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Evaluation of The Listening Program in Assessing Auditory Processing and Speech Skills in Children With Down Syndrome

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Abstract

It is well documented that children with Down syndrome have difficulty with auditory processing and language development. This pilot study was undertaken to trial tests and questionnaires for suitability for use with the children to determine if any benefit could be established from the use of The Listening Training Program as a prelude to a more formal study. Nine children between the ages of 5 and 12 years took part acting as their own controls. They used The Listening Program over a 10-week period, and this involved each child listening to acoustically modified music, through headphones, for two 15-min sessions, 5 days a week, over 10 weeks. A battery of tests, recommended by specialists in speech and language and human communication, were performed before and after intervention, and questionnaires were completed at the end by parents and teachers involved. Because the children are educated in a variety of settings, main stream, special school, and part time in both, the testing took place on a Saturday and the children were drawn from the Down Support Group, Nottingham. Where possible, the Program was implemented in school, but where this was not possible, it was undertaken in the home setting.

Keywords

Down syndrome, The Listening Program, speech, music

It is well documented that children with Down syndrome have difficulty with auditory processing and language development. Many research studies emphasize the high incidence of communication problems in individuals with Down syndrome. The following is a quote from "Enhancing Communication Skills of Children with Down Syndrome."[1]

> People who have Down syndrome have been found to display distinctive problems in language development and use which cannot be explained by intellectual impairment.[2–4] They are further behind in their language development than are mental-age-matched, normally developing children or other groups of intellectually impaired children. Besides the general language deficiency, the development of speech seems to be particularly delayed in children with Down syndrome.[5,6] Several researchers have reported deviant auditory processing in persons with Down syndrome.[7-9]

It is a presupposition of this study that children with Down syndrome have specific problems in language acquisition, and particularly in developing speech, and that deficient auditory processing is contributing to this problem. The need to investigate whether auditory training can improve communication skills in people with Down syndrome has been put forward by other academics.

The following is from an article in the *International Journal of Language and Communication Disorders*, entitled "Verbal Deficits in Down's Syndrome and Specific Language Impairment: A Comparison" by Laws and Bishop.[10] This study concludes that a

> similarity between language profiles in Down syndrome and Specific Language Impairment weakens any notion that language impairment in Down syndrome should be considered an inevitable consequence of learning disability ... In Specific Language Impairment (SLI), intervention has targeted auditory processing deficits... and researchers claim remarkable gains for children with SLI following the training. However, there remains the need for considerable research effort to determine which children can benefit from auditory training, which aspects of language can be improved, and what the precise mechanism is for any improvement. If it can be established that higher level auditory processing deficits contribute to language impairment in children with Down syndrome, there is the hope that auditory training might also benefit these children.

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This article was published in October 2004. Since then, no studies have been published regarding auditory processing training and the Down syndrome population.

According to a fact sheet about Down syndrome, "The life expectancy for people with Down syndrome has increased dramatically in recent decades from 25 in 1983 to 60 today."[11] They may well then, as adults, be living independent lives, and clarity of speech and communication will aid them in the wider world.

The authors looked at possible auditory training programs that might potentially benefit children with Down syndrome. It was decided to use The Listening Program. Gwyneth Jeyes had previously undertaken a study in a primary school with this program and had found evidence of improvement in auditory processing skills and other improvements.[12]

This pilot study was undertaken to trial tests and questionnaires for suitability for use with the children, to see if any benefit could be established from the use of The Listening Training Program, as a prelude to a more formal study. The tests were selected after discussion with speech and language professionals who had experience of working with children with Down syndrome. They were chosen to provide a baseline preintervention and comparative data to allow selection of test and control subjects.

Because the children are educated in a variety of settings, main stream, special school, and part time in both, the testing took place on a Saturday and the children were drawn from the Down Support Group, Nottingham, randomly as volunteers. Nine children between the ages of 5 and 12 years took part acting as their own controls. Where possible the program was implemented in school, but where this was not possible, it was undertaken by parents in the home setting.

The Listening Training Program, from Advanced Brain Technologies, was used with Sennheiser Headphones 555. The children listen to acoustically modified music, through headphones for two 15-min sessions, 5 days a week, over a 10-week period. The testing took place pre- and postintervention, mainly in the home of Caroline Newton.

The Listening Program's psychoacoustically modified music and patent-pending production techniques are designed to stimulate and exercise the different functions of the auditory processing system to enable the brain to better receive process, store, and use the auditory information they receive in their day to day lives, such as in speech. It was designed by a multidisciplinary team made up of musicians, psychologists, speech and language therapists, neurologists, and experts in sound recording, psychoacoustics, and neurosonics.

The method of The Listening Program builds on the work of ear, nose, and throat surgeon Alfred A. Tomatis (1920–2001). Dr Tomatis helped identify the relationship between different frequencies of sound and their effect on the functions of body and mind. In particular, he found lower frequency sounds associated with balance, rhythm, sense of direction, and laterality as well as muscle tone, coordination, and left and right discrimination. Mid- and higher frequency sounds he associated with memory, concentration, attention and speech, language, and vocal control. One of the functions affected by the higher frequency sounds was auditory cohesion.

For the music of The Listening Program, classical music from Mozart, Vivaldi, Corelli, Danzi, and Haydn is used because of its structure and frequency range. The music is played by the Arcangelos Chamber orchestra and is recorded in high definition, which allows the recoding of harmonic structure up to 192,000 Hz, although due to the limitations of CD recording, the CDs contain the frequency 20 Hz to 20,000 Hz, the full range of human hearing. High frequencies present in high-definition music significantly affect the brain activity of listeners.[13] The results showed increase in regional cerebral blood flow, increase in alpha-EEG in the occipital region, and from psychological evaluation, the music with high frequencies included was a more pleasant listening experience than without this input.

Psychoacoustic and neurosonic processes are used to enhance the musical structure. In the psychoacoustic processes, the key can be selected, orchestration, tempo, performance, varying of meter, and simplification of lines can be used. The neurosonic processes include filtration where the lower frequencies are gradually removed to allow attention to be focused on higher frequencies. Audio bursting is included where the volume intensity of certain sounds is increased in contrast to the sounds that are not audio burst. Audio bursting reflects the passive/relaxed and active/alert phases for hearing and listening. By switching back and forth between these phases, the listener's awareness of changes increases. It helps to attenuate loud sounds to protect the inner ear and to amplify soft sounds for improved auditory discrimination and vocal control. The audio bursting is variable with different timing patterns for auditory temporal processing, and there are sufficient pauses that allow for a periodic rest and improve attention by creating auditory anticipation. Spatial surround is part of the patent-pending music production by Advanced Brain Technologies. There is multi-channel sound allowing recording of individual instruments in different positions. The effect is to place the listener in the middle of the Arcangelos Chamber Ensemble, as a conductor is with an orchestra. The music surrounds from a 360-degree spatial sound field, which allows for better perception and more effective auditory stimulation.

In each 15-min session, the music is delivered in 3 tracks according to modular design of the program. The first track is full spectrum sound, which relaxes the listener and prepares them for the second track. Track 2 is the modified track with filtration and audio bursting to give more intense auditory training. The third track is full-spectrum sound to return the listener to the relaxed state and allow integration.

The 10 CDs are divided into 4 subcategories, including full spectrum with no filter and frequency range 0–20,000 Hz (2 CDs); sensory integration with low pass filter 0–750 Hz (2 CDs); speech and language with band pass filter 500/750–3000/4000 Hz range, (2 CDs); and high spectrum with high pass filter 3000/4000–20,000 Hz range (4 CDs). The divisions after full spectrum are in line with the Tomatis zones but overall cover the full range of frequencies. Each CD is listened to for a week before moving on the next.

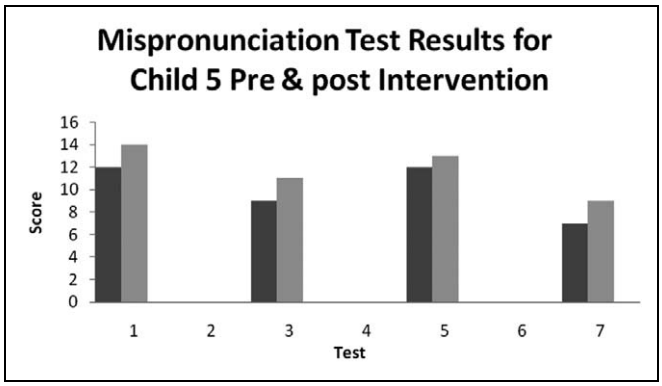

Figure 1. Mispronunciation test results for child 5, pre- and postintervention.

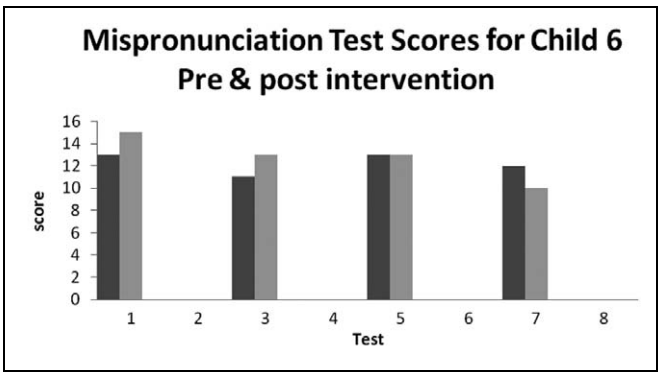

Figure 2. Mispronunciation test scores for child 6, pre- and postintervention.

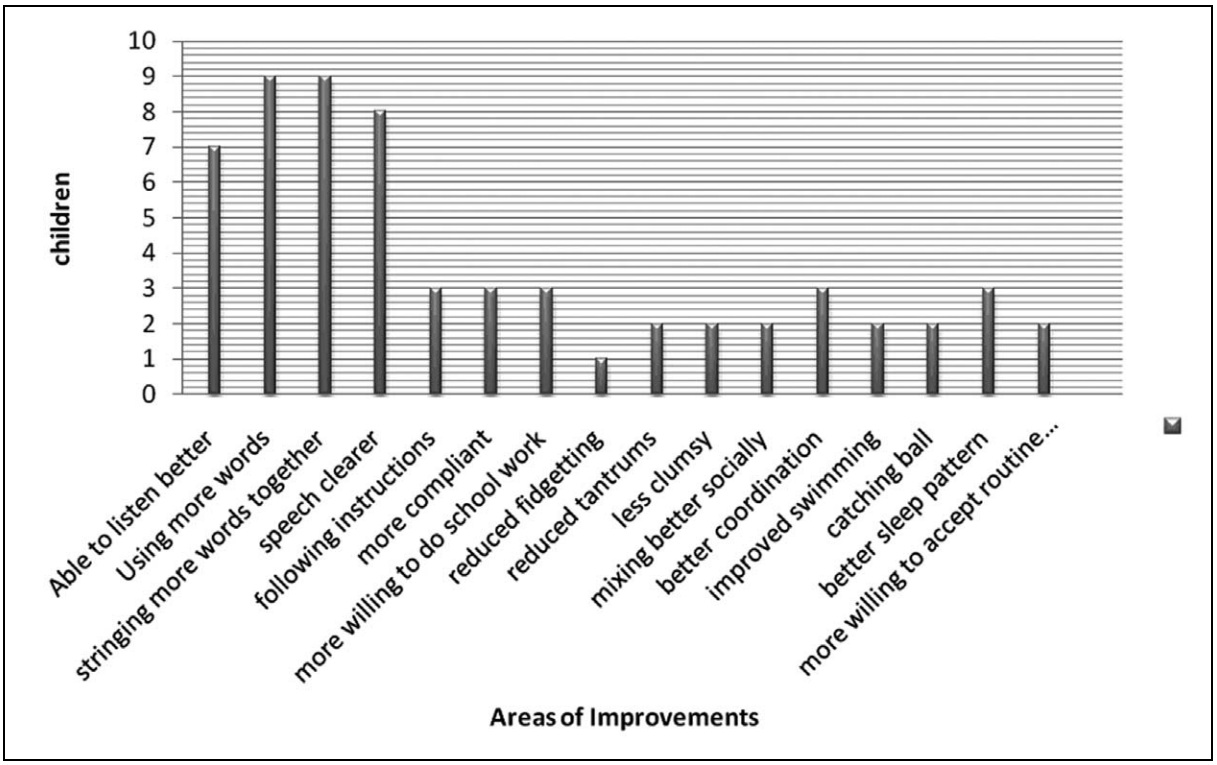

Figure 3. Areas of improvement noted by parents.

Exposure to the full range of frequencies gives opportunity to improve the tonotopic mapping such that the listener is able to recognize the individual frequencies more easily in speech and so improve auditory discrimination. Such improvements would be expected to be reflected by improved communication and speech.

The children were measured using a battery of tests, including The Mispronunciation Test by Maggie Vance et al,[14] which is a computer test, where the children have to identify whether words sound the same or different without background noise initially and, then with background noise. This is a test of auditory discrimination and the ability to block out extraneous noise. The actual tests are preceded by 30 practice examples. In The Rhythm Test from Dilys Treharne,[15] the children have to tap out a copy of a rhythm sequence heard on a CD. This is a test to assess their ability to recognize rhythm, which is an important constituent of speech. CELF Receptive & Expressive Language tests are 2 of the tests from *CELF, The Clinical Evaluation of Language Fundamentals*, used to find a baseline of the child's ability in these 2 areas.[16] The Naglieri Nonverbal Cognitive Ability Test[17] was used to get a measure of the intellectual ability of the children, the Renfrew Word Finding Test,[18] in which children give the word for the picture shown, was used to get a baseline for vocabulary, and the Digit Span Task[19] was considered a marker for memory. These tests were recommended by specialists

Table 1. Teacher Questionnaire

Over the last 10 weeks have you seen any change in ___ in the following areas (if necessary please write on the reverse of paper):

Behavior	Yes	No	Don't Know
If yes, please explain in what way behavior has changed			
Concentration/Attention Span	Yes	No	Don't Know
If yes, please outline how concentration/attention span has changed			
Communication	Yes	No	Don't Know
If yes, please detail how communication has improved (clarity, longer utterances, improved grammar, willingness to communicate, etc.)			
Reading Ability	Yes	No	Don't Know
If yes, please indicate how it has progressed			

Are there any other areas in which you have seen an improvement? If so please comment below and overleaf.

Table 2. Parent Questionnaire

Tick if you have found changes in any of the following areas or they have been remarked on by others. If an area has never been a problem put "N/A"

- Is more able to listen
- Is stringing words together more
- Speech is clearer
- Is more compliant
- Reduced fidgeting
- Less clumsy
- Better coordination
- Catching a ball
- More willing to try other foods
- Is using more words
- Is stringing words into sentences more often
- Is following instruction better
- More willing to do school work
- Reduced tantrums
- Mixing with other children more easily
- Improved swimming
- Better sleep pattern
- More willing to accept changes in routine

in speech and language and carried out before and after music intervention.

The Teacher Questionnaire in Table 1 had the following questions devised by us, in the absence of any suitable published examples, and was completed by teachers involved at the end of intervention.

A Parent Questionnaire (Table 2) was completed by parents after the child had completed The Listening Training Program. We designed it such that the parents were free to comment on a wide variety of areas but not pressured to comment on any particular area. Parents were also keen to give oral comment supporting their findings on the different areas.

Most of the standardized tests used were not found to be successful for use with these children. The questionnaires from teachers showed a positive improvement in clarity of speech and active listening, highlighting the discrimination of sounds in words particularly at the ends (auditory closure) and the use of a greater number of words and connectives. Parental questionnaires showed particular improvements in communication and attention skills. The Mispronunciation Test from Vance et al[14] was beyond the comprehension of many of the children, but those able to attempt it showed improvements in the ability to discriminate sounds in words and some were able to attempt the test after intervention, where previously this was not the case, which is of significance in itself as it indicates they are more able to understand the instructions to attempt the test at this point. Children 5 and 6 who were able to do the Mispronunciation test were both among the oldest of the group. This test might be useful in future work if the study involved older children (see Figures 1 and 2). For younger children, a shorter, simpler test is required.

Results

Parental Survey responses (out of 9)

See Figure 3. The following is a quote from a parent:

> Grandpa came last weekend. He last saw our daughter just as she was starting The Listening Program. He was overjoyed. This was the first time he had been able to understand what his granddaughter was saying to him.

In Conclusion

The children on the study have shown improvements from the use of the program in that they have clearer speech, more extensive vocabulary, and they are using a greater number of words which are more effectively sequenced. In the school setting, the child's improved auditory discrimination gives rise to a greater attention span, with resulting improved communication with their peers and the school staff. At home, parents and relatives are more able to understand their children, which reduces the frustration that can be felt by all parties.

Whereas some children made improvements in a great number of additional areas, which could be attributed to the ''Tomatis effect,'' this was not universal, unlike the speech and listening effects. The results mirror those found in research studies using The Listening Program with typically developing children. Our study highlighted the fact that more appropriate tests need to be developed for children with Down syndrome.

There were positive initial findings, but a further, larger, formal study would be recommended to confirm these findings. It would need to be funded and might be undertaken as the subject of university project or the subject of a large organization such as a Down syndrome research group or hearing research body because, if controls are considered valid, a large number of individuals would need to be screened to produce sufficient subjects to act as matched test and controls. It would be best to work in conjunction with schools so that the program could be implemented in school to reduce variability of input and, if that were the case, it may well be necessary to use the extended schedule, which involves only 15 min per day but over 20 weeks. The number of tests pre- and postintervention could be limited to those associated with speech and listening skills. Video evidence would be a useful addition.

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Bios

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