Early Speech Perception Test Development for Malayalam Speaking Children with Hearing Impairment

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Abstract

The 'Early speech perception test for Malayalam speaking children with hearing impairment' was developed have two versions. The low verbal version was developed for children between the age of 2 to 3 years and the standard version for children aged 3; 1 to 5 years. The developed material was evaluated on a group of twenty Malayalam speaking children with hearing impairment, ten from each age group. The performances of the two age groups on the developed test are discussed.

Introduction

Early onset of hearing loss can impose substantial delays in communication and psychosocial development unless immediate and appropriate intervention is undertaken. Much of the impact of the sensorineural hearing loss has been noted to depend on the extent to which it affects speech perception (Boothroyd, 1988). It has also been found that those with a greater problem in speech perception are considered to have a greater communication problem than those with fewer problems in speech perception (Boothroyd, 1984).

The primary goal of management is to improve speech perception by using appropriate sensory devices and management strategies. Hence, it is very essential to assess the speech perception capabilities of a child, for the effective selection and planning of management strategies. It has been reported that pure-tones have poor predictive power of the speech perception abilities for children whose average threshold for 500, 1000, and 2000 Hz was in the range of 85 to 100 dB. Hence, it was recommended that audiologist should consider a child's word recognition ability as well as his pure-tone threshold in making further management options (Erber, 1974).

Efforts to develop speech materials suitable for the paediatric speech audiometry dates back to at least the 1940's. Haskins (1949) developed word material for speech audiometry in children, with limited number of test items representatives of the vocabulary of kindergarten children. Watson (1957) used the same principle of test construction to generate word and sentence for paediatric speech audiometric tests. Paediatric speech intelligibility testing was advanced by Siegenthaler (1975) by modifying the stimuli and response paradigms to confirm to the children's interests and abilities.

Later, many tests for the evaluation of speech intelligibility in children were developed (Ross and Lerman, 1970; Erber, 1974; Elliot and Katz, 1980; Moog and Geers,

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1990). Some of them have been developed for the Indian population (Abrol, 1970, cited in Nagaraja, 1990; Kapur, 1971, cited in Nagaraja, 1990; Swarnalatha, 1972, De, 1973, cited in Nagaraja,1990; Mayadevi, 1974; Mathew, 1996; Rout, 1996; Vandana, 1998; Prakash, 1999; Begum, 2000).

It is ideal to have speech identification tests in all languages as an individual's perception of speech is influenced by his/her first language or mother tongue (Singh, 1966; Singh and Black, 1966). It is essential that speech identification tests be available even for children with limited vocabulary. Such a speech perception test would be a tool used to determine the further line of rehabilitation for children with hearing impairment. The test score could help choose appropriate devices to be worn by the child. It can also be used to monitor the progress of children with hearing impairment who are provided auditory listening training.

Hence, the study aimed to develop a speech perception test for Malayalam speaking children with hearing impairment, having limited vocabulary. It aimed at developing two versions, one for children aged 2 to 3 years and another for children aged 3;1 to 5 years.

Method

The study was carried out in two phases. Phase I involved the development of the test material and checking the familiarity of the material on a group of typically developing children. Phase II dealt with the evaluation of the developed material on a group of children with hearing impairment.

Phase I

Development of test material

The test material was developed in lines similar to the 'Early speech perception test' (Moog & Geers, 1990). Appropriate adaptations were made regarding the stress patterns utilized and number of phonemes across the words, as present in Malayalam. The words for the test were selected from age appropriate books and caregivers of children aged 2 to 3 years and 3;1 to 5 years.

Participants for phase I of the study

Thirty normal hearing children were selected to check the familiarity of the test items. Fifteen of them were aged 2 to 3 years and fifteen were aged 3;1 to 5 years. Equal number of males and females were taken in both the groups. They were exposed to Malayalam from early childhood and spoke the language. None of then had any ear infection, speech and language impairment or any developmental delay. It was ensured that they did not have any illness at the time of testing.

Procedure to check familiarity

To ascertain that the word lists that were prepared was familiar to typically developing children in both the age groups (2 to 3 years & 3;1 to 5 years), they were evaluated. The testing was done in a distraction free, quiet room. Each child, who was seated facing the examiner, was tested one at a time.

Pictures representing the words were shown and each child was asked to name the item presented. A word was considered to be familiar only if 90% of the children named it correctly. From the words that were familiar a low level version (version I) and a standard version (version II) of the test were developed. Words familiar to children aged 2 to 3 years were used for version I and words familiar to children aged 3;1 to 5 years were used for version II. It was ensured that each test and subtest contained low, mid and high frequency speech stimuli. Pictures representing all the words in both of the versions were also developed. The test developed was titled 'Early Speech Perception Test in Malayalam'. The details of version I and version II are described below.

Version I (low verbal version): This version, developed for children between the ages of 2 to 3 years, had the following two tests with the second test having two subtests:

- Syllable categorization test having 2 test items
- Word identification test
  - Bisyllabic word identification subtest having 4 test items
  - Trisyllabic word identification subtest having 4 test items.

Details of the test items are given in appendix I

Version II (standard version): Version II, which was developed for older children, had two tests. The second test had two subtests. The two tests and subtests were as follows:

- Syllable categorization test having 12 test items
- Word identification test
  - Bisyllabic word identification subtest having 12 test items
  - Vowel identification subtest having 10 test items

The syllable categorization test contained four bisyllabic words, four trisyllabic words and four polysyllabic words. Further, the word identification test had two subtests. The bisyllabic word identification subtest had twelve words, represented the phonemes of Malayalam that are used by children in the target age. The vowel identification subtest had words with the vowel varying (Appendix II).

Phase II

Evaluation of the performance of children with hearing impairment, using the constructed material, was carried out in phase II. Each child was tested independently. The details of the instrumentation, environment and procedure are given below.

Instrumentation

A clinical audiometer (Orbiter 922) with option for speech audiometry was used. The output of the audiometer was routed to a loud speaker placed 1 meter away from where the child was seated, at 0^0 Azimuth.

Test environment

The testing was done either in a two-roomed sound treated set-up or in a in a quiet distraction-free room. The ambient noise levels in the sound-treated room were within the permissible limits prescribed by ANSI-S3.1-1991.

Participants for phase II of the study

Twenty children with hearing impairment, in the age range of 2 to 5 years were selected. They were divided into two groups, one group in the age range of 2 to 3 years and other in the age range of 3 to 5 years. It was ensured that the children had been exposed to Malayalam from early childhood and spoke the language. In addition, they had severe to profound hearing loss, aided audiogram within the speech spectrum at least up to 2 kHz, awareness of normal conversation with their prescribed hearing aids, no additional handicap like mental retardation or visual impairment and no illness at the time of testing.

Procedure for phase II of the study

While most the children were tested in a sound tested room, a few of them had to be tested in a non-sound treated room. The latter had to be done since some of the children refused to enter the sound treated room. All the children wore on their prescribed binaural hearing aids, which had been earlier checked to be functioning well.

Testing done in a sound treated room:

All 10 children from the older age group and 3 children from the younger age group were tested in the two room set-up. They were seated at a distance of one meter from the loud speakers which was placed at an angle of 0^0 Azimuth. The pictures representing the test item were placed before them on a table. The words were presented one by one at a presentation level of 50 dB HL. The level of the live speech was monitored using a VU meter.

Testing done in a quiet room situation:

Seven children in the younger age group were tested in a quiet, distraction free room, as they did not cooperate to be evaluated in the sound treated room. They were seated at a distance of 2 feet from the examiner and the test material was placed in front of each child on a table. The stimuli were presented one-by-one by the tester at a normal conversational level (60 dB SPL).

For testing in both situations, initially the caregiver was asked whether the child was familiar with the test items. If a child was not, he/she was given training using the test items until he/she could readily carryout the activity through an audio-visual mode of presentation.

The test items were presented once with audio-visual cues and twice with only auditory cues. The items were randomized during each presentation. It was ensured that the children were attentive prior to the presentation of each stimulus. The children were required to point out to the appropriate picturised item.

While administering the low verbal version, the syllable categorization test was carried out first, followed by the word identification subtest. Likewise, for the standard version also the syllable categorization was evaluated first, followed by the word identification tests. Bisyllables were tested initially followed by the vowel identification. The entire testing was carried out in 2 to 3 sessions. The duration of each session was 15 to 20 minutes depending on the attention span of a child.

Scoring

Responses were recorded on a scoring sheet for each child (Appendix III & Appendix IV). For the syllable categorization test, a score of '1' was given when the child identified any picture from a given category, and a score of '0' if it was identified from a different category. Similarly for the identification test a correct response was given a score of '1' and a wrong response a score of '0'. Descriptive statistics, paired sample 't' test and ANOVA were used to carry out the analyses.

Analyses

The data obtained from children on the 'Early speech perception test in Malayalam', using the developed low verbal version and standard version, were analyzed. The Statistical Package for Social Sciences version 10 for Windows was used to carry out the analyses on children aged 2 to 3 years and 3;1 to 5 years respectively. A comparison was also made between the performances of children on the two versions of the test. Descriptive statistics, paired sample 't' test and ANOVA were used to carry out the analyses.

Results

Results of the Low Verbal Version Test

Descriptive statistics were carried out on the responses of the younger age group on the low verbal version of the developed test. From Table 1 it is evident that mean score of the pattern perception test was higher than that of the word identification tests. Also, the standard deviation (SD) was highest for the pattern perception test. This indicates that variability in the scores obtained by the participants on the pattern perception test was greater than the bisyllabic and trisyllabic word identification subtests.

Table 1: Mean score and SD for the 'Pattern perception test' and 'Word identification test' for the low verbal version

Tests scores	Mean percentage scores	SD
Pattern perception test	85.00%	17.48
Bisyllabic word identification	73.75%	9.22
Trisyllabic word identification	77.50%	11.48
Combined word identification	75.62%	9.05

To compare the pattern perception test scores and word identification scores, paired 't' test was performed. The results revealed a significant difference between mean percentage score of the pattern perception tests and word identification test ($p < 0.05$).

Bisyllabic word identification scores and trisyllabic word identification scores were also compared using paired sample 't' test. The results brought to light that there was no significant difference between these two tests ($p > 0.05$).

Results of the Standard Version Test

The mean scores of the bisyllabic, trisyllabic and polysyllabic pattern perception test revealed that the polysyllabic pattern perception score was better than the trisyllabic and bisyllabic pattern perception scores. Further, the overall pattern perception test scores were higher than that obtained for both the word identification scores (Table 2). From the Table 2 it can also be noted that the SD was maximum for the bisyllabic word identification test. However, the variability was only marginally more than that obtained for pattern perception test. Though the variability was least for the vowel identification test, it also happened to have the lowest mean score.

Table 2: Mean scores and SD for the 'Pattern perception test' and 'Word identification test' for the standard version

Tests	Mean	SD
Bisyllabic pattern perception	63.75%	9.22
Trisyllabic pattern perception	73.75%	9.22
Polysyllabic pattern perception	86.25%	9.22
Total pattern perception test	74.58%	4.14
Bisyllabic word identification test	50.00%	9.82
Vowel identification test	44.00%	6.58
Total word identification test	47.27%	7.85

To determine the significance of difference between the overall pattern perception scores and overall word identification scores, paired 't' test was performed. A significant difference ($p < 0.01$) between the two was observed with the latter test obtaining significantly lower values.

A comparison of the bisyllabic, trisyllabic and polysyllabic words within the pattern perception tests was done using a repeated measure ANOVA, in which syllable duration was taken as the independent variable and the identification scores as the dependent variable. The results showed a significant effect of syllable duration on pattern perception scores [$F(2, 18) = 12.48$; $p < 0.001$]. Boneferroni pairwise test revealed that there was a significant difference ($p < 0.05$) present only between the bisyllabic and polysyllabic pattern perception test.

The bisyllabic word identification scores and vowel identification scores were compared using the paired sample 't' test. It was observed that the two were significantly different [$t(9) = 2.90$, $p < 0.01$]. Significantly higher scores were obtained by the children with hearing impairment aged 3 to 5 years on the bisyllabic word identification test.

Comparison between the low verbal version and standard version test scores

A comparison of the performance of the younger group with that of the older group was made for the pattern perception scores and the word identification scores. The responses of the two age groups are shown in Table 3 for the pattern perception and word identification scores respectively.

Table 3: Mean scores and SD for pattern perception and word identification scores

Test	Mean		SD	
	Low verbal version	Standard version	Low verbal version	Standard version
Pattern perception	85.00%	74.58%	17.4	4.14
Identification	75.62%	47.27%	9.0	7.85

The overall pattern perception scores were compared between the two age groups using independent sample 't' test. The results revealed that there was no significant difference ($p > 0.05$) between mean score of the pattern perception tests between the two age groups. In contrast, for the word identification tests, there was a significant difference ($p < 0.001$) between the two groups, with the younger group getting higher scores.

Discussion

The results of the study are discussed in relation to the findings obtained for the low verbal version meant for children aged 2 to 3 years and the standard version meant for children aged 3;1 to 5 years. In addition, the comparisons between the two versions of the tests are also discussed.

Low verbal version

The results of the present study revealed that the younger age group found the pattern perception task significantly easier than the word identification task. The former task mainly required participants to identify suprasegmental information related to the length of the test stimuli, while the latter required them to identify segmental information also. It has been reported by many authors that suprasegmental features are better perceived than segmental features in individuals with hearing loss (Smith, 1975; Bilger & Wang, 1976; Risberg, Agelfor, 1978; Hack & Erber, 1982). The above results are in accordance with the previous studies by Begum (2000) and Tamilmani (2002). They too observed that pattern perception scores were significantly better than the word identification scores.

Zeiser and Erber (1977) reported that children with profound hearing impairment probably receive only time and intensity information (that is, vibratory patterns) through their hearing aids. Hence, one of the acoustic features of speech that seems to be available even to those children through the vibratory sense is the number of syllables in a word, phrase, or sentence. Though the children in the present study had aided audiograms within the speech spectrum up to 2 kHz, they too probably made better utility of the temporal based cues.

Standard version

In the standard version of the test in the current study, it was observed that the pattern perception test scores were significantly better than the word identification test scores. This was in accordance with several studies, which report that in subjects with sensorineural hearing loss, suprasegmental features are better perceived than segmental features (Smith, 1975; Bilger and Wang, 1976; Risberg, Agelfor, 1978; Hack and Erber, 1982). Better pattern perception over word identification was also reported by Moog & Geers (1990), Begum (2000) and Tamilmani (2002).

In addition, it was also found that the mean percentage score for the polysyllabic pattern perception test was significantly better than the mean trisyllabic pattern perception test. Further, the trisyllabic pattern perception test score was significantly better than the mean bisyllabic pattern perception test score. Thus, it is evident that stimuli that have a longer duration are better perceived by children having hearing impairment.

It was found in the present study that the bisyllabic word identification score was significantly better than vowel identification score. Similar findings were reported in the previous studies (Moog & Geers, 1990; Begum, 2000). Poor vowel recognition in individuals with sensorineural hearing loss was also reported by Turner and Henn (1989). They reported that poor frequency resolution commonly noted in sensorineural hearing loss can be a significant factor in the poor recognition of vowels in these subjects.

The reduced scores on vowel identification task could also be attributed to poor vowel formant discrimination ability in individual with hearing impairment. Liu and Kewley Port (2004) reported that the thresholds of vowel formant discrimination for syllables and sentences were significantly elevated for individual with hearing impairment compared to thresholds for young normal hearing listeners. Formant discrimination was found to be elevated in the F2 region by almost 100%, where the greater hearing loss occurred, rather than in the F1 region.

Liu and Kewley-Port (2007) also reported that high levels of presentation for speech signals degraded thresholds for formant discrimination for listeners with hearing impairment rather than improved performance when audibility was assured. Several factors were considered to account for the level effect on formant discrimination, including audibility, frequency selectivity, and upward spread of masking on F2. All these factors may have interacted with each other to affect formant discrimination. In the present study, decreased frequency selectivity and greater upward spread of masking on F2 at the high signal level may have contributed to the reverse level effect of formant discrimination.

Comparison between low verbal version and standard version

The results of the current study revealed that the older group performed significantly poorer than younger group in the word identification test. However, there was no significant difference between the two groups for the pattern perception test. This shows that both the age groups found the pattern perception test to be equally easy, but with increase in age word identification abilities improved.

In contrast to the present results, Begum (2000) reported that children in the older age group performed significantly better on the pattern perception test. However, she found no significant difference between the two groups on the word identification test scores. Subject variability may have accounted for the difference in findings. The kind of training received by the children in the two studies may have also influenced the findings. Though both studies evaluated children who were enrolled in the same clinical

program, the focus of training has changed over the years. At the time when Begum carried out the study, the main focus of training was through an audio-visual mode. In the last few years the focus has shifted towards a more auditory based training program. The findings of the present study, where the younger children obtained higher word identification scores than the older children, probably reflect their ability to make better use of their auditory skills. The older group probably did not use their auditory skills to the same extent.

This finding is supported by the results of the study by Meyer, Svirsky, Kirk and Miyamoto (1998). They too found that a group of children with profound hearing loss, who had enrolled for an oral communication program, obtained 25% to 40% higher scores on a speech perception test. This was in comparison to a group who had not enrolled in such an oral program, as their thresholds of hearing were higher.

Conclusions

From the findings of the present study it is evident that the pattern perception scores were significantly better than the word identification scores. This was observed in the low verbal version and the standard version of the test. However, there was no significant difference between the bisyllabic and trisyllabic word identification test scores in the low verbal version. Unlike the low verbal version, for the standard version the mean percentage scores for the polysyllabic pattern perception scores was significantly better than the mean trisyllabic pattern perception score which was significantly better than the mean bisyllabic pattern perception score. Further, the mean score of the bisyllabic word identification test was significantly better than that of the vowel identification test.

The comparison of the low verbal version and standard version indicated that there was no significant difference between the pattern perception test scores between the two age groups. On the contrary, the mean score of the word identification test was significantly poorer in the older group compared to the younger group.

The findings of the study indicate that the developed test material can be administered effectively on children with hearing impairment in the age range of 2 to 5 years who are exposed to Malayalam for a period of 6 months or 1 year prior to being tested. It is suggested that the low verbal version can be used to evaluate older children who have inadequate speech and or language skills to perform speech tests relevant to their age and also for those with poor attention span. The standard version of this test can be used to for children of 3-5 years age and also those younger children with higher language abilities. If required, the test can be administered after some training to evaluate the performance of the child on speech perception tasks. This would help to eliminate the disadvantage of lack of vocabulary to carry out the test. Hence, it can also be the first speech identification test administered for children with hearing impairment.

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APPENDIX I
LOW VERBAL VERSION

Pattern Perception Test

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Word Identification Test

Bisyllabic Word Identification Subtest

കണ്ണ്
പൂച്ച
പശു

മാങ്ങ

Trisyllabic Word Identification Subtest

കസേര

തവള

പൂമ്പാറ്റ
കടുവ

APPENDIX II
STANDARD VERSION

Pattern Perception Test

Bisyllabic pattern perception test
കണ്ണ്
മാല

മുട്ട

പാമ്പ്

Trisyllabic pattern perception test
പൂമ്പാറ്റ
കുതിര

വിമാനം

മത്തങ്ങ

Polysyllabic pattern perception test

കാളവണ്ടി
തലമുടി
അലമാര
മുന്തിരിങ്ങ

Bisyllabic word identification subtest
മാങ്ങ :

കുട

പന്നി

വായ
കയ്
പല്ല്
ചക്ക
പട്ടി
പൂച്ച
പശു

മൂങ്ങ
ചെവി
Vowel idenification test
പട്ടി

പെട്ടി

പുട്ട്

പൂട്ട്
പാറ
പൊട്ട്
പിന്ന്
പീലി
പേന
പൈസ