RESEARCH ARTICLE

A Quantitative Summary of The Listening Program (TLP) Efficacy Studies: What Areas Were Found to Improve by TLP Intervention?

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Abstract

A quantitative summary of existing research examining the effects of The Listening Program (TLP) on various functions in children is presented. Nine studies were used, looking at TLP intervention effects across studies, within each study and for various outcome measures. The studies looked at TLP intervention on children with autism spectrum disorder, Down syndrome, learning disabilities, auditory processing disorders, attention deficit hyperactivity disorders, Rhett syndrome, dyspraxia, cerebral palsy, fibromyalgia, arthritis and stroke. The magnitude of the TLP effect size revealed a mean value of 0.41 across all studies. For each individual study, effect size ranged from 0.23 to 1.28. Two studies yielded significantly larger effect size than the other studies. One of these studies (effect size 1.19) examined the improvement in auditory processing for children identified with autism. The other study (effect size 1.28) examined improvement in academically related skills of underachieving school children. Larger effect sizes were obtained for research that examined auditory processing/listening skills (mean effect size 0.72) than for research looking at non-auditory areas (mean effect size 0.31), although all revealed positive changes. The effect size of various outcome measures is discussed in order to identify variables that might affect the outcomes as well as what these results mean to occupational therapists who would consider TLP intervention for clients. Copyright © 2016 John Wiley & Sons, Ltd.

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Keywords

The Listening Program; effect size; auditory processing; sound therapy

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The Listening Program (TLP), created by Advanced Brain Technologies (ABT) (The Listening Program, 2014), is a music-based auditory intervention programme using psychoacoustically modified classical-type music designed to provide auditory stimulation that aims to improve brain functioning (Doman and Lawrence, 2003; The Listening Program, 2014). The music used in the programme is designed to stimulate the auditory system to improve the person's responses to sounds, consequently having a global effect on the brain, improving a wide range of brain performance areas (National Association for Child Development, 2014). The areas of the brain claimed to be involved include those areas that control executive functioning,

communication, auditory processing, social and emotional regulation, reduction in stress, motor coordination and creative expression (Advanced Brain Technologies, 2013; Lucker and Doman, 2012; National Association for Child Development, 2014). The areas of function considered to be the focus of TLP intervention include executive functioning, communication, auditory processing, social and emotional regulation, reduction in stress, motor coordination and creative expression (Advanced Brain Technologies, 2013; Gee, Thompson, & St. John, 2014; Lucker and Doman, 2012; The Listening Program, 2014).

The effect of TLP intervention has been examined and reported by researchers of different professional disciplines looking at various subjects investigating different outcomes. Positive results are reported in both qualitative and quantitative studies (The Listening Program by Advanced Brain Technologies: Case Studies, 2014; The Listening Program by Advanced Brain Technologies: Research, 2014). Many success stories have been reported through case studies, papers and personal correspondences (Gee, Thompson, & St. John, 2014; The Listening Program by Advanced Brain Technologies: Case Studies, 2014). The identified disorders of subjects who are reported to have shown positive effects after completing TLP intervention include people with autism spectrum disorder (ASD), Down syndrome, learning disabilities, auditory processing disorders (APD), attention deficit hyperactivity disorders, Rhett syndrome, dyspraxia, cerebral palsy, fibromyalgia, arthritis and stroke (Gee, Thompson, & St. John, 2014; The Listening Program by Advanced Brain Technologies: Case Studies, 2014). Subjects have ranged in age from toddlers to older adults. Outcomes measured have looked at changes in toilet intervention, auditory processing, visual perception, motor coordination and emotional stability (The Listening Program by Advanced Brain Technologies: Case Studies, 2014). Other areas may also change after TLP intervention, but these areas are not covered in the research used for the present analyses.

There are several quantitative research studies that have looked at the efficacy of TLP on various functions in children (e.g. The Listening Program by Advanced Brain Technologies: Research, 2014). Currently, most available research studies have employed exploratory approaches using a single-group pre-test/post-test design with small numbers of participants via convenient sampling. Additionally, most of the research presents only descriptive statistics. Because such research studies have been exploratory in nature, great variation in outcome measures has been found, and different types of subjects were used as participants. Of the studies investigated, all found positive effects of TLP intervention in different areas for different subject groups. In order to systematically examine the overall effect of TLP intervention and compare the magnitude of effect among different studies and outcome measures, a quantitative summary of these studies is desired. The present investigation presents this quantitative analysis, summarizing the findings of these various exploratory studies. The results are presented in quantitative terms for ease of examining and interpreting results from available studies in order to identify trends when grouping outcomes from studies and to plan what is needed for future research. When considering what the analyses provide, the research questions asked were as follows:

(1) What is the average magnitude effect of TLP intervention?
(2) In which functional areas is the largest effect observed following TLP intervention?
(3) What factors may have influenced the magnitude of the TLP intervention effect?
(4) What does the present analysis reveal regarding the needs for future research?

Methods

Study selection

The studies used in the present investigation were located through Internet searches using the following keywords: The Listening Program, sound therapy, auditory intervention and Advanced Brain Technologies. Furthermore, the studies initially found were examined to locate other studies worthy of being investigated.

The inclusion criteria for a study in the present investigation were that the researchers investigated the effects of TLP intervention, used a group of subjects, used some form of formal pre-treatment and post-treatment assessment and presented sufficient data of the results of these assessments in order to calculate the effect size (ES) for various measures. Thus, single-subject case studies were not included in the present investigation.

Fifteen studies were identified, with nine meeting the inclusion criteria (Butler and Clarke, 2003; Lawrence and Davies, 2003; Esteves et al., 2009; Harris, 2002a, 2002b, 2002c; Jeyes, 2004, 2013; Treharne, 2004). All

Table I. Characteristics of the studies used in the present meta-analysis

Year, author, place	Participants: type, number and age	Reported TLP schedule	Evaluation tools	Measurements and mean ES for the measures	Overall mean effect size
2013: Jeyes, Ireland	Autism (ASD); $n = 12$; 5 years and 8 months to 12 years and 4 months	0.5 hour day^{-1}; one cycle for 10 weeks; 25 hours total	SCAN-C	Auditory processing: filtered words, auditory figure-ground, competing words, competing sentences; mean ES = 1.19[a] – homogeneous	1.19[a] (based on four independent measures) – homogeneous
2009: Esteves et al., United States	ADD/ADHD, ASD, developmental delay, brain injury, central processing dysfunction; $n = 6$; 3 years and 11 months to 8 years and 7 months	Two 15-minute sessions per day; at least 30-minute break between sessions; two listening cycle totaling 20 weeks/50 hours	BOT; Beery, VMI	Fine and gross motor skills, visual motor integration, visual perception, motor; coordination: overall ES = 0.1[c] – homogeneous	0.29[c] (based on 23 independent measures) – heterogeneous
			Sensory Profile	Tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsiveness, auditory filtering, lower/weak energy, visual auditory sensitivity; mean ES = 0.32[c] – homogeneous	
			Pragmatic Language Skill Checklist	Auditory attention, listening skills, comprehension, communication, conversation, social interaction; mean ES = 0.57[b] – homogeneous	
			ROWPVT and EOWPVT	Receptive and expressive vocabulary; mean ES = 0.18[c] – heterogeneous	
			OWLS	Listening comprehension, oral expression, oral composite score; mean ES = 0.20[c] – heterogeneous	
2002: Harris, United States	Auditory processing disorders (APD) and learning disabilities; $n = 4$; Grades 5–7	Two cycles: each cycle used CD Tracks 1–8 in sequence; one CD for 5 days	TARPS	Auditory word memory forwards and backwards, auditory sentence memory, auditory interpretation of directions, auditory word discrimination, discrimination, auditory processing; mean ES = 0.30[c] – heterogeneous	0.56[b] (based on 11 independent measures) – heterogeneous
2002: Harris, United States	Learning disabilities having academic IEPs; $n = 4$; Grades: 3, 6 and 8	40 days/20 hours total			
2002: Harris, Unites States	Majority were Hispanic with Spanish as the primary language spoken at home; $n = 4$; Grade 5	Total of 40 hours	SCAN-C	Filtered words, auditory figure-ground, competing words, competing sentences; mean ES = 0.82[a] – homogeneous	0.56[b] (based on 4 independent measures) – homogeneous

(*Continues*)

Table I. (Continued)

Year, author, place	Participants: type, number and age	Reported TLP schedule	Evaluation tools	Measurements and mean ES for the measures	Overall mean effect size
2003: Butler and Clarke, Australia	Learning disabilities, auditory problems; $n = 20$; 5–10 years old	2 times a day for 15 minutes each completed in pairs of two students with 2 weeks of preparatory listening using SI classic CD for 2-minute sessions per day	QNST-II	Neurological integration, primitive reflexes; mean ES = 0.51[b] – heterogeneous	0.57[b] (based on 9 independent measures) – homogeneous
			SCAN-C	Filtered words, Auditory figure-ground, competing words, competing sentences; mean ES = 0.72[b] – homogeneous	
			Auditory-visual Digit Span Test	Auditory and visual memory	
			Lindamood Auditory Conceptualization Test	Auditory sound–symbol association; ES = 0.43[c] – (only one ES)	
2003: Lawrence and Davies, UK	Dyslexia, dyspraxia, language deficits with educational and social problems	20 hours over an 8 week time period	SCAN-A	Filtered words, auditory figure-ground, competing words, competing sentences; mean ES = 0.49[b] – homogeneous	0.49[b] (based on 4 independent measures) – homogeneous
2004: Jeyes	Academically underachieving students; $n = 38$; 7–11 years and 5 months	Up to 6 children each term; two daily sessions: one AM one PM, 8-week programme	Quest test of pre-reading skills	Auditory discrimination and memory; mean ES = 2.03[a] – heterogeneous	1.65[a] (based on 4 independent measures) – homogeneous
			NFER	English and Mathematics; mean ES = 1.0[a] – homogeneous	
2004: Treharne, UK	Auditory processing disorders (APD); $n = 10$; 8–10 years	Strictly followed base schedule	GFW Auditory Test of Selective Attention	Fan noise, cafeteria noise, competing story (speech); mean ES = 0.51[b] – homogeneous	0.45[b] (based on 5 independent measures) – homogeneous
			Auditory Sequential Memory Test	Auditory memory forwards and backwards; mean ES = 0.38[c] – homogeneous	

Based on Cohen (1988).

[a]Large.

[b]Medium.

[c]Small.

Names used for tests: BOT = Bruninks–Oseretsky Test of Motor Proficiency; GFW = Goldman–Fristoe–Woodcock; NFER = National Foundation for Educational Research; OWLS = Oral and Written Language Scales; QNST = Quick Neurological Screening Test; ROWPVT and EOWPVT = Receptive (R) and Expressive (E) One-word Picture Vocabulary Test; SCAN-C and SCAN-A = Test for Auditory Processing Disorders in Children (C) and in Adults and Adolescents (A); TARPS = Test of Auditory Reasoning and Processing Skills; ES = effect size; VMI = The Beery-Buktenica Developmental Test of Visuall Motor Integration.

of these studies were exploratory in nature, including five studies having the words "pilot studies" in their title (Butler and Clarke, 2003; Lawrence and Davies, 2003; Harris, 2002a, 2002b, 2002c). The three studies by Harris (2002a, 2002b, 2002c) used the same outcome measures for a similar age level and diagnostic group of subjects but completed the research in different schools in the State of Washington. In each study, Harris used four subjects. These three studies were combined so that ES was investigated as if the results were included in one study having the individual scores of students combined. From the review of these 15 studies, a total of nine met inclusion criteria. However, by combining the three investigations by Harris forming one unified study, there were only seven investigations considered. The studies were conducted internationally in the United States, Britain, Ireland and Australia.

All studies selected are published in the ABT site under researches. Because ABT is the manufacturer of TLP, using the papers published on the ABT website may present a risk for bias if the results of the present investigation are used to predict the positive effects of TLP intervention in the general population. Additionally, only a few of these studies are indicated as being published in peer-reviewed journals or were peer reviewed for presentation at professional conferences. However, these appear to be the only published data available looking at the efficacy of TLP intervention providing quantitative data. Thus, these were the only studies able to be found providing information useful in the statistical analyses provided by the authors of the present study. The present analysis merely presents a summary of the findings from the studies used. It is hoped that the findings will help future researchers determine the goal and methods for future research while providing a baseline of improvements occupational therapists would expect to find after having clients complete TLP training.

Table I presents the individual characteristics for these studies, including researchers, location of the research, year of publication, subjects' characteristics, TLP schedule, the number of subjects used in each study, subjects' ages, measures used for pre-TLP and post-TLP analyses, areas of assessment and ESs calculated. Of the nine studies used, only four were published or presented via peer review (Esteves et al., 2009; Jeyes, 2004, 2013; Treharne, 2004). The overall mean ES of each study and the mean ES of the outcomes measured by each of the tests used in each study are also presented.

Several differing variables were identified in each study. The variables include subject characteristics (age, gender and diagnosis), history of additional rehabilitation services, variations in TLP administration, location of the research and the researchers' professional affiliations. There was a wide variation of these independent variables in each study, resulting in confounding of results. Because of the small number of the studies and wide varieties of variables, it was not feasible to isolate these factors. Thus, the studies were combined based solely on the outcomes measured.

The quality of a study can also be a variable that influences the outcome measures. However, all studies used in the present analyses shared the same level of quality. The same threats to internal and external validity applied to all studies. The threats to validity were identified as the small number of subjects (except for one study), non-randomized subject selection, single-group pre–post design, numerous outcome measures within a study and non-blind tester/scorer as well as providers of TLP intervention. Therefore, it is assumed that study quality was equal in all studies selected so that grouping of outcomes was an appropriate way to measure ESs. Additionally, because only a small number of studies indicate some level of peer review and none of the studies indicate that they went through some level of institutional review board, the threats to validity are understood as being rather high. Yet, the present statistical analysis provides baseline measures to aid researchers regarding what further investigations are needed as well as provide occupational therapists with some expectations as to what might be expected after clients complete TLP training.

The subjects used in the studies, as reported by the researchers, included children with ASD, learning disabilities, sensory processing disorders, APD, Down syndrome, attention deficit disorders, dyspraxia, dyslexia, developmental delays and brain injuries. The number of subjects in any single study ranged from 5 to 38. The subjects' ages ranged from 3 years and 11 months to 16 years of age. The subjects' identified problems varied according to each study, but most of the subjects were reported to have auditory and speech-language-related deficits as well as sensory motor-related problems.

The professional affiliations of the TLP providers included speech-language pathologists and occupational

therapists. Four of the research studies were conducted in the United States, and five were conducted in foreign countries. There was some variation among studies in the method of application of TLP. However, the data were not sufficient to identify the methodological differences to be considered as a significant variable.

The areas of investigation and the measurement tools used also varied from study to study. The outcome measures used in the various studies included measures of auditory functioning; language abilities; educational functions; and visual, sensory, motor and neurological functions.

The specific evaluation tools used by the various researchers, including the areas they assessed, are presented in Table I. The table also includes the specific calculated ES identified for each outcome measure.

Data collection

Each study included in the present investigation presented individual scores for the subjects. From the studies that presented graphs instead of scores, numeric values were obtained from the graphs. These individual scores became the bases for ES calculations. Two extreme outliers were eliminated from analyses.

Effect size calculation

Effect sizes were calculated using Hedge's g formula (Lipsey and Wilson, 2000). The pre–post gain scores were standardized by the pooled standard deviation of the pre-test and post-test scores to identify the ES. Each ES was adjusted for the trend of upward bias due to the small sample size using Hedge's correction formula. Inverse variance weight was assigned to each study in order to minimize variance of the combined effect (Borenstein et al., 2007; Lipsey and Wilson, 2000 and Cooper and Hedges 1994).

The ES values presented indicate how much change in performance was made after use of TLP. ESs are standardized and are on the same scale unit. Thus, the scores of one test can be compared or combined with other scores. ES, in this case, expresses how many standard deviation differences are found between the mean of the pre-test scores and mean of the post-test scores. For example, if the ES is 0.25, the mean post-test score was a quarter of a standard deviation greater than the pre-test mean. The ES is a datum point, which can be combined to calculate mean ES of a group of outcomes. In calculating the mean ES, one needs to look at the number of the contributing ESs and their homogeneity. The greater the number of the contributing ESs used in the combined calculation, the more stable is the mean. For example, the mean from 100 points is generally more trustworthy and stable than the mean from only 2 points (Lipsey and Wilson, 2000).

The contributing ESs may be homogenous or heterogeneous. Theoretically, the homogenous data points have a single source, whereas heterogeneous data can come from any number of sources. When the data points are homogenous, it is likely that the data came from similar constructs and subjects of the same characteristics, whereas heterogeneous data suggest that they are measurements of different traits or constructs and/or different subject characteristics. When an ES is found to be heterogeneous, some influence of the variables within the study is suspected. The variables used in the present investigation were placed into subgroups to determine if homogeneity was achieved (Krus and Blackman, 1988).

Effect sizes were calculated for the following:

- Mean ES for the studies as a whole
- Mean ES of each individual study
- Mean ES for the three categories of outcomes
- Mean ES for different outcome measures of each study

Results

Mean effect size

The overall mean ES found was 0.41, which is significantly different from zero. The ES of 0.41 indicates that the mean of the post-test scores exceeded the pre-test mean by 0.41 standard deviation or about 65% of the pre-test scores fell below the average post-test scores. Furthermore, this ES is considered a clinically significant improvement in the measure used after TLP intervention was completed.

The distribution of the overall ESs lacked homogeneity, meaning that there were significant variations among the ESs for the measures when compared between studies, which would be more than expected by chance. It was attempted to subgroup the studies to identify possible factors that might have affected the outcomes, but because of wide variations of independent variables in each study, it was not feasible to reasonably subgroup

the studies. Therefore, the individual studies were examined for homogeneity.

Individual study effect sizes

Individual study ES was calculated in an attempt to examine if the heterogeneity of the mean ES could be explained just by the ES differences among individual studies. The individual study ESs ranged from 0.23 (small) to 1.23 (large). The variations among the study ES were statistically significant ($F = 7.77$; $df = 6$; $p = 0.00$).

The studies formed two clusters. The first cluster included studies by Jeyes (2004, 2013), which yielded large ESs. The second cluster included all of the other studies, which yielded small ESs. Studies by Jeyes (2004, 2013), Butler and Clarke (2003), Lawrence and Davies (2003) and Treharne (2004) yielded homogeneity, indicating that similar constructs were measured within the studies. Within study, heterogeneity was present in the studies by Esteves et al. (2009) and Harris (2002a, 2002b, 2002c). The research focus of the study by Esteves et al. (2009) was on changes after TLP intervention on non-auditory areas including sensory, motor, visual perception and language skills. The outcome variables involved both language and non-language skills, measuring two different factors. The studies by Harris investigated auditory functions, language abilities and educational factors. The ES for auditory functioning yielded homogeneity, but measures of language abilities were heterogeneous. The influencing variable for this variation could not be identified. Thus, the heterogeneity of the total ES is due to between-study and within-study variability of factors (Figure 1).

Effect sizes for different outcome measures

The ES for outcome measures was then investigated to further identify the nature of heterogeneity of the total ES. One factor that was identified when analysing the various studies used in the present investigation is that they incorporated a wide variety of outcome measures. It was possible to categorize these measurement variables into three general categories and obtain ES for each category. These measures were classified as auditory functions; language and educational functions; and measures of visual, sensory, motor and kinesthetic functions. These classifications were made depending on the outcome description of the researchers. Table II presents the results of these analyses.

A review of Table II indicated the following. The largest ES was obtained for the category of auditory factors, which included measures of auditory attention and auditory processing skills. The smallest effects were noted for the category that measured non-auditory outcomes (sensory, motor, visual and neurological functions). These non-auditory measures were the ones most often used by occupational therapists, while the previous factors (auditory category) are measures most often used by audiologists and by some occupational therapists, as well as by speech-language pathologists and psychologists (Figure 3).

The ES in the auditory category as well as in the visual, sensory, motor and neurologic category yielded homogeneity, indicating that the items possibly measured similar constructs. The language and educational category included a wider variety of measures including assessment of memory, academic skills and oral and written language abilities. Thus, analyses indicated that these measures yielded a heterogeneous distribution of ES. However, because of the limited number of studies, a separate coding for these variables was not feasible.

The heterogeneity of the language and educational categories was further investigated by creating subgroups including receptive language skills, expressive language skills, memory skills and academic skills. Results of the ES analyses for each of these subgroups of measures were indicated in Table III.

The heterogeneity of the ES in receptive language and memory outcomes may be due to the specific tests used, subject characteristics and the specific TLP protocol involved. Again, because of the small number of the measures included in these analyses, results should be interpreted with caution.

Additional findings

After completing the previous analyses, it was decided to examine the ES distribution of some additional data. The study by Esteves et al. (2009) looked at the TLP effect on sensory processing disorder using the measures in the Sensory Profile. The Sensory Profile is a rating scale based upon subjective caregiver observations. The mean ES of this category was 0.32 (small), and the items were homogenous. As the distribution was homogenous, there were no statistically significant differences among the sub-skills. However, examining the

trends of the results, it was found that auditory sensitivity reduction yielded the largest ES (Figure 2). Thus, TLP intervention was again demonstrated to have a positive effect on improving an auditory-based factor (i.e. auditory hypersensitivity), one of the sensory processing areas often treated by occupational therapists.

Discussion

The results of the present investigation identified some interesting findings. However, the authors want to insure the reader to remember that a small number of studies were included and that these studies were exploratory pilot studies investigating the effect of TLP intervention on many different areas and with different subjects. Additionally, about half the studies were published or presented via peer review criteria. However, little is known on whether any of the studies were accepted for research via institutional review board reviews. Thus, the reader should remember these limitations of the research studies explored. Furthermore, factors from the studies varied, including subjects' characteristics and outcome measures. Thus, care should be taken in interpreting the findings from the present research. However, this research is felt to be an initial step in analysing the results of existing studies investigating the outcomes of TLP intervention with children. The calculated ES for each study and for the outcome measures should provide useful information for clinicians and future researchers.

When reviewing the present research, it was noted that ES varied between studies as well as within studies for the different measures used. Overall, when grouping all studies together, the ES was significantly different from zero (e.g. ES of 0.41), which indicates that some improvement was observed in children after completing TLP intervention. The effect of TLP intervention was not equivalent in the improvements noted between studies so that each individual study and each area of measurement used provided greater insights into what changes might be expected after TLP intervention.

When looking at individual studies, there are two studies that yielded large ESs of 1.19 and 1.65. These were the studies by Jeyes (2004, 2013). When reviewing these two studies to determine what factors might have accounted for their large ES, no common variables were identified. However, this finding does support a conclusion that one might expect significant improvements after TLP intervention, especially in auditory-based and educational-based skills, and supports a need for future research to verify the TLP effects and determine what actual factors account for the significant improvements that are seen.

The study by Jeyes (2013) used a sample of children with ASD and measured changes in auditory processing as reported by pre-treatment and post-treatment measures via the Test for Auditory Processing Disorders in Children (SCAN-C) test. In contrast, the study by Jeyes (2004) used a group of students identified as "underachievers", finding large changes in math and reading scores for these subjects after completing TLP intervention. What is not known is whether these "underachievers" had auditory processing deficits similar to the subjects who completed the auditory processing testing (SCAN-C) in the other study by Jeyes (2013). Additionally, what is not understood is why completion of a TLP intervention would have an impact on improving math and reading scores. Looking at areas of language and educational factors, the ES results were also greater than zero but not as great as the ES found for auditory processing skills. These language and educational factors included auditory–verbal memory, oral and written language skills, language comprehension and math and English academic skills. As stated earlier, why TLP intervention led to improvements in these skills can only be hypothesized. One hypothesis presented by the authors is that the improvements found were related to improvements in auditory processing and, thus, listening skills, so that learning increased for these subject areas. Further research is needed (1) to identify what specific academic areas and factors are improved after TLP intervention and (2) to look at the relationship between academic areas and auditory processing skills.

Unfortunately, this was the only study identified that looked specifically at academic achievement as the measure of change so that comparisons with other studies could not be accomplished. Thus, further investigations are needed to look into the impact of TLP intervention on auditory processing abilities in children as well as on academic functioning with a focus on academic variables because many parents, educators, occupational therapists and other professionals are highly concerned with students' academic performances when these children undergo listening intervention such as TLP.

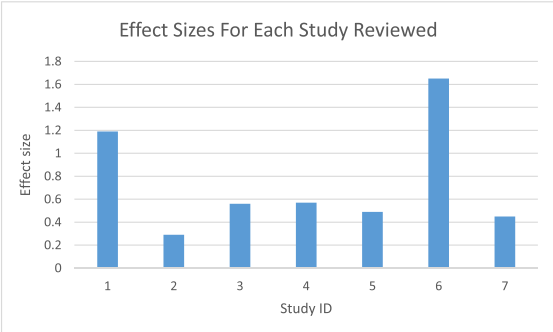

Figure 1 Effect sizes calculated for each of the studies used in the meta-analysis. The following is a key to which study goes with each effect size calculated: number – author and date of study (1 – Jeyes, 2013; 2 – Esteves et al., 2009; 3 – Harris, 2002a, 2002b, 2002c [combined]; 4 – Butler and Clarke, 2003; 5 – Lawrence and Davies, 2003; 6 – Jeyes, 2004; 7 – Treharne, 2004)

Another important finding from the present research looking at ES involved the specific measures used. As identified earlier, the large ES seen in the study by Jeyes (2013) involved pre-treatment and post-treatment measures of auditory processing abilities using the SCAN-C. When looking at the measures used for each of the different studies, the largest ES was seen for measures involving assessment of auditory processing skills such as that identified via administration of the SCAN-C and the Test for Auditory Processing Disorders in Adults and Adolescents (SCAN-A). For example, Jeyes (2013) used the SCAN-C and yielded an ES of 1.19. Studies by Harris (2002a, 2002b, 2002c) and by Butler and Clarke (2003) also used the SCAN-C with children, yielding ES values of 0.82 and 0.72, respectively. The study by Lawrence and Davies (2003) used SCAN-C and SCAN-A for children 9–14 years of age and was found to have an ES of 0.49. Thus, the studies that used auditory processing measures based on the SCAN revealed the higher ES values of all studies investigated. Furthermore, all of these ES values reveal clinically significant improvements in auditory processing abilities after TLP intervention, and many occupational therapists provide services for children with auditory sensory processing problems.

This finding supports a conclusion that one would expect to see large improvements in auditory processing areas for children who complete TLP. This is not felt to be surprising in view of the fact that TLP intervention is auditory based, having the children listen to specially recorded music and sounds. However, the

Table II. ES measures by categories measured

Category	Measures used researchers	Areas assessed by the measures	Mean ES, equality and number of measures
Evaluation of auditory processes	SCAN-C and SCAN-A, GFW Test of Auditory Selective Attention	Auditory processing, listening attention, auditory distractibility	0.72[a], homogeneous and $n = 19$
Measures of language and educational functioning	Pragmatic language checklist, ROWPVT, EOWPVT, OWLS, TARPS, LAC, quest, NFER sequential memory tests	Pragmatic/social language, vocabulary, general language, language reasoning, sound–symbol association related to phonics and phonemic awareness, early reading skills, English and math knowledge, auditory–verbal memory	0.41[b], heterogeneous and $n = 28$
Visual, sensory, motor and kinesthetic functions	BOT, Beery VMI, Sensory Profile, QNST	Fine and gross motor skills, visual perception, visual motor skills, sensory processing, sensory motor integration, integration of primitive reflexes	0.31[c], homogeneous and $n = 14$

[a]Large.
[b]Medium.
[c]Small.
ES = effect size; SCAN-C and SCAN-A = Test for Auditory Processing Disorders in Children (C) and in Adults and Adolescents (A); GFW = Goldman–Fristoe–Woodcock; NFER = National Foundation for Educational Research; OWLS = Oral and Written Language Scales; ROWPVT and EOWPVT = Receptive (R) and Expressive (E) One-Word Picture Vocabulary Test; TARPS = Test of Auditory Reasoning and Processing Skills; QNST = Quick Neurological Screening Test; BOT = Bruninks–Oseretsky Test of Motor Proficiency; LAC = Lindamood Auditory Conceptualization Test.

Table III. ES for subcategorization of language, motor and academic skills

Area	Number of measures used	Mean ES	Homogeneity
Receptive language	9	0.28[c]	Heterogeneous
Expressive language	5	0.29[c]	Homogeneous
Motor skills	8	0.43[b]	Heterogeneous
Academic skills	2	1.00[a]	Homogeneous

[a]Large.
[b]Medium.
[c]Small.
ES = effect size.

research reviewed only looked at changes on the specific measures of the SCAN and did not look at the specific profile of APD identified for each subject. Thus, future research needs to look more specifically at the various types of auditory processing problems one might identify during formal APD testing to determine who might be the most appropriate candidates for TLP intervention, especially auditory sensory factors such as auditory hypersensitivity, a problem seen in many children served by occupational therapists.

Auditory hypersensitivity was investigated by Esteves et al. (2009). These researchers present results of the Sensory Profile. Results from their study indicated a large ES, revealing a reduction in auditory hypersensitivity based on observations of the persons completing the Sensory Profile. However, the Sensory Profile is subjective in nature so that future research should look at more objective measures of auditory hypersensitivity such as the procedure identified by Lucker (2013).

The purpose of the present study was to investigate previous research, identify changes in performance after TLP intervention based on ES measures and present ideas for future research. The present investigation is felt to support a conclusion that occupational therapists, educators and other professionals could expect to see improvements in auditory skills (i.e. auditory sensitivity and auditory processing) and some academic areas after TLP intervention, but the specifics of these improvements are still unclear so that further research is needed. The outcomes of the ES calculations and comparisons support a conclusion that improvements in these areas of listening and learning can be noted after TLP intervention. What is needed is additional, carefully developed, controlled studies using double-blind research methods and control groups. Quasi-experimental research is clinically and educationally useful and appropriate, but greater control of variables is needed. Additionally, more quantitative research is needed along with continued qualitative analyses.

The present investigation identified numerous needs for future researches. The following are some suggestions:

(1) In conducting the research, plan to limit the age range of subjects. Clearly indicate specific factors related to subjects, not merely their diagnoses.

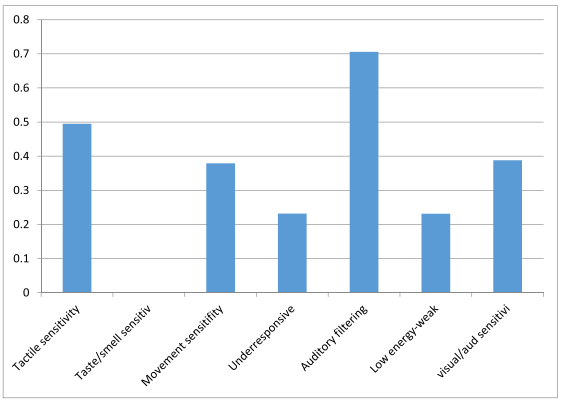

Figure 2 Effect sizes for sensory processing

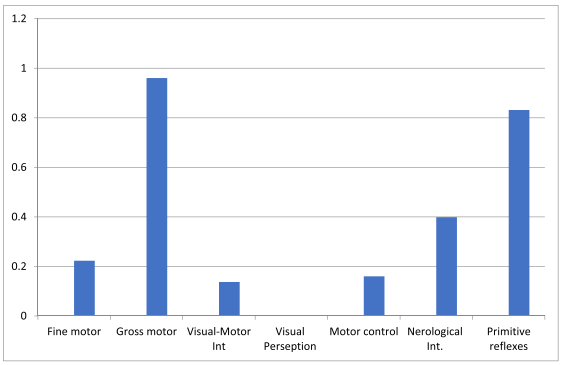

Figure 3 Effect sizes of motor, visual and neurological abilities

For example, identify if they were found to have APD, sensory processing disorders, attention deficits and so on. If possible, choose participant groups with similar problems or diagnoses. If the group consists of more than one diagnostic or problem factor, record and score the test result separately for each of these factors, making them subgroups, and compare the results for the group as a whole and for each individual subgroup. Subjects for these future studies should be carefully chosen, and comparisons between different subject variables should be made including age groups, diagnosis and problem areas and genders.

(2) Identify the purpose and specific application method of TLP intervention. Also, indicate the therapy history of the individuals in the participant groups.

(3) In order to verify the findings from the present study, replicate this investigation using different outcome measures that look at the same factors. For example, the high ES for the outcomes measured by the SCAN test may be further verified by using other measures of auditory processing that look at the same factors measured on the SCAN.

(4) Examine different outcome measures involving auditory processing skills, sensory processing and motor skills, academic skills and other factors such as emotional regulation and reactivity and cognitive abilities. Focus on identifying what areas change and what changes are made after TLP intervention.

(5) Compare the effect of TLP intervention with a placebo. For example, use music that is not modified as is performed for TLP listening and use both programmes for the same duration. This comparison may include examination of auditory processing and other auditory-related functions.

(6) Look at the effects of TLP intervention on non-auditory-related areas such as other sensory processes, motor skills and academic skills.

(7) Related to TLP intervention, review of the studies used in the present investigation indicated that the authors did not always use the same protocol for TLP intervention, especially length of time. TLP is not always completed in exactly the same format by clinicians, so that length of time for TLP intervention, scheduling for intervention and the specific TLP material used should be considered as other variables to be investigated in future research. Additionally, comparisons between TLP intervention and other therapy programmes should be made as well as looking at combinations between TLP intervention and other intervention activities.

Limitations

Every study has its limitations, and the present one is no exception. However, it is felt that the limitations present are not significant when considering that this study was one of the first quantitative analytic research studies to investigate the efficacy of TLP intervention on children. There were a small number of studies used in the present investigation. Furthermore, all studies were obtained from the website of the manufacturer of TLP and could, thus, present with biases in favour of the intervention. Thus, future research should look at studies accepted after peer review by professionals not directly affiliated with ABT. Additionally, only four of the nine studies used in the present analysis were identified as having some degree of peer review before being published or presented, and none of the studies were identified as having undergone some level of institutional review although a few of these were completed by professionals affiliated with institutions where review boards may be required to complete research. In the end, what is felt to be most important in the present review is that it is a first step in looking at the efficacy of a listening therapy (TLP) that is used by many occupational therapists.

Another limitation was that all studies investigated were exploratory in nature, presenting only descriptive statistics so that there were no experimental studies found nor were there published studies identified that used quantitative analyses of their data. Therefore, the present study may be one of the first to look at the efficacy of TLP intervention employing a quantitative analysis approach by employing ES measures. This meta-analytic approach provided a quantitative analysis of TLP intervention, which needs to be expanded in future research.

The present analysis summarizes available published research and provides guidance for occupational therapists and other clinicians using TLP intervention as well as future researchers. The authors, once again, caution the reader regarding interpreting the findings presented because the studies used in this meta-analysis are limited and few. However, it is felt that this is a first step in increasing our understanding of the effects of TLP intervention on children, and the authors hope it will open areas for future research, which can provide stronger evidences of these effects.

Conflict of interest

Dr Jay R. Lucker is a member of the Scientific Advisory Board of ABT, the producers and distributors of TLP. This research was not supported by ABT, and neither Dr Lucker nor Dr Vargas obtains any financial benefits from completing this research.

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