the placebo group.
Auditory Integration Training and Autism: Two Case Studies	1999	Mark Morgan Brown	2 subjects ASD	Report of Observations made at three and six months	following AIT. Improvements were reported in attention, arousal and sensory modulation, balance and movement perception, praxis and sequencing, speech and language, social and emotional maturity, and eye control.

The Effects of Auditory Integration Training on Children Diagnosed with Attention Deficit /Hyperactivity Disorder: A Pilot Study	2000	Wayne J. Kirby	5 experimental, 5 controls	A placebo-control design, Subjects were assessed using the Auditory Continuous Performance Test (ACPT) prior to and three months following AIT.	Comparison of the two groups at three months post-AIT indicated a statistically significant reduction in the total number of errors for those in the AIT group. Improvement on the impulsivity and inattention scores were not significantly different from the placebo group.

Comments Regarding Two Particular Criticisms of Ait

Patricia Howlin's criticism is based on her misunderstanding the interpretation of the statistics. e.g. She stated *"Thus, the mean fall in the ABC score was less than 0.4 points; hardly a dramatic change in a scale of 58 items"* (page 348) [35]. Howlin assumed that the maximum possible score on the ABC-1 was 58; however, the maximum possible score was only 3. Thus, the difference of almost 0.4 points is a meaningful proportion of the 0 to 3 range and is clinically significant.

Regarding another measure, Howlin stated that a 12-point difference on the 93-item FAPC was also not clinically important. Howlin was wrong again. The FAPC contains 25 items, not 93 items; thus, an average change on 12 of 25 items is quite dramatic and is clinically significant. Again, the results were positive, not negative

In another criticism, Rankovic, Rabinowitz, and Lof measured the sound output levels of a single AudioKinetron, set at its loudest output possible – 118dB [36]. They conclude it can be harmful to hearing. However, they ignored the protocol for AIT which recommends maintaining client comfort and safety in setting loudness. They also conjecture harm, where none has ever been found. The opposite is more likely to occur, where in fact some improvement in graphs is the change found.

Note

Scientific or evidence-based opinions about AIT should be based on evidence and observable facts rather than prejudice or supposition.

Research Outcomes : Auditory Integration Training, Post- 2000

Topic	Date	Author	Subjects	Design	Summary of Results
A Pilot Study: Into the Effects of a Single Course of Bérard Auditory Integration Training on the Progress of a Population of Children Diagnosed With Autistic Spectrum Disorder	2002	Rosalie Seymour	16 ASD exp 8 ASD controls	Baseline to matched exp and controls using form E2, ATEC, ABC, Parents Questionnaire	The AIT group's pre-post differences were more likely to be positive than the control group. It is also seen that only the control group showed any negative change (i.e. worsening). The AIT group total score improvement was significant, The improvement in hyperactivity scores was *highly significant* in the AIT group. And the difference between the control and AIT was highly significant.

Research: Report on the Changes in Scores for a Group of 13 Children with Autism After Berard Auditory Integration Training	2005	Rosalie E Seymour, Maoilíosa Ó Rathaille unpublished	12 pupils with ASD	This study to answer two questions: 1. To determine whether AIT made any difference for those children with autism who participated . 2. The next question to answer was, is this difference bigger than one can expect from ordinary chance? Used ATEC and ABC and PQ.	Results showed significant changes to the ATEC subscales for Sociability, and for Sensory/Cognitive, and the total scores. These results show that there were improvements for the group in all the areas covered by this checklist. There were significant changes in the areas of irritability, lethargy, hyperactivity, and the Total scores. That is, we can confidently say they were not as a result of chance but are likely to have been due to AIT.
The Hearing Ear and the Listening Brain – an Evaluation of Auditory Integration Training in Children/Students with Concentration Problems and Learning Difficulties	2006	Britta Alin Åkerman, Lars Borazanci Persson	56 subjects, 21 students with ASD 28 AIT 28 controls	Listening tests, parents and teacher questionnaires rating attention, and household behaviours.	Show a difference between the intervention and control groups ranging from slight difference to considerable difference. Additional observed improvements included:- Improved eye contact, improved communi- cation, longer sentences, improved interaction, attention and calmness. Reduced sound sensitivity.
Research	2006	Alaa El-Din Abou-Setta, MD; Iman Sadek, MD; Amani Shalaby, MD; Nagwa Hazzaa, MD, *Ain Shams University*	15 children with ASD. Included 8 with hyperacusis.	To explore the value of AIT as a complementary measure in rehabilitation of autistic children. Autism Performance Observation Sheet (APOS) was developed for parents to report on behaviour and communication..	Reduction in hyperactivity, in social withdrawal, in auditory problems, in restlessness and in anxiety following AIT. Found an increase in attention span, a decrease in sound sensitivity, and an increase in language. Commented: *'AIT can be viewed as a reasonably effective complementary tool in the rehabilitation of autistic children. It seems that it paves the road for more benefit from the classical ways of rehabilitation'.*

Berard AIT Supports a Memory Training Program The Mediterranean Project	2013	Dr Selvi Borazanci Persson	68 subjects, ages 6-65 yrs AIT before memory training only. 33 controls - memory training	A study was to determine if memorizing can be enhanced by AIT. Task = 1. memorizing image cards (auditory & visual 2. peg words (auditory), 3. face recognition with names (auditory & visual)	In each task, and for all age groups, the improvement in the AIT condition was highly significant, and continued to improve over a 9-month period post-AIT.
Effectiveness of Auditory Integration Therapy in Autism Spectrum Disorders—Prospective Study	2013	Prof. Laila Y. Al-Ayadhi, Abdul Majeed Al-Drees and Ahmed M. Al-Arfaj, Saudi Arabia	72 with ASD (CARS: 21 moderate, 51 severe)	To determine the effectiveness of auditory integration training (AIT) in people with ASD. Pre-intervention and post-intervention (3 and 6 months) scores were calculated using CARS, Social Responsiveness Scale (SRS), and the Autism Treatment Evaluation Checklist (ATEC).	All subjects demonstrated improvement 3 and 6 months following the AIT. ASD subject showed 22% and 26% percentage improvement in SRS scoring. Statistically significant changes in social awareness, social cognition, and social communication. Similar results were achieved with the ATEC '***The results of this study support the therapeutic effects of auditory integration training on social awareness, social cognition, and social communication, as well as speech and communication.'***
Berard Auditory Integration Training: Behavior Changes Related to Sensory Modulation.	2014	Sally S. Brockett, Nancy K. Lawton-Shirley and Judith Giencke Kimball	Cases of 54 children with disabilities (34 with autism), ages 3–10 years, who received Berard AIT, were reviewed.	A study to determine if behaviours specifically related to sensory modulation showed positive changes following 10 days of Berard auditory integration training (AIT).	Behavioural problems reduced on all five factors of the Aberrant Behaviour Checklist (P , 0.01), maintained at three and six months. The Short Sensory Profile scores improved.

The Effects of Auditory Integration Training (AIT) on Mismatch Negativity in Children with Autism	2015	2015 E. M. Sokhadze , S. M. Edelson , L. L. Sears , M. F. Casanova, A. Tasman and S. Brockett	11 ASD 11 control	The aims of the study was application of Berard's Auditory Integration Training (AIT) techniques in children in autism and assessment of AIT course outcomes using MMN, frontal P2a and P3a evoked potentials, and behavioral questionnaires (ABC,CPI).	Berard AIT resulted in significant decrease of Irritability, Hyperactivity and Lethargy scores on the Aberrant Behavior Checklist (ABC), and improved Emotion, Behavior and Receptive Language Scores on the Comprehensive Performance Index (CPI) scales. The study demonstrates that Berard AIT positively affects auditory stimulus processing, reflected both in early (MMN) and late (P2,P3a) evoked potentials.
Before-and-After Central Auditory Processing Test Results For AIT – a Clinical Retrospective Study	2015	Judith Paton	210 subjects:- with learning disability (LD), dyslexia, speech/language disorders, and/or central auditory processing disorders (CAPD or APD).	Changes in central auditory processing test scores between pre-and post-AIT evaluation. Used 11 CAP tests. The four tests showing the most improvement (70-90%) were: a) Speech Discrimination in Ipsilateral Noise at 0dB S/N (signal-to-noise ratio) (90%) b) Filtered (low-pass) Speech at (81%) c) Time Compressed Sentences (at 60% compression) (73%) d) Pitch Pattern Sequencing (70%) Second-most improved by AIT (50-69%) were: a) Sound Blending (68%) b) Duration Pattern Sequencing (56%) c) Dichotic Competing Sentences (56%) d) Binaural Fusion (55%) e) SSW (Staggered Spondaic Word) test (54%). f) Competing Words (47%).	The average improvement for LD and ASD groups together across tests was 67%. *(A small number of ASD patients showed 61% improvement, with the even smaller number of adults at 78%.)* The total amount of improvement after AIT for all subjects on all repeated tests was: a) 80 to 100% improved -- 49% b) 50 to 79% improved -- 50% c) 12 to 49% improved -- 1% '*Results of this study show that AIT can be reasonably quick and effective way of improving functioning of the central auditory nervous system'.*

Impact of Auditory Integrative Training on Transforming Growth Factor-β1 and Its Effect on Behavioural and Social Emotions in Children with Autism Spectrum Disorder	2018	Prof. Laila Al-Ayadhi, Abdulrahman Mohammed Alhowikan, Dost Muhammad Halepoto Saudi Arabia.	15 children with ASD	This study investigated the impact of Auditory Integration Training (AIT) on transforming growth factor (TGF)-β1 and its effect on behavioral and social emotions in children with autism spectrum disorder (ASD).	The increased plasma levels of TGF-β1 after AIT support the therapeutic effect of AIT on TGF-β1 followed by improvement in social awareness, social cognition, and social communication in ASD children.

Summary and Conclusion

It is clear that a large body of evidence has accumulated regarding the efficacy of the Bérard method of Auditory Integration Training. (This overview does not include other auditory techniques such as the Tomatis Method, Fast ForWord, and others). This includes data from research, reports, studies, and published material. There have been some cautions relating to loudness of the music, but that study was flawed in making incorrect, unusual settings on the measured device, rendering the conclusions invalid [36]. In practice, since the commencement of its popularity in 1993 there have been no reports of harm linked to this method of auditory training. It is evident that the application of this ten-day training may have benefit for some, significant benefit for a few users, and little benefit for a few users. Such beneficial effects that are reported range through auditory, sensory processing, cognitive, social and behavioural improvements.

To be truly 'scientific', the community of professionals attempting to assist children with ASD would need to pay much closer attention to this data. To inform the professional commitment to 'evidence-based practice', it should be borne in mind that these changes result from a brief, ten-day (ten hours) training, and that this auditory training utilises a 'bottom-up, primitive' design of stimulation. However, it is clear that between 1993 and 2020 the professional community has not given much evidence of its commitment to 'evidence-based practice', in that the chief intervention for such childhood disorders as ASD remains educational, 'top-down' cognitive learning. This bias is also noted in many therapeutic approaches where 'auditory techniques' require the child to make voluntary efforts to overcome (?) the auditory processing problems they exhibit. The largest body of material used to remedy Auditory Processing Problems is of a visual-supportive nature.

It can therefore be concluded that research , or more precisely – the response of professionals to evidence from research – is not effective in informing 'evidence-based practice' This is true in the case of intervention programme design for childern with ASD, but also for children with significant sensory processing difficulties such as Dyslexia, Attention difficulties and SLI [37-63].

It appears that evidence has not the power to inform intervention. It could be of value for those who train future professionals to research new methods of training, to enable professionals to assimilate new information in order to ensure that their practice may become - in reality - 'evidence-based'.

Postscript

In "The Nature of Science and the Scientific Method". Christine V. McLelland comments:

Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement. (NSES, 1996, p. 171) The *National Science Education Standards.*

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