METHOD
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Objectives of the study

The objectives of the present study were:

1) To develop a computer based therapy module in Kannada for children with auditory processing disorders in the processes of auditory separation and auditory integration.

2) To examine the efficacy of the newly developed therapy module in treating children with auditory processing disorders.

Subjects

A total of 34 subjects with auditory processing disorder participated in the study. The diagnosis was based on the results of series of tests to identify central auditory processing disorder (CAPD). Based on the type of auditory process impaired, the subjects were classified into three groups: Group 1 consisted of 9 subjects with difficulty in auditory separation task: Group 2 comprised of 11 subjects with difficulty in auditory integration task and the remaining 14 subjects who exhibited difficulty in both auditory separation and auditory integration tasks formed the third group. The subjects from these three groups were randomly selected and subclassified into experimental and control group. The experimental subjects from the respective groups received therapy using the newly developed computerized training module in the specified tasks, whereas the control group subjects were not given any therapy.
Table M 1: Shows the distribution of subjects among the Experimental and Control group.

<table>
<thead>
<tr>
<th>Auditory Processing tasks</th>
<th>Experimental group</th>
<th>Control Group</th>
<th>Total number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory separation</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Auditory integration</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Auditory separation and auditory integration</td>
<td>7</td>
<td>7</td>
<td>14</td>
</tr>
</tbody>
</table>

Test Material Used for Identification of Children with Central Auditory Processing Disorder:

- The Auditory Processing Screening Checklist- Teachers/Parents (Rajalakshmi & Gopi Sankar, 2003).
- The CD version of Dichotic Digit Test (DDT) developed in Audio lab version –II (Regishia, 2003).
- The CD version of Pitch Pattern Test (PPT) developed in Audio lab version –II (Shivani, 2003).
- The CD version of Competing Sentence Test (CST) developed in Audio lab version –II (Ravan & Rajalakshmi, 2004).
Therapy Materials Used for Facilitating Auditory Integration and Auditory Separation Tasks:

*Materials for Auditory Integration:*

Auditory integration module included two different activities- auditory closure and Dichotic offset training activities. The activities for auditory closure were: missing word exercises at the sentence and phrase level, missing syllable and missing phoneme exercises at the word level. The materials were organized at varying levels of difficulty.

For Dichotic Offset training activities, dichotic material with words, phrases and sentences were developed. The lag was varied starting with gross offset lags, where the stimuli were presented one after the other with a sufficient time gap in between two stimulus presentations. The hierarchy of items was prepared ranging from easy to the more difficult activities.

*Material for Auditory Separation:*

This involved preparing speech material in the presence of different types of noise at different levels. Material such as words, phrases, sentences were used. The material was presented at different signal-to-noise ratios with the different types of noise including white noise, speech noise, narrow band noise, traffic noise, cafeteria noise, classroom noise, kitchen noise, market place noise and noise from the chirping of birds. The S/N ratio varied from +20 dB to -10 dB. The material was prepared in increasing level of difficulty, such that the children were trained first with the easier task and then moved to the more difficult task. Initially phrases and sentences were
presented at a +20 dB S/N ratio. As the child became proficient at performing a task, the S/N ratio was decreased. A similar procedure was followed for words as well.

The therapy modules for auditory integration and auditory separation were initially recorded in the form of wave files into a computer and then using the Audio lab version –II they were converted to dichotic files and saved into separate wave files. The subjects receiving therapy were played the files through auditory mode using head phones for the first 25 sessions. Later it was presented through speakers. The subjects were given training for 45 minutes daily. Initial 20 minutes of therapy was utilized to train the child in the specific task while during the remaining time, the child played interactive games. This was done to make the child more attentive and it also acted as reinforcement for the child.

Environment

All the tests for the diagnosis of auditory processing disorders were carried out in a sound treated room of the Department of Audiology, AIISH, Mysore. The training was carried out in a distraction free environment.

Instrumentation:

- A calibrated two-channel audiometer with facility for CD/Tape input.
- A calibrated Immittance instrument.
- An audio CD player to present the various tests’ stimuli for identifying auditory processing disorder.
- Audio lab version–II for developing the Competing Sentence Test and for preparing the training modules.
- A personal computer to impart training.
Procedure

The procedure involved the following stages.

**Stage one:** Competing Sentence Test–revised in Kannada for children (Ravanam & Rajalakshmi, 2004) was developed and standardized.

**Stage two:** Screening was carried out to identify children at risk for auditory processing disorders. Three schools located in the city of Mysore were selected. A total of 440 children in the age range of 8 to 12 years were screened for any speech, language, hearing or ENT problems. 21 children were found to present speech, language or hearing problem. These children were not included in the study. Following this, the children were administered Auditory Processing Screening Checklist- parents/teachers (Rajalakshmi & Gopi Sankar, 2003). 98 children failed the screening checklist. These 98 children were later administered Ravines Colored Progressive Matrices (RCPM) Raven., Court, & Raven.,( 1977). Of which, eight children were found to possess below average intelligence and thus were not part of the present study. The remaining 90 subjects were carried to next stage of the study.

**Stage three:** A battery of diagnostic tests was administered on the 90 children who failed in the auditory processing checklist. The tests administered were Dichotic Digit Test (DDT), Pitch Pattern Test (PPT), and Competing Sentence Test (CST).

**A) Dichotic Digit test (DDT) in Kannada:** The CD version of Dichotic Digit Test (Kannada) developed in Audio lab version-II (Regishia, 2003) was used. Two pairs of digits in Kannada were presented dichotically, while the children repeated orally what they heard. A total of 30 presentations were given for each child. Initially, the children were given practice trails followed by the test material. The time interval
between two stimulus presentations was varied from 4 to 8 seconds. Both single and double correct scores were obtained.

B) Pitch Pattern Test (PPT): The CD version of the Pitch Pattern Test developed in Audio lab- version-II (Shivani, 2003) was used. It consists of thirty items per ear. There were three presentations per item. The subjects were instructed to report the tonal pattern heard in each ear. The responses were scored as each item correct.

C) Competing Sentence Test (CST) in Kannada: Based on the available Competing Sentence Tests (Jerger & Jerger, 1975), a Kannada version of CST for Children was developed and standardized for the purpose of this study. It consists of 30 target and 30 competing sentences. The sentences were presented binaurally such that the target sentence was routed to the test ear while the competing sentence fed to the non-test ear. The child should hear both the sentences and respond to the target sentence. Scores were obtained for the correct responses.

Following the tests administration, 34 children failed in either or all of the tests. These children were selected as subjects for the study. The scores obtained for the various tests were tabulated and formed the baseline assessment score of each child. The 34 subjects were grouped into three categories as children who had problem in auditory integration task, auditory separation task, and those who had difficulty in both the tasks. The subjects were then classified into experimental group and control group within these three categories.

Stage four involved development of master CD. The CD contained therapy material for the processes of auditory separation and auditory integration. The material consists of extensive range of vocabulary with pictures in the form of audio files. The
vocabulary was selected from the school text books appropriate to the age level of children.

**Stage five:** A pilot study was carried out on two learning disabled children aged 10 and 12 years respectively, to check the feasibility of newly developed computerized therapy material. The children performed below par on the Auditory Processing Screening Checklist (Rajalakshmi & Gopi Sankar, 2003) and the diagnostic tests of DDT, PPT, and CST. Computer based training was imparted to these children with the newly developed therapy modules in auditory separation and auditory integration tasks for thirty sessions, with each session lasting 45 minutes. Following therapy, for the children with APD, the scores of the experimental group (Learning Disability Children) were compared with the age and gender matched normal control group children who did not receive any training. The results showed a steady improvement in the test scores of experimental group children at pre and post therapy. The normal controls, however, did not show any change in scores after the same period. The pilot study was also helpful in making certain alterations that led to improvement of the training modules. An abstract of the article based on the pilot study has been accepted for presentation at the World Congress of Applied Linguistics to be held in Madison, USA from 25th to 27th July 2005 (Ravan & Rajalakshmi 2005).

**Stage six:** Children diagnosed as APD were divided into experimental group and control group based on random sampling. The experimental group children were given therapy with either or both of the newly developed material for thirty sessions of approximately 45 minutes duration each. The type of training module to be used depended on the auditory process that was found to be deficient in the baseline assessment. The therapy included interactive games as well. The items were
prepared in a hierarchical order such that the tasks were easier initially and gradually progressing to the more difficult items.

**Stage Seven:** Re-evaluation with the same test materials was done for all the subjects at the end of fifteen sessions, thirty sessions, and after two months of therapy to check any improvement in the test scores compared to the baseline measures. The re-evaluation was also needed to examine the consistency of performance or if any degradation in scores is present over a period of time during therapy. In addition, feedback was obtained from the school teachers, care takers and family members regarding progress of the child, any behavioral changes, or any other relevant changes. After the completion of therapy for thirty sessions, all the subjects were given a break of two months and re-evaluated again on the same tests to determine if there was any variation in scores. This provided information whether the subjects who attended therapy were able to sustain improvement or if any deterioration is noticed after the termination of therapy.

The results have been presented and discussed in detail in the next chapter.