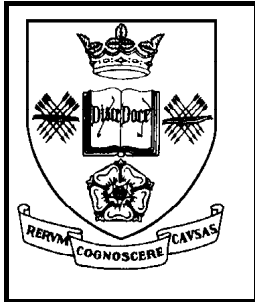


Research Study – The Listening Program®

University of Sheffield



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A Pilot Study to Investigate the Efficacy of The Listening Program® in the Management of Auditory and Verbal Information Processing Disorders.

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ABSTRACT

10 children between the ages of 8 and 16 years referred to a specialist clinic for auditory processing disorders participated in this study. All children showed some improvement in one or more of the areas studied. The greatest improvement was seen in the areas that were most severely affected. Improvement continued over a period of variable length after completion of the programme.

INTRODUCTION

Auditory processing disorder formerly referred to as central auditory processing disorder or CAPD is a hidden problem. It affects the processing of information received by the ear although the individual's performance on pure tone hearing tests and even speech audiometry may be normal. Keith 1986 (in Northern and Downs 2002) defined it as an impaired ability to attend to, discriminate, recognise, remember, or comprehend information presented auditorily even though the person has normal intelligence and hearing sensitivity.

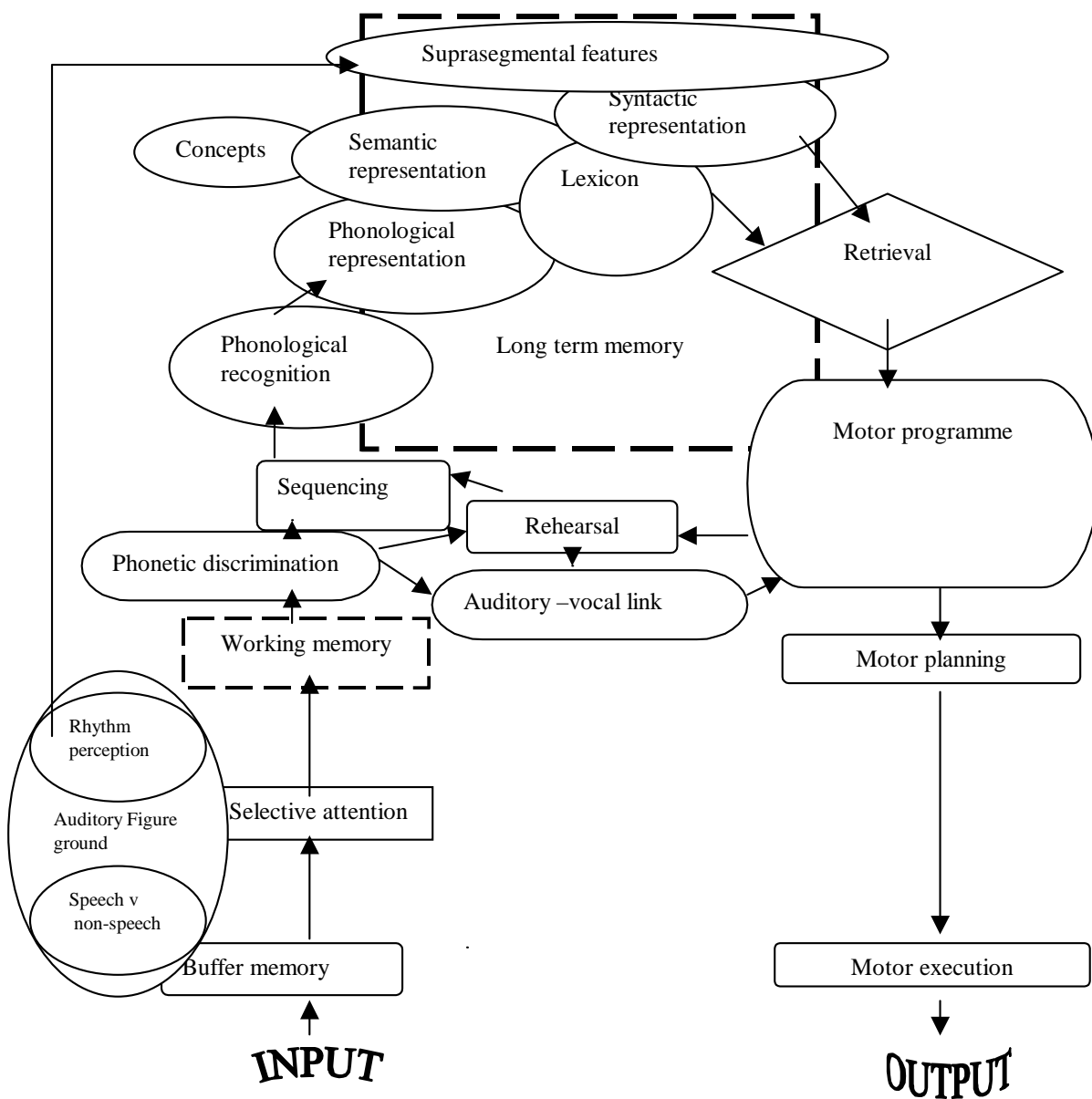
In many children there is a history of delayed language development although language for conversational purposes is often superficially satisfactory by the age of seven or eight. There may be problems with reading and spelling and processing complex sentences, or processing language at the normal speaking rate. Many are referred for testing for dyslexia but are found not to have the problem or to be borderline at risk. The child's performance in school is unsatisfactory and teachers often think that the child could do better. His attention wanders and he is easily distracted, some may be diagnosed with attention deficit disorder. IQ scores particularly performance IQ is within the normal range, some having above average scores, yet they still fail at school. The children themselves frequently complain of not being able to hear in the classroom or follow what the teacher is saying. The difficulty in sound processing may also show in non-verbal tasks such as music. Some have hypersensitivity to sound and become agitated or upset in busy places such as in a shop with loud music playing.

At home and school they may have difficulty in completing tasks, fail to organise themselves and their work, forget to do homework or to hand it in at the correct time and forget simple routines. The disorganisation may extend to poor coordination of body movements and integrating verbal tasks with motor activity. Some will withdraw to avoid drawing attention to their difficulties, others become disruptive. Most suffer from low self-esteem which may be severe.

Some of these problems are due to difficulty in processing sound and others due to an associated verbal information processing problem. There is no single list of features. Each child has a different constellation of difficulties and may have co-occurring problems such as language disorder, AD(H)D, dyslexia, learning disability, and developmental disability, autistic spectrum features. Other family members may also show some of the same or other features of auditory processing disorder or other attention or learning difficulties.

Assessment must be detailed and cover a wide range of tasks to obtain the pattern of difficulties experienced by each individual. The major processes involved in dealing with auditory information are detailed in fig 1. A model such as this cannot start to illustrate the complexity of processing which is a continuous multi-modal condition. However it shows at least part of the role of the elements tracked in the present study.

Fig 1: Model of language processing related to central auditory processing (Treharne)



The children in the study all had difficulty in one or more of the following areas, maintaining attention, hearing a speech signal in a noisy background, difficulty with auditory short term memory, recognising or copying non-speech sound patterns and recognising prosodic patterns (stress and number of syllables only) of words in a sentence. Some or all of these difficulties are found in most of the children assessed at the centre at which the study was conducted.

THE STUDY

The purpose of the pilot study was to identify areas of processing that may be enhanced by The Listening Program and to evaluate the effectiveness of the The Listening Program in the management of these areas.

Participants

Ten children referred to the Centre for investigation of their auditory processing.

| Subject number | Participants | Gender | Age at pre-programme assessment | Non – verbal IQ (Ravens Matrices) centiles average 50 |
|----------------|--------------|--------|---------------------------------|---|
| 1 | Mark | M | 16yrs | 95 |
| 2 | Diane | F | 15yrs 4m | 10 |
| 3 | David | M | 11yrs 10m | 30 |
| 4 | Angela | F | 11yrs 9m | 79 |
| 5 | Richard | M | 10yrs 11m | 35 |
| 6 | Sara | F | 10yrs 6m | 75 |
| 7 | Jack | M | 10yrs 4m | 35 |
| 8 | Rachel | F | 9yrs10m | 75 |
| 9 | John | M | 8yrs | 50 |
| 10 | Katie | F | 8yrs | 35 |

Table 1: Participants in the pilot study (names have been changed to protect identity)

Assessments and Procedure

A. Preliminary assessments

A pure tone audiogram indicating normal hearing thresholds was obtained for each child before he or she attended for auditory processing assessment.

Each child was screened for auditory processing difficulties using the SCAN-C revised (Keith 2000) or an equivalent non-standardised adult test. Children were accepted onto the study if they were in the low borderline or disordered categories on one or more of the subtests. Ravens Matrices was also administered at this point.

In addition the following tests were given on two occasions before the intervention programme. The first assessment was followed two months later by a second assessment using the same tests to measure the test –re-test effect and the rate of maturation or change without intervention. Children were accepted into the study if there was no change between the first and the second assessments.

B. Repeated Assessments

Goldman Fristoe Woodcock, Auditory Skills Battery, Selective Attention subtest, (Woodcock 1974). This is a more detailed test of listening in background noise than the subtest within SCAN – C. The background noise gradually increases throughout the test until it reaches a level beyond that of the target noise. This reflects more accurately the real situation in many classrooms where the children are working in groups and ambient noise levels can reach 70+dB (Dockrell and Shields 2002). The background noises used are a fan, cafeteria babble and a voice reading a story. TAPS – R digit span forwards and reversed, (Gardener 1996). These tests of sequential memory are said to be related to working memory. Good working memory is required

in order to process language. In reverse digit span a child is expected to hold the sequence in his working memory and carry out a transposition of elements before speaking.

TRaCoL – 1 a test of temporal pattern perception and recognition and prosody of language. (Treharne1999). This test is only standardised up to 9yrs at present, a revision being underway. A child’s performance on the temporal pattern (rhythm) recognition is highly correlated with language comprehension. The test allows one to compare verbal pattern recognition with non-verbal pattern perception and so allows exploration of pattern perception without the interference of verbal knowledge. There are three sections to test a. non-verbal pattern perception, b. the ability to hold a non-verbal pattern in the memory and compare it to another and c. the ability to recognise word rhythms which may facilitate fast-track processing of language (Fig 1.).

Each participant then followed The Listening Program Base Schedule exactly following the instructions provided in the manual. Parents and children were asked to keep a record of listening, behaviour patterns and feelings.

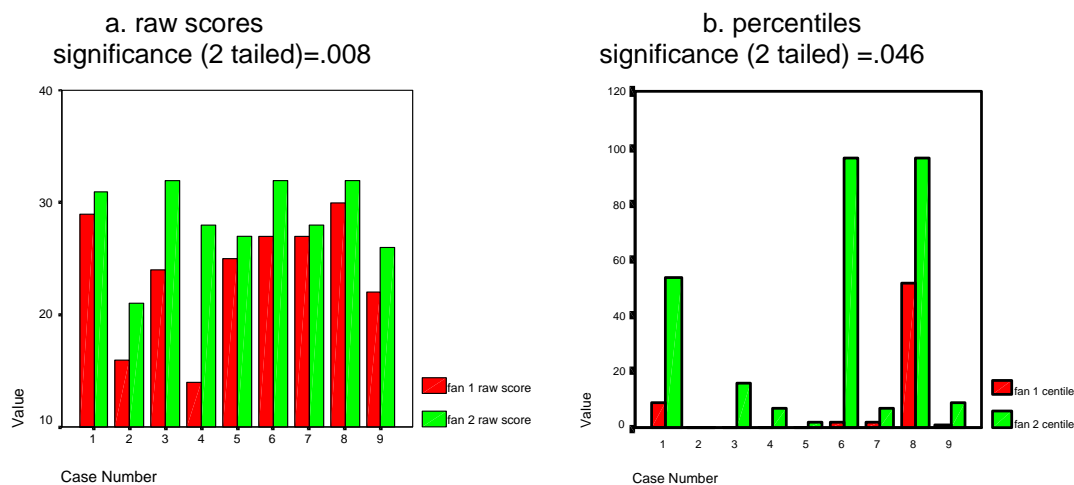
The children were re-assessed immediately on completion of the Program and again two months later. In each case only the set B. repeated assessments were used.

RESULTS AND DISCUSSION

Children differed in their rate of response. Participant 7 showed very little change in his scores immediately after the completing The Listening Program. He did show appreciable change two months later. Others cases 1, 3 and 5 showed some change immediately and further improvement without intervention two months later. It seemed that some children took longer to show change in function than others. For this reason the results from the pre-program assessment are compared with the results of the two months post program assessment.

GFW selective attention tests (auditory figure –ground)

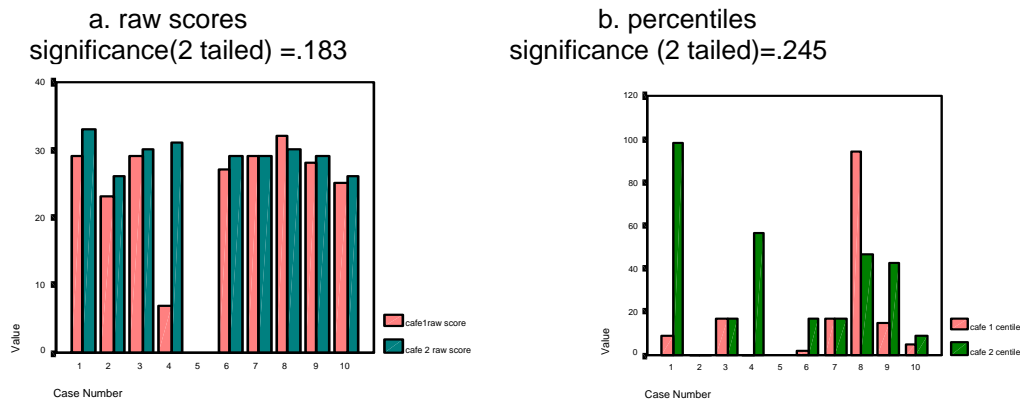
Fig 2: Graphs comparing a. raw scores b. centiles on GFW selective attention (fan background) before (1) and after (2) The Listening Program



Raw scores (graph a) and percentiles (graph b) before (red bars) and after (green bars) are shown. Some children performed so poorly prior to receiving sound therapy that they did not register on the percentile chart. All children improved their scores following The Listening Program (TLP) the majority increasing their percentile rank by an appreciable amount. Subject 2 (Diane) still did not register a percentile rank after TLP as she was still below the first centile. She was one of the oldest subjects in the cohort and had one of lower scores. However graph a. shows that her raw score increased by an appreciable amount, so in terms of her ability to tolerate background noise there was an improvement, even if this was still considerably below that of her

peers. Diane was also the least able student in the cohort but did carry out the program meticulously as she was hoping to continue to college and wished to demonstrate an improvement in her scholastic ability.

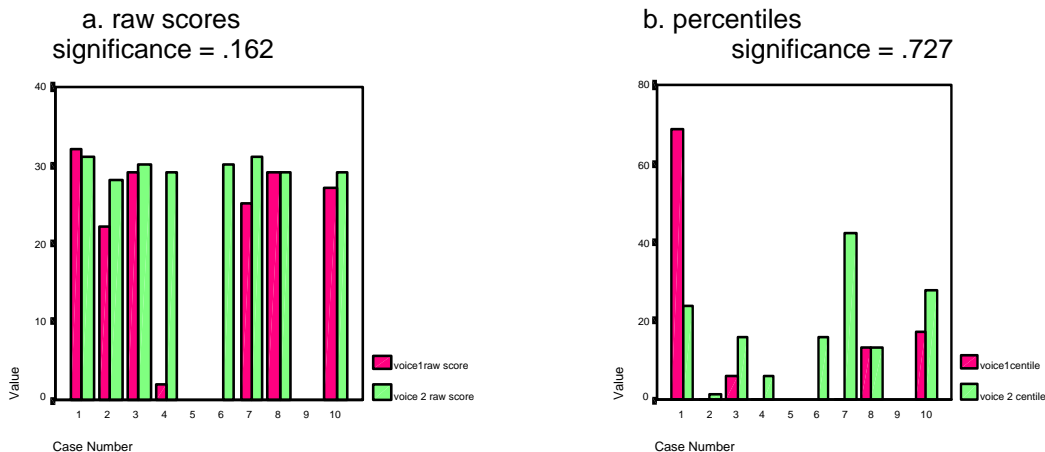
Fig 3: Graphs to show change in raw scores (a) and percentiles (b) of GFW selective attention cafeteria subtest following The Listening Program



The majority of children showed an improvement in their tolerance of cafeteria noise after The Listening Program. Generally the improvement was relatively small, an increase of one or two items in raw score terms but this meant a marked improvement in percentile levels for subjects 1 and 9, but no change for subject 3. Subject 4 showed a marked improvement in her raw score and increased her percentile ranking from below the 1st to the 57th. Diane, subject 2, made a small improvement of 3 raw score points but still did not reach the 1st centile for her age. Rachel, subject 8, has suspected ADD with autistic tendencies. For most of the testing her attention was good in the one to one situation. The deterioration in her performance at the post TLP assessment may well have been an attention problem. On subsequent testing she did in fact show an improved performance but that is not the subject of this pilot study. The limited significance in the improvement rate of this cohort is largely but not entirely due to Rachel. If she is excluded from the calculations the change in raw score has a significance of .155 and the significance of the centile change = .076. Child 5, Richard, did not participate in this subtest.

The third subtest of the GFW selective attention (auditory figure-ground) test is a competing voice reading a story. Many children with normal auditory processing skills have problems with this subtest. Interestingly it did not cause as great a problem for many of the children attending the clinic. This may be because their language processing speed is poor and they cannot process the story fast enough to follow it. If they can recognise the difference between continuous speech rhythm and single word rhythm they may be able to differentiate between the two auditory streams. This group of tests is long and those children (5 and 9), who tired easily or who were beginning to show anxiety symptoms did not participate in this subtest.

Fig 4: Graphs to show scores on GFW selective attention voice subtest before and after The Listening Program.



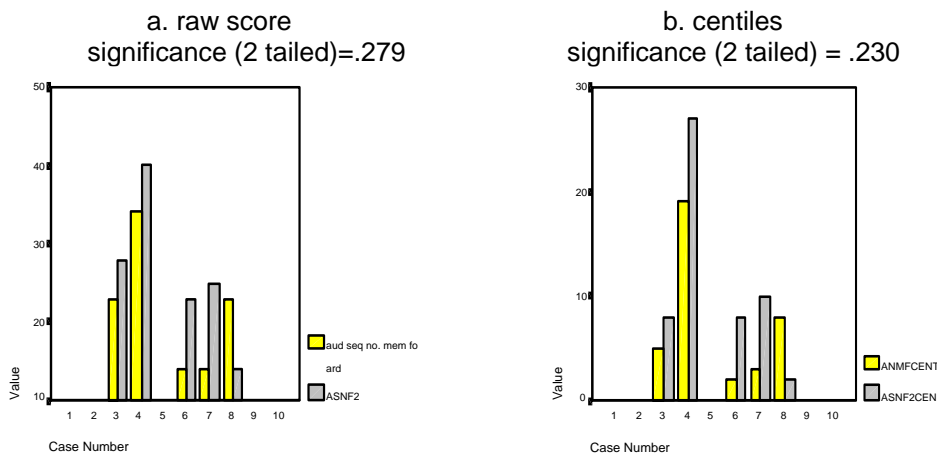
Subject 1, Mark, scored one less at the post test period. At this level and age one point can dramatically change the percentile level.

There appears to be less change in these scores, compared with the other subtests, over the 16 week period (8 weeks of TLP and 8 weeks post TLP). It is possible that it takes a longer period of adjustment or repeated procedures (TLP) to establish change at this task. In the case of Mark the one point drop could have been a momentary lapse in attention or an indication of the type of interference that occurs in normally processing children who find the story more interesting (at least the first time they hear it) than the stimulus words. It is possible that the level of tolerance that Mark has reached is the critical border between deficient and normal processing for him.

Auditory Sequential Memory

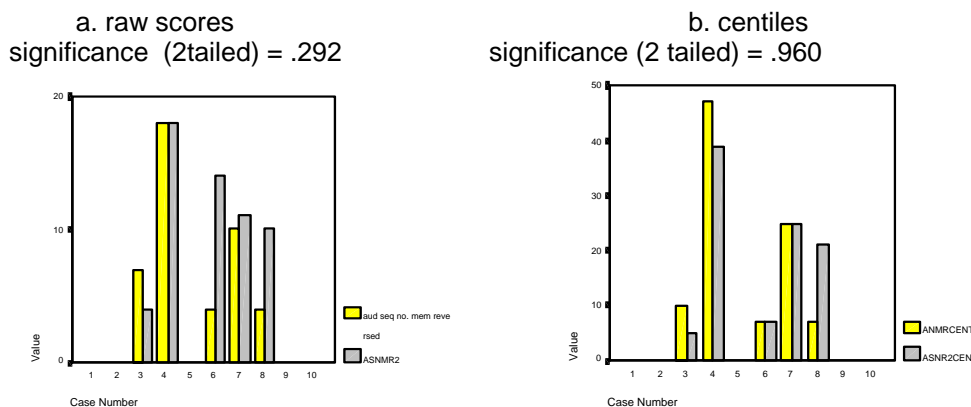
Another area of difficulty for children with auditory processing problems is a short auditory sequential memory. In this cohort five children had problems in this area.

Fig 5: Graph showing auditory sequential number memory forward scores before (yellow) and after (grey) TLP



Subject 8, has suspected ADD and can have brief fluctuations in attention. All the other participants with sequential memory problems showed substantial improvement in their scores.

Fig 6: Graph showing auditory sequential reversed number memory scores before (yellow) and after(grey) TLP



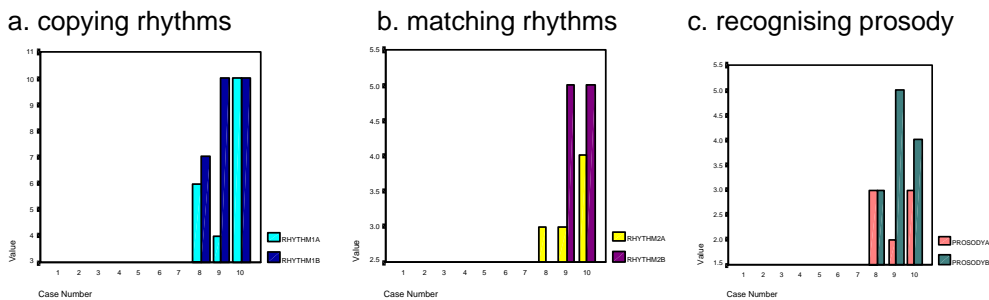
Subject 8, Rachel, showed an improvement in her reverse digit span scores. Possibly because this task is harder she was more focussed. Subject 3, David had an unexpected deterioration in his score at the post TLP assessment. This could be the result of fluctuating attention or tiredness. Subject 4 maintained the same raw score for reverse recall of digits but had moved into the next age bracket for calculating percentiles. The remaining subjects 6,7 and 8 all improved their raw scores and maintained or improved their percentile rank.

TraCoL 1

Only a small number of children completed this test as it is only standardised up to 9 years and even many 9 year olds reached ceiling level. For various reasons some children only completed a pre or a post TLP test. Three children completed both a before and after TLP test. Due to the low numbers involved no statistical evaluation has been attempted. The graphical representations are

provided to allow the reader to judge the degree of change. The clinical pattern of improvement post TLP suggests that the revised version of TraCoL should be included in the full study.

Fig 7 Graphs showing the scores on the three subtests of TraCoL before and after The Listening Program



Attention is a major factor in any study of this type involving children who are known to have possible attention maintenance difficulties. The fluctuations of one point in raw scores can confound results when measuring change over such a relatively short period of time. However given the pre-test consistency and the repeated improvement across the subjects, attention fluctuations are probably a minor confound.

Attention was not evaluated in the present study but all parents commented on a perceived improvement in attention maintenance early in the programme. In the main study this area will be formally assessed. The effect of fluctuating attention may be reduced by increasing the number of items in a test or by testing on two occasions and using the mean. However this would extend the test period by a significant amount.

There was no correlation between amount of change in the ability to cope with background noise and intelligence or age. There was a significant correlation between degree of impairment as indicated by the GFW selective attention fan subtest raw score obtained pre-TLP and amount of improvement on auditory figure ground tasks in general recorded after TLP sig =.001 (2 tailed). This interesting finding must be viewed with caution because of the small numbers involved in this pilot study. It does suggest however that the greater the impairment the greater the change.

Although not strictly part of the pilot study the children were monitored for several months after the study. Progress continued even in the absence of further intervention.

| | Pre TLP | 2 mths post TLP | 3 mths post TLP | 7 mths post TLP | 12 mths post TLP | 14 mths post TLP |
|-------|---------|-----------------|-----------------|-----------------|------------------|------------------|
| Quiet | 11 | 11 | 11 | 11 | 11 | 10 |
| Fan | 14 | 22 | 28 | 29 | 30 | 26 |
| Cafe | 7 | 28 | 31 | 27 | NT | 27 |
| Voice | 2 | 28 | 29 | 30 | NT | 31 |

Table 2: Raw scores for Angela on the GFW selective attention test

In some the greatest progress was within 2-9 months of completion of TLP others made steady progress over a period of a year and then began to plateau and drop slightly at which point a further course of TLP reversed the decline. The rate of change was not even across all subtests. Some processes took longer to show change but also sustained that more gradual progress over a longer period of time. Children who were failing on other intervention programmes such as Earobics (Cognitive Concepts) were able to achieve success after TLP.

It is therefore important to follow users of TLP through for a number of months to determine the effectiveness of the programme. It is also important to look at the individual's profile to evaluate total effect. A child who has difficulty over a broad spectrum of processes may show a different rate of progress compared to a person with fewer difficulties.

| | GFW fan | GFW cafe | GFW voice | Digit span forwards | Digit span reverse | |
|----|---------|----------|-----------|---------------------|--------------------|----|
| 34 | | | | | | 34 |
| 32 | 32 | | | | | 32 |
| 30 | | | | | | 30 |
| 28 | | 29 | | | | 28 |
| 26 | 27 | 27 | | | | 26 |
| 24 | | | | | | 24 |
| 22 | | | | 23 | | 22 |
| 20 | | | | | | 20 |
| 18 | | | | | | 18 |
| 16 | | | | | | 16 |
| 14 | | | | 14 | 14 | 14 |
| 12 | | | | | | 12 |
| 10 | | | | | | 10 |
| 8 | | | | | | 8 |
| 6 | | | | | | 6 |
| 4 | | | | | 4 | 4 |
| 2 | | | | | | 2 |

Fig 8: Progress chart for Sara

Pre-TLP Post TLP

| | GFW fan | GFW cafe | GFW voice | Digit span forwards | Digit span reverse | |
|----|---------|----------|-----------|---------------------|--------------------|----|
| 40 | | | | 40 | | 40 |
| 38 | | | | | | 38 |
| 36 | | | | | | 36 |
| 34 | | | | 34 | | 34 |
| 32 | | | | | | 32 |
| 30 | | 31 | | | | 30 |
| 28 | 28 | | 29 | | | 28 |
| 26 | | | | | | 26 |
| 24 | | | | | | 24 |
| 22 | | | | | | 22 |
| 20 | | | | | | 20 |
| 18 | | | | | 1818 | 18 |
| 16 | | | | | | 16 |
| 14 | 14 | | | | | 14 |
| 12 | | | | | | 12 |
| 10 | | | | | | 10 |
| 8 | | | | | | 8 |
| 6 | | 7 | | | | 6 |
| 4 | | | | | | 4 |
| 2 | | | 2 | | | 2 |

Fig 8: Progress chart for Angela

Pre-TLP Post TLP

CONCLUSION

The participants in this study showed an improvement in their ability to distinguish speech against a variety of background noises following a basic course of The Listening Program. Greater improvement was shown against a constant steady-state broad spectrum “pink” noise (fan) significant at .010 level than with the intermittent distraction provided by compressed cafeteria noise and verbal distraction. It is suggested that the latter two conditions may take longer to master.

Four of the five children with auditory sequential memory difficulties improved their retention of a series of digits and in reverse recall of digits. This test was particularly subject to fluctuations in attention.

The three children with problems in temporal pattern perception and prosody recognition showed progress in these areas.

In all processes progress was most evident several weeks after completion of The Listening Program and continued for variable amounts of time afterwards. Therefore progress should be monitored for several months.

The changes in listening and sound awareness released mechanisms that allowed participants to successfully complete additional programmes to develop phonemic discrimination and phonological awareness, which they had failed to do before completing The Listening Program.

This study has indicated a number of additional areas to be monitored in a full scale study of the efficacy of The Listening Program in the management of difficulties with auditory processing.

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End of Research Study

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