# EARLY SPEECH PERCEPTION TEST DEVELOPMENT FOR MALAYALAM SPEAKING HEARING IMPAIRED CHILDREN

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**ALL INDIA INSTITUTE OF SPEECH AND HEARING**
**NAIMISHAM CAMPUS, MANASAGANGOTHRI**
**MYSORE-570006**
**MAY 2008**

Dedicated to my beloved parents

# CERTIFICATE

This is to certify that this dissertation entitled ***"Early speech perception test development for Malayalam speaking hearing impaired children "*** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Audiology) of the student (06AUD006). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

*Mysore*

***April, 2008***

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# CERTIFICATE

This is to certify that the dissertation entitled ***"Early speech perception test development for Malayalam speaking hearing impaired children"*** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

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# DECLARATION

I declare that this dissertation entitled *'**Early speech perception test development for Malayalam speaking hearing impaired children**"* is the result of my own study under the guidance of Prof. Asha Yathiraj, HOD, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted in any other university for the award of any diploma or degree.

**Mysore**

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# Chapter 1

# 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 depends on the extend to which it affects speech perception (Boothroyd, 1988). 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 (Boothroyd, 1988). 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 threshold averages for 500, 1000, and 2000 Hz were 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).

Speech audiometry has several advantages over the non-speech materials. Speech audiometry helps in early detection of slight losses which are otherwise overlooked (Martony, Risberg, Spens & Agelfors, 1970). Speech has been considered the most important class of sounds that humans hear (Martin, Howkins & Beiley, 1962). Children have been found to verbal stimuli more than non-verbal stimuli (Hardy & Bordley, 1957). Olsen and Matkin (1979) have observed that children finds speech test easier and less abstract than pure-tone tests and are willing to participate on such tests.

Assessment of speech perception in the paediatric population is important for several reasons. Results on speech perception measures help determine whether a child benefits from a hearing aid or should be considered for a cochlear implant. Speech perception measures are important for comparing differences between sensory devices and/or processing algorithms. Speech perception tests help in evaluating aided versus unaided differences and also help to evaluate monaural versus binaural fitting and the side of fitting differences (Dillon & Ching, 1995, cited in Plant & Spens, 1995).

Efforts to develop speech materials suitable for the paediatric speech audiometry dates back to at least the 1940's, concurrent with the pioneering work of Carhart and Hudgins (1979). 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.

There are many tests for the evaluation of speech intelligibility in children. (Ross & Lerman, 1970; Erber, 1974; Elliot & Katz, 1980; Moog & Geers, 1990). Some of them have been developed for 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).

## Need for the study

It is ideal to have speech identification tests in all languages as the individual perception of speech is influenced by his/her first language or mother tongue (Singh, 1966; Singh & 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 of children with hearing impairment. The test score could help to 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.

## Aim of the study

To develop a speech perception test for Malayalam speaking children with hearing impairment, having limited vocabulary. It was aimed to develop two versions, one for children aged 2 to 3 years and another for children aged 3 to 5 years.

# Chapter 2

## REVIEW OF LITERATURE

For over one hundred years speech has been used in a systematic way to assess hearing ability (Wolf, 1874, cited in Lyregaard et al., 1976). In clinical Audiology, speech audiometry is most often used diagnostically to place the patient into one or more of a number of auditory function categories such as, normal auditory function, non organic hearing loss, conductive hearing loss, sensory or end organ disorder, peripheral- neural disorder and central auditory disorder.

### *Diagnostic uses of speech audiometry*

Speech tests have been used to confirm the pure-tone audiogram assessment of hearing loss. Both Fletcher (1950) and Carhart (1971) noted that pure-tone average is a good predictor of speech recognition threshold (SRT) in individuals with flat hearing loss. Fletcher (1950) also reported that in case of sloping hearing loss, the average of the better two speech frequencies is a better predictor of SRT. This was considered particularly valuable when nonorganic hearing loss was suspected. Gold, Lubinsky and Shahar (1981) compared the speech discrimination scores (SDS) of normal hearing individuals and malingers by increasing level of presentation. Both performed better as levels increased, but the suspected malingerers yielded SDSs at 5, 10, and 15 dB significantly higher than controls by 20.8, 12.5, and 5.2 percentage points, respectively. The higher SDSs at low sensation levels (SLs) yielded by the suspected malingerers were assumed to be due to the exaggerated SRTs admitted by them.

Although a characteristic pattern of response (or rather characteristic deviation from a normal response) may be found in conductive hearing loss, speech audiometry is rarely value in such cases. Carefully masked air conduction and bone conduction pure-tone audiometry, combined with acoustic immittance and stapedial reflex measurements has been considered as a more appropriate way of identifying and investigating middle ear disorders. However, it has been used for identifying unusually poor speech identification capability in patients in whom the conductive component overlies a sensorineural hearing loss with considerable involvement of the acoustic nerve (Evans, cited in Martin, 1987).

Liden (1954) reported poor speech recognition as a characteristic of retrocochlear disorder. Prior to that time (Dix, Hallpike & Hood, 1949) and for several years afterwards (Hood & Poole, 1971) poor speech recognition was held to be a consequence of loudness recruitment. Jerger and Jerger (1971) found that the roll-over index separated cochlear and retrocochlear disorders without overlap.

Speech test for the brainstem function generally investigate aspects of binaural interaction which arise from the binaural representation of auditory information through the crossing neural pathways at various levels. They include binaural fusion test (Matzker, 1959), rapidly alternating speech perception test (RASP) (Lynn & Gilroy, 1977) and masking level difference (MLD) (Olsen, Noffsinger & Carhart, 1976).

Owing to the complexity of the central nervous system, a limited impairment of cortical function may have little effect upon the perception of good quality of speech, analyzed by an intact peripheral auditory system. Most tests of cortical dysfunction therefore rely upon a reduction in the redundancy of the speech material to improve their sensitivity. This may be achieved by degrading the acoustic signal conveying the speech information.

*Other uses of speech audiometry*

Dillon and Ching, 1995, (cited in Plant & Spens) reported that speech tests have been used to determine the relative effectiveness of different hearing aid electroacoustic characteristics. They also reported that speech test has been employed to examine whether hearing aids are to be fitted monaurally or binaurally. If the hearing aid is to be fitted monaurally, selecting the ear in which it should be fitted has also been done using the speech test results.

It has been noted that if a hearing loss is mild, the advantage of a hearing aid may be uncertain. It has been recommended that this may be solved by measuring the increase in speech perception offered by the hearing aid. This would help decide whether hearing aids are warranted or not. Thus, performance on a speech test has been used to decide whether a person is a candidate for hearing aids and helps in the selection of appropriate hearing aids (Dillon & Ching, 1995, cited in Plant & Spens).

Further the goals for auditory training have been decided based on the speech perception abilities of clients. A number of speech tests have been used to evaluate children's pre- and post implant performance (Boothroyd, 1991 cited in Tyler, 1995; Geers and Moog, 1989).

The specific errors seen in speech perception can be determined through speech identification tests. Through the use of speech tests, it has been shown that subjects with sensorineural hearing loss perceive suprasegmental features better than segmental features, vowels better than consonants, vowel height better than vowel place, word initial consonant better than word final consonant, and consonant voicing better than consonant place (Bilger & Wang, 1976; Erber, 1972; Hack & Erber, 1982).

*Variables affecting speech audiometry*

A number of factors have been found to influence the results of speech perception evaluations in children. They have been broadly divided in to three categories:

- Variability at the level of perception
    - Degree of hearing loss
    - Age of onset of hearing loss
    - Current age of the child
    - Individual variability
    - Amount of training received

- Variability at the level of transmission
    - > Room acoustics and reverberation
    - > Presentation level
    - > Response method
    - > Recorded versus monitored live
    - > Talker variability
    - > Carrier phrase
- Variability at the level of material for testing
    - > Closed versus open set
    - > Word familiarity
    - > Number of item
    - > Acoustic frequency composition
    - > Phonetic versus phonemic balance

**Variability at the level of perception**

*Degree of hearing loss*

Comparing individual with normal hearing and hearing impairment, it was found by Hirsh, (1950) and Tonning, (1971) that reduced frequency analysis in the hearing impaired lead to poor speech intelligibility. The pure-tone audiogram was found not to perfectly correlate with the spondee recognition in children with hearing impairment. The predictive power of pure-tones was found to be poor for children whose threshold averages for 500, 1000, and 2000 Hz were 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 educational recommendations (Erber, 1974).

The possible reasons for a lack of perfect correlation between pure-tone threshold and other aspects of auditory capacity have been reported to be several. One reason could be that different underlying pathologies could have differential effects on threshold, loudness perception and auditory resolution. Another reason noted is that small conductive hearing losses often go undetected in the presence of profound deafness leading to an overestimation of the sensorineural component. Yet another reason reported is that young deaf children often give behavioural thresholds that are 5 to 10 dB above the real thresholds. This occurs until they have adequate listening experience (Boothroyd, cited in Tyler, 1995).

Erber (1972) reported that individuals with hearing loss of 70 to 95 dB HL had difficulty with the auditory perception of place of articulation but not of manner or voicing. In contrast, individuals with losses above 95 dB HL had difficulty with the auditory perception of all consonantal features.

Children with profound hearing impairment have been found to perceive little more than the gross time and intensity pattern in acoustic speech signals (Erber, 1972). Their responses suggest that, they perceive only the rhythmic pattern of amplified sound delivered to their ears (Erber, 1974; Zieser & Erber 1977).

*Age of onset of hearing loss*

Stevenson (1977) noted that a prelingual or post lingual hearing loss had the same effect on an individual's difficulty to communicate with the hearing and speaking world. However, Boothroyd (1984) observed that a prelingually acquired severe to profound hearing loss was likely to have more serious long term effect in speech perception than others. Severe congenital or prelingual deafness was found to have a greater impact on language voice and articulation because the individual does not develop communication in a natural way. This individual was noted not to have the acoustic stimulation of the language and accurate feedback of his own speech production (Katz & White, 1982).

Thus, the age of onset of hearing loss must be considered as a major factor for the construction of speech test material. Speech tests meant for young pre-lingually deaf children should be different from tests meant for post-lingual children who have a larger vocabulary.

*Current age of the child*

It is reported that speech perception test should not be influenced by factors unrelated to perceptual abilities, particularly limitations imposed by children's vocabulary or physical abilities (Tyler, 1995). It is necessary to ensure that the test words are within the vocabulary of the child. Otherwise any error would not reflect the inability of the child to perceive or recognize the stimulus, rather a limitation in the vocabulary of the child.

The responses of children have been recommended to be within their physical abilities. Test sessions lasting more than 10 to 15 minutes have been found to be quite difficult for very small children. Many do not have the memory capabilities to listen and respond to a 4 to 6 items or sentences or choices (Boothroyd, 1991, cited in Tyler, 1995). Thus, immediate picture pointing responses have been recommended for very young children (Ross & Lerman, 1970).

The age of testing is a very important variable to be considered while evaluating the pediatric population, especially for the evaluation of speech functions.

*Individual variability*

The child's intellectual ability has been observed to greatly influence the rate of learning and the learning potential. Learning abilities has been reported to affect the language capabilities of children (De Conde, 1984). Further, the socio economic factors have also been noted to influence the development of the child as the same opportunities and programs may not be available for all the children (De Conde, 1984). Thus, a test which minimizes the individual variability should be selected for evaluation of the paediatric population.

*Amount of training received*

If the child has been trained on or is overly familiar with the specific test item, the results obtained may overestimate the child's true speech perception abilities. Although children may learn the auditory pattern of the small set of the test items, this may not be representative of their overall speech perception abilities. This also places trained children at an unfair advantage over untrained children (Tyler, 1995).

Tyler (1995) noted that it is appropriate to train the child on same item on which he or she will be tested. However Tye-Murray (1995) had reported that though training is important, the training on the test items confounds the interpretation of the results.

Moog and Geers (1990) recommended that very young children can be trained on the test items so that the evaluation of speech perception would not be biased by the linguistic knowledge of the children.

Burk, Humes, Amos and Strauser (2006) evaluated the effectiveness of a training program for hearing-impaired listeners to improve their speech-recognition performance within a background noise. Both young normal-hearing and older hearing-impaired listeners performed significantly better on the word list in which they were trained versus a second untrained list presented by the same talker. Improvements on the untrained words were small but significant, indicating some generalization to novel words.

Burk and Humes (2007) examined how repeated presentations of lexically difficult words within a background noise affected a listener's ability to understand both trained (lexically difficult) and untrained (lexically easy) words in isolation and within sentences. They reported that listeners' performance improved significantly for the trained words in an open and closed-set condition, as well as the untrained words in the closed-set condition. They concluded that with enough training on isolated words, individual listeners can generalize knowledge gained through isolated word training to the recognition of lexically similar words in running speech.

From the above studies it can be commended that most authors agree that if some of the test items are not known to the child and still the test is most appropriate one in regard to age, degree of hearing loss, then he can be trained on those items in the test.

## Variability at the level of transmission

*Room acoustics and reverberation*

It is well known that people with cochlear hearing impairment perform more poorly than normally hearing people when trying to understand speech, especially when background noise is present (Moore, 2003). The deficit (relative to normal) has been noted to be particularly large when the background is fluctuating and when the target speech and background are spatially separated. The deficit has been attributed to several factors: reduced audibility, whereby part of the speech spectrum becomes inaudible; reduced frequency selectivity, which contributes to difficulty in discriminating spectral shape and in separating speech and background frequency components; loudness recruitment, which reduces the available dynamic range and distorts loudness relationships among components of speech and; dead regions in the cochlea, which prevent transduction of information at certain places on the basilar membrane (Moore, 2003).

Sound reaching a listener in a reverberant field is composed of energy, while the direct signal will decrease in intensity according to the inverse square law (Roller & Crum, 1974). The reverberant energy that is maintained by the room's surface will build up and may even exceed the intensity of the direct sound (Finitzo Hieber & Tillman, 1978).

According to Lochner and Berger,1964 (cited in Olsen, 1981) there is a complete integration of the reverberance or reflected sound with the direct signal up to 30 msec and at least partial integration between 30 and 80 msec.

In a room with a reverberant time of 1.2 msec or over 0.4 msec, the reflected energy has been noted to change some of the important aspects of a speech signal and interfere with speech intelligibility by producing a 'time smearing' or distortion of the original signal ( Hautgast & Steeneken, 1972).

Several evidence suggests that the acoustical environment in classrooms can affect the achievement and performance of the hearing impaired children (Ross & Giolas, 1971; Finitzo Hieber & Tillman, 1978).

Jamieson et al. (2004) examined the speech perception abilities in young children aged five to eight when listening in a background of real life class room noise. All children had some difficulty understanding speech when the noise was at level found in many classrooms. However, at an intermediate level (-6 dB SNR) kindergarten and grade 1 children had much more difficulty than did older children. These results suggest that the youngest children in the school system whose class rooms also tend to be among the noisiest are most susceptible to the effects of noise.

People with normal hearing typically require an S/N ratio of +6 dB for the reception of intelligible speech. Due to auditory distortion of hearing loss itself, it has been suggested that individuals with hearing loss need an S/N ratio of +20 dB (Gengel, 1974; Hawkins, 1984).

Gengel (1974) found that the children having a moderate to severe sensorineural hearing loss required an S/N ratio of at least +10 dB and preferably + 20 dB to function effectively. Thus, the noise level should not be more than 40 dB on the C scale or 30 dBA, presuming that the average speech level at a distance of 3 feet to 15 feet would be 60 dBSPL. Fourcin et al. (1980) recommended similar noise levels.

Hearing impaired listeners are more susceptible to the effect of reverberation than listeners with normal hearing (Finitzo-Hieber & Tillman, 1978). Hence, it is essential that reverberation should be properly controlled while evaluating speech perception.

*Presentation level*

Carhart (1965) reported that by making use of one intensity level, one cannot be sure that he is determining the maximum identification score of the individual unless he has got a score of 100% at that level. The effect of presentation level on understanding of different stimulus material has been visualized by employing the performance intensity functions. However, Boothroyd (1968) opined that it is not always practical to obtain an articulation function in routine testing. Thus, he suggested for routine testing purposes, speech intelligibility be obtained at one particular level.

The importance of the presentation level even during live voice presentation has been emphasized. It has been suggested by Geers and Moog (1989) that live voice should always be presented while the examiner is viewing his out put on the SLM or VU meter of the audiometer. The overall level should be 70 dBA.

Researchers who used speech sounds or monosyllabic words as stimuli showed that children with moderate to severe hearing loss typically require acoustic speech levels 20 to 40 dB above the speech detection level to obtain maximum auditory or auditory visual recognition scores ( Numbers & Hudgins, 1948; Hudgins, 1954).

Plyler and Hedrick (2002) investigated whether varying the presentation level of stop consonant stimuli resulted in similar phonetic boundary shifts for listeners with normal and impaired hearing. Listeners with hearing impairment had significantly more missing boundary values than normal hearing listeners. However, the correlation between the number of missing boundary values and hearing sensitivity was not significant. Comparison of boundary shift with level demonstrated that listeners with impairment had a smaller boundary shift with increasing level than normal-hearing listeners. The amount of boundary shift was not correlated with audibility. The results of the study suggested that increasing the presentation level of a signal did not result in performance similar to that of listeners with normal hearing.

*Response method*

It has been reported by Martin (1987) that subjects can indicate their perception of speech in several ways. In the most commonly reported method, the subject verbally repeats what they heard. Alternately the response could be written down. The problem with the verbal response is it might be misheard by the tester. However written responses can still be problematic if the person has spelling errors leading to misinterpretation of his perception leading to an erroneous scoring and moreover write down responses are limited to literates.

In some cases the test items can be presented as pictures to which the subject points so that the test subject does not need accurate speech production. Martin (1987) cautioned that whatever might be the response method, it must be remembered that speech test of hearing should investigate the listeners hearing function not their speech production, mental physical linguistic or educational abilities.

*Recorded versus monitored live*

Speech test may be administered by means of phonographic or tape recorded presentations and by monitored live voice (Penord, 1972). Tylor (1972) noted that recorded test materials are preferable over live voice materials for a number of reasons. Some of the reasons are that the acoustical characteristics of recorded stimuli can be measured or analyzed; there is less opportunity for bias introduced by the talker unintentionally slowing down or talking more clearly or loudly; the same test conditions can be exactly repeated to the child at another time or to another child; in monitored live voice the talker is often familiar to the child and this may inflate performance and the talker could mispronounce the word.

Boothroyd (1986) reported that the way in which the material is recorded effect the richness of acoustic context of the test item or the number of cues present in one item. The use of monitored live voice has been prevalent due to its flexibility, rapidity, and ease of administration.

Moog and Geers (1990) have reported poor test-retest reliability scores for live voice stimuli (0.5 to 0.62) than for recorded stimuli (0.84 to 0.93). However, Geers (1994) observed that an important consideration in selecting a speech perception in the availability of stimuli for recorded presentation.

The use of monitored live voice has been recommended with young children due to its flexibility, rapidity and ease of administration (French & Steinberg 1974, cited in Penord, 1972; Hirsh et al 1954; Palmer 1991; Silverman & Hirsh 1955; Carhart, 1965).

*Talker variability*

According to Moog and Geers (1990), the source of the talker variability on live voice presentation such as speaker's fundamental frequency, voice characteristics, and stress pattern should be considered during the development of speech perception test for children. They noted that words that are expected to be representing equal stress, so that correct identification can be based only on perception of spectral cues, may actually be identified on the basis of suprasegmental cues unintentionally added by the speaker (Geers, 1994).

Pisoni (1992) reported that identification performance was always better for words that are produced by a single talker than for words produced by multiple talkers. Trial-to-trial variability in the speaker's voice affected recognition performance. The perceptual system must engage in some form of adjustment or recalibration each time a novel voice is encountered during the set of trials using multiple voices. When test items were spoken by more than one talker, listeners performed poorer on speech intelligibility task (Creelman, 1957; Peters, 1995).

Peters (1995) found that the response latencies to same judgments were slower when target words were produced by two different voices. Balota and Chumbley (1984) reported response latencies to be faster for words in single talker condition than words in multiple talker condition. Similar findings were found in children in the age range of 3-5 years by Pisoni and Martin (1986).

It is also pointed out that the test results obtained by different talker's are not readily comparable unless the equivalency of talker has been demonstrated (Carhart, 1965). Using the same unfamiliar talker across different children and across different test sessions for the same child will reduce different talker variability (Taylor, 1985).

Kruel et al. (1969) reported that the scores for repeated testing for either of the two talkers on different occasions are not significantly different. Though most studies show that multiple talker reduces the performance on a speech identification test, one study contradicts this.

*Carrier phrase*

Carrier phrase is one of the variables that have influence on the speech identification scores. Use of carrier phrase in speech audiometry is assumed to alert the listener for the test word and allows the clinician to monitor his voice, but usually the exact context of carrier phrase is not considered important (Egan, 1944; Carhart, 1952).

Fletcher and Steinberg, 1930 (cited in Jamielson, 1972) reported increase in score of the identification of CVC syllables when using an introduction sentence. Kruel et al. (1969) noted similar findings, employing the modified rhyme test. Likewise, Northern and Hattler (1974) found that when a carrier phrase was omitted discrimination scores were worse. However, Martin et al. (1962) found no difference in performance when the carrier phrase was omitted and that the carrier phrase only serve to confuse individuals who have severe discrimination problems.

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Kruel and Moll (1972) reported that the carrier phrase has the acoustic cues for some manner of articulation distinction for initial consonant and also for the tongue advancement cue for syllabic nuclei of the test word. When the test material was presented in a carrier phrase, the effect in phonemes adjacent to the test item could help to identify the target.

Gladstone and Siegenthaler (1972) compared the effect of three carrier phrases, 'say the word', 'you will say' and 'point to the', on speech intelligibility and reported the carrier phrase 'you will say' gave the best score with along vowel /ei/ at the end as it has greater potential for being influenced by the phonemes of the word and gave additional cues to the intelligibility.

Carrier phrases have been recommended to be used in studies carried out in India. Mathew (1996) in the picture test of speech perception in Malayalam had used the Malayalam translation of 'point to' for children in the age range of 3-6; 5 years. Prakash (1999) had used the Tamil translation of 'show me' as a carrier phrase for children in the age range of 3-6; 5 years in the picture identification test in Tamil.

Hence, it is recommended to use carrier phrase that alert the children and those that does not affect the acoustic characteristics of the stimuli.

**Variability at the level of material for testing**

*Closed versus open set*

Speech tests are often categorized as open response or closed response. In closed response format the response alternatives are provided so that the child can correctly identify the item based on perception of even a part of a word which distinguishes from others. They are generally easier than open set, where the listener repeats verbally or write down the sound that they thought they heard (Dillon & Ching, 1995, cited in Plant & Spens).

Miller et al. (1951) and Geers (1994) opined that larger the number of choices, the fewer the syllables per stimulus word and the greater the similarity among choices, the more the difficult task and lower the scores. The difficulty of open set task was also found to vary with the amount of information in the stimulus and its familiarity.

Moog and Geers (1990) reported that profoundly deaf children who use hearing aids typically are able to understand words presented auditory only in situations in which choices are known. Such children are rarely able to understand words presented open set without responses choices available.

The closed set response formats have been increasingly used in research studies on speech perception in hearing impaired (Schultz, 1964; Picket et al., 1970). This is used in young children where pointing to one of the several pictures is a common response mode.

Holmes, Kricos and Kessler (1988) investigated whether the pattern of performance differed between young and elderly normally hearing adults on a closed versus open-set discrimination task. The only significant difference occurred within the young group between conditions (closed-set, open-set). The young group's speech discrimination was significantly better in the closed-set condition than in the open-set condition. No other differences were significant.

There are many tests for speech perception in children aged 2-3 years old ( Toy test for young children who have English as second language, Bellman & Marcuson, 1991; The Auditory Number Test, Erber, 1974; PBK 50, Haskins,1949 and BKB sentence list, Bench, Kowal and Bamford, 1979) which had the open set as response mode. Among the test standardized for Indian population there were open set response test for children as young as 5 years old ( PBK word list in Hindi, Abrol,1970, cited in Nagaraja, 1990; Speech Perception Test in Tamil and Telugu, Kapur, 1971, cited in Nagaraja, 1990), to 10 years old. (A Common Discrimination Test for Indian Languages, Mayadevi, 1974).

The test that used closed set response for children range from 2 year old (Early Speech Perception Test, (Moog & Geers, 1990) to 10 year old (NU- CHIPS, Elliot & Katz, 1980). The closed set response tests for the Indian population were constructed for children in the age range of 3 to 8 years (Mathew, 1996; Rout, 1996; Vandana, 1998&Prakash, 1999).

From the above study it can be concluded that the closed set response mode is more appropriate for children as young as 2 years of age. However, as children get older an open set task can be used.

*Word familiarity*

Word familiarity is one of the important variables that can affect the scores of the speech test. The use of item that is not in the vocabulary of the patient can have marked effect on the performance. It is the responsibility of the audiologist to select material that is linguistically appropriate for the patient. The use of items that are not in the vocabulary can result in low scores leading to unnecessary testing misdiagnosis or management (House, 1957; Epstien & Owens, 1969).

Pollack, Rubenstein and Decker (1959) found that practice effect reduced the influence of word frequency. Owens (1961) noted that persons with high intelligence and superior verbal ability found more test words familiar and could take advantage of available phonetic cues resulting in higher discrimination scores than a person with lower level of intelligence and low verbal ability.

*Number of item*

In order to ensure the reliability, it has been suggested that the test items should be repeated more than once. To compare performance across time or across children, it is important that test conditions be as similar as possible.

However, Boothroyd, 1995 (cited in Tyler, 1995) noted that repeating the test stimulus creates two problems. If some children received repetitions and others did not, it provided an unfair advantage for the former group. Even if all the children receive the same number of repetitions there may be individual differences, unrelated to the information provided by the amplification system that confounds the results.

Nygaord et al. (1994) reported that speech recognition scores were better for single speaking rate than for mixed speaking rate due to the increased acoustic phonetic variability which resulted in the poor scores. Similar findings obtained by Mullenix et al. (1989).

A test must be reliable enough to measure significant differences (Boothroyd, 1991, cited in Tyler, 1995). The reliability of a test has been noted to partly depend on the number of items. A test with more items has been considered more reliable than a test with fewer items (Thorton & Raffin, 1978).

Dillon and Ching, 1995, (cited in Plant & Spens) also opined that the number of items is the primary determinant of test reliability and is thus one of the most important characteristics of a speech test. This has found to create problems while testing young children with short attention span. For this reason many of the tests have been designed with small number of test items, 20 or less. It has been suggested that the test can be repeated two or three times and scores can be added (Boothroyd, 1995, cited in Tyler, 1995; Moog & Geers, 1990; Thornton & Raffin, 1978).

Boothroyd, 1991 (cited in Tyler, 1995) reported that for any test to be useful it must be reliable enough to measure significant differences. While testing very young children it is difficult to use a large number of items. For this reason many test have been designed with a small number of items, 20 or less.

Boothroyd, 1995 (cited in Tyler, 1995) suggested that it will be difficult to measure significant changes in a test with small number of items and a high chance score. Thus, it may be inappropriate to use the test altogether. Sometimes the test can be repeated two or three times and the scores added. The reliability of any test should be known before it can be used for clinical and research issues.

*Acoustic frequency composition*

French and Steinberg, 1974 (cited in Penord) demonstrated the importance of high frequencies for correct identification of CVC syllables. Similar findings are reported by Hirsh et al. (1954) using filtered CID-22 monosyllables.

Hornsby and Ricketts (2003) investigated the speech understanding of persons with 'flat' hearing impairment (HI) and compared their responses to a normal-hearing (NH) control group. This was done to examine how hearing loss affects the contribution of speech information in various frequency regions. They reported that even though absolute speech scores for the group with hearing impairment were reduced, performance improvements as the speech and noise bandwidth increased were comparable between the groups. These data suggest that the presence of hearing loss results in a uniform, rather than frequency-specific, deficit in the contribution of speech information. They also reported that differences in performance between the HI and NH groups were primarily due to audibility differences between groups.

Hornsby and Ricketts (2006) compared the speech understanding of persons with sloping high-frequency (HF) hearing impairment (HI) to that of normal hearing (NH) controls. Performance, were significantly lower for the sloping HI, compared to NH, group suggesting that HF HI limits the utility of HF speech information.

The prominent role of high frequency energy with respect to speech understanding becomes even more complex when one examines the relative power of individual speech sounds. It is the high frequency energy that contains the least power and yet it is these sounds which provide major contribution of intelligibility (Fletcher, 1950).

The frequency of the test material should be evenly distributed as low, mid and high frequency sounds. Most phonetically or phonemically balanced tests do this.

*Phonetic versus phonemic balance*

The speech tests constructed can be either phonemically or phonetically balanced. Both seem to play an important role in speech discrimination score. Grubb (1963) defined phonetic balancing as proportional representation of fundamental speech sounds.

Most of the speech tests were phonemically balanced word list. The rationale for using phonemically balanced test material is that if the listener were unable to perceive a particular phoneme which occurs infrequently in normal everyday speech, the handicap experienced is not as severe as it would have been had the phoneme been a more common one. However, a given phoneme can have different phonetic realizations in the neighborhood of different sounds. Transitions from one sound to another are often important cues for identification especially in sound sequences in which there may or may not be a steady state pattern, such as those in connected speech. The relevance of precise fulfillment of phonemic balance in speech test materials is to predicting communicative difficulties in everyday life due to hearing loss is questionable (Dillon & Ching, 1995, cited in Plant & Spens).

Speech perception tests should be used so that it defines the particular phonetic contrasts the child is able to perceive, independent of that child's phonological knowledge of English (Boothroyd, 1995, cited in Tyler, 1995).

The phonetic construction of English language is such that there is no way to balance a list of words phonetically, especially a relative short list. This is because of the almost infinite number of variations that can be made on each phoneme (allophones) as it is associated with other phonemes (Martin, 1991).

As the speech tests are aimed at assessing the individuals communication difficulty, it can be concluded that phonemically balanced word lists would be preferable than phonetically balanced words. This is especially true for evaluation of paediatric population.

From the review of literature, it is evident that a number of important factors must be taken into consideration when assessing speech perception in children. Among the factors, the task factors have been considered to require the greatest consideration due to their influences of maturation and language on test outcomes. Hence, it is essential to control task related variables when constructing speech perception test for the paediatric population.

# Chapter 3

# METHOD

The aim of the present study was to construct a picture test of speech perception for Malayalam speaking children with hearing impairment in the age range of 2 to 5 years. The study was carried out in two phases. Phase I involved the development of the test material and phase II dealt with the evaluation of performance of children with hearing impairment, on the material constructed.

## **Phase I**

The following activities were carried out in the first phase:

- Development of test material
- Check the familiarity of the test item on children with normal hearing

### *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 to 5 years. A list of 30 bisyllabics, 15 trisyllabics and 10 polysyllabics in Malayalam was initially made.

From the above list, 25 bisyllabics, 7 trisyllabics and 4 polysyllabics were used for the development of the tests.

*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 aged 3 to 5 years. Equal number of males and females were taken in both the groups. They also met the following criteria:

- They were exposed to Malayalam from early childhood and spoke the language,
- They had no history of ear infection,
- They had no history of speech and language impairment or any developmental delay, and
- They did not compliant of illness at the time of testing.

*Procedure to check familiarity*

To ensure that the word list that was prepared was familiar to typically developing normal hearing children in both the age groups (2 to 3 years & 3 to 5 years) 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.

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Pictures representing the words were shown and each child was asked to name the item presented. If a child was not able to name the picture, cues were given to elicit the response. For example for the word 'cup' the given cue was "What do you use to drink milk?" if the child could not name the item the next item was presented.

A word was considered to be familiar only if 90% of the children identified or named it correctly. From the words that were familiar a low level version (version I) and a standard version (version II) were developed. Words familiar to children aged 2 to 3 years were used for version I and words familiar to children aged 3 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 having 8 test items:
  - Bisyllabic word identification subtest having 4 test items
  - Trisyllabic word identification subtest having 4 test items.

The syllable categorization test had one continuant and one noncontinuant, eg: aaaa (to represent something nice) and va va va va (to call a doll). Both the subtests of word identification had four words each (Appendix I).

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

- Syllable categorization test having 12 test items
- Word identification test having 22 test items
  - 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 of the target age. The vowel identification subtest had words with the vowel varying (Appendix II).

## **Phase II**

Evaluation of 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° 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-S3.1-1999.

*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 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*

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° Azimuth. The pictures representing the test item were placed before them on the 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 the child. The stimuli were presented one-by-one, by the tester at a normal conversational level (60 dBSPL).

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 signal. The children were required to point out to the appropriate picturised item.

While administering the low verbal version, the syllable categorization test was first carried out, followed by the word identification subtest. Likewise, for the standard version also the syllable categorization was first evaluated, followed by the word identification. 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'.

*Analyses*

A comparison was made between the performance of the children with hearing impairment on developed tests and subtests. This was done for both the age groups. Descriptive statistics, paired sample 't' test and ANOVA were used to carry out the analyses.

# Chapter 4

# RESULTS

The data obtained from children for the 'Early Speech perception test in Malayalanm, 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 to 5 years respectively. A comparison was also made between the performances of children on the two versions of the test. For each of the versions and for the comparison between the two versions, the following were studied:

1. Low verbal version (2-3 years)

   1.1 Comparison of pattern perception test scores and overall word identification scores

   1.2 Comparison of bisyllabic and trisyllabic word identification test score

2. Standard version (3-5 years)

   2.1 Comparison of overall pattern perception and overall word identification scores

   2.2 Comparison of bisyllabic, trisyllabic and polysyllabic word scores within the pattern perception tests

2.3 Comparison of bisyllabic identification scores and vowel identification scores.

3. Comparison between low verbal version and standard version.

## 1. Results of the Low Verbal Version Test

Descriptive statistics were carried out to determine 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 variability for the pattern perception test was maximum which was demonstrated by the highest standard deviation (SD) value. This indicates that variability in the scores obtained by the subjects on pattern perception tests 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'

| **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 |

## 1.1 Comparison of pattern perception test scores and overall word identification scores

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 ($p < 0.05$). The difference in performance can be seen in Figure 1.

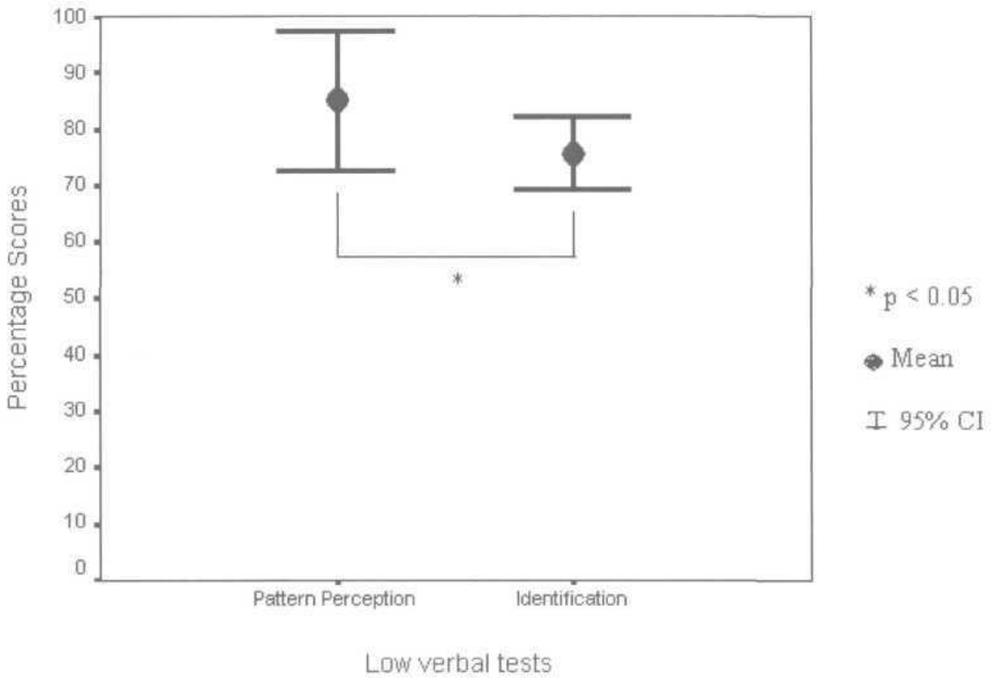


Figure 1: Mean scores, 95% confidence interval and significance level for the pattern perception scores and word identification scores, for the low verbal version test.

## 1.2 Comparison of bisyllabic and trisyllabic word identification test scores

Bisyllabic word identification scores and trisyllabic word identification scores were compared using paired sample 't' test. The results brought to light that there was no significant difference between these two tests ($p > 0.05$). This is illustrated in Figure 2.

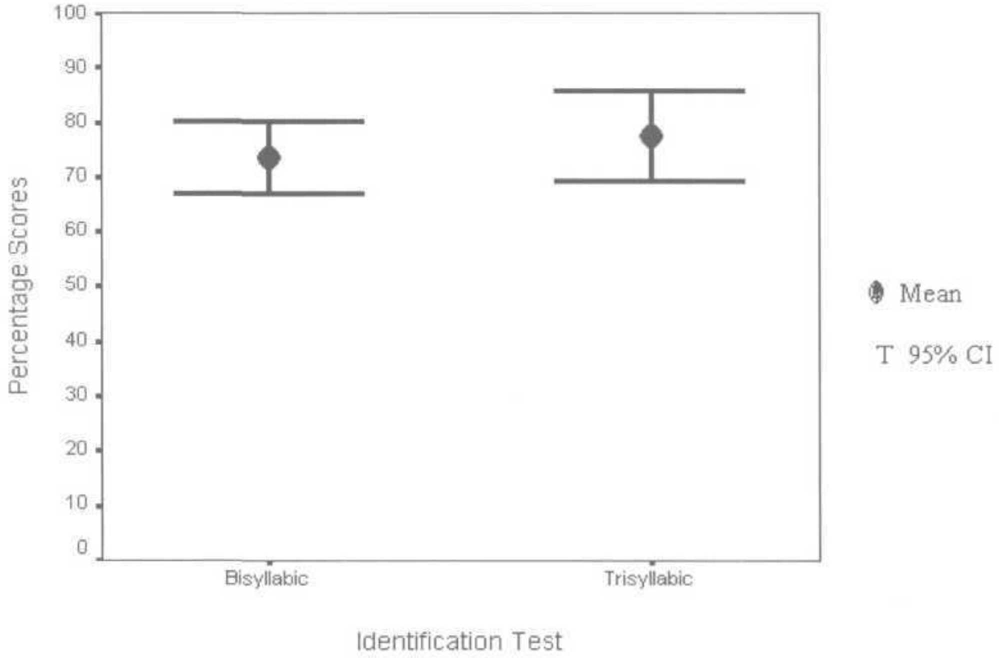


Figure 2: Mean and 95% confidence interval for bisyllabic and trisyllabic word identification scores for the low verbal version test.

## 2. Results of the Standard Version Test

The mean scores of the bisyllabic, trisyllabic and polysyllabic pattern perception test revealed that polysyllabic pattern perception score was better than the trisyllabic pattern perception score and bisyllabic pattern perception score. 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'.

| 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 |

**2.1 Comparison of the overall pattern perception and overall word identification scores.**

To determine the significance of difference between the overall pattern perception scores and overall word identification scores, the paired 't' test was performed. A significant difference ($p < 0.01$) between the two was observed with the latter test obtaining significantly lower values (Figure 3).

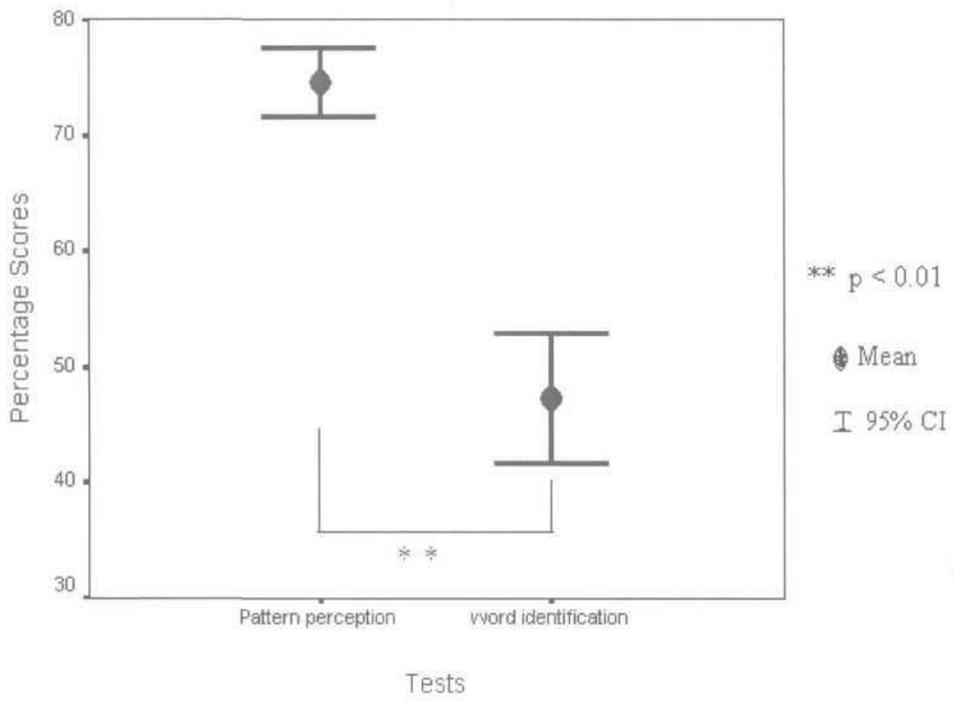


Figure 3: Mean scores, 95% confidence interval and significance level for the overall pattern perception test scores and word identification test scores for the standard version of the test.

## 2.2 Comparison of bisyllabic, trisyllabic and polysyllabic word scores within the pattern perception tests.

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 bisyllabie and polysyllabic pattern perception test Table 3.

Table 3: Pairwise comparison of bisyllabie, trisyllabic and polysyllabic words of the pattern perception test

| | Bisyllabic | Trisyllabic | Polysyllabic |
|---|---|---|---|
| Bisyllabic | | P > 0.05 | P < 0.05 |
| Trisyllabic | | | P > 0.05 |
| Polysyllabic | | | |

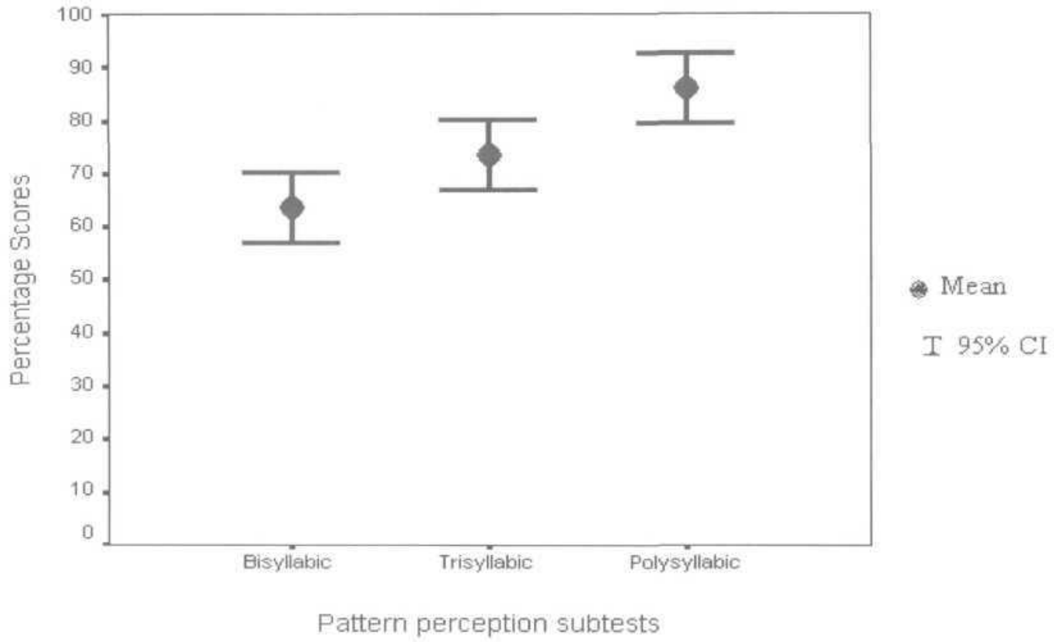


Figure 4: Mean and 95% confidence interval of the bisyllabic, trisyllabic and polysyllabic word scores within the pattern perception test of the standard version.

### 2.3 Comparison of bisyllabic identification scores and vowel identification scores

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 (Figure 5).

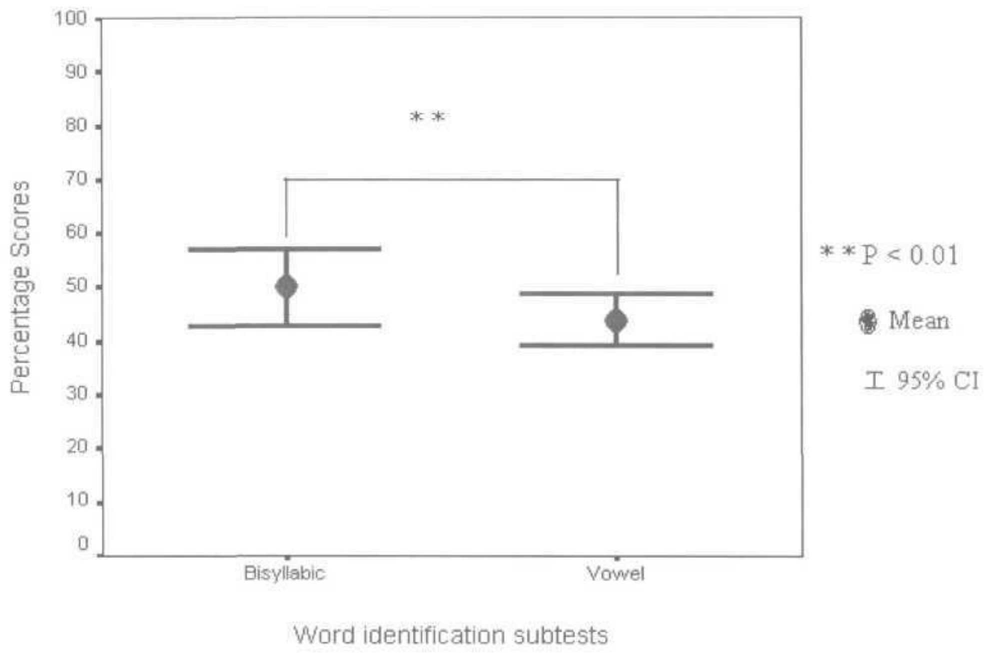


Figure 5: Mean and 95% confidence interval and significance level for the bisyllabic and vowel identification test scores of the standard version test.

### 3. 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 Figure 6 and 7 for pattern perception and word identification score respectively.

Table 4: 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 age groups (Figure 6). In contrast, for the word identification tests, there was a significant difference ($p < 0.001$) between the two groups (Figure 7).

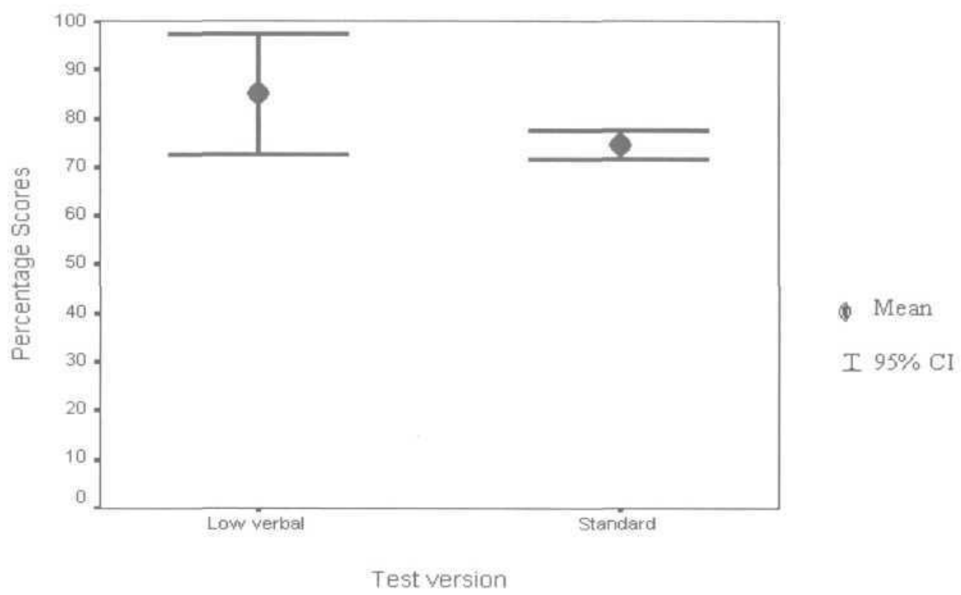


Figure 6: Mean scores, 95% confidence interval for the pattern perception scores between low verbal version and standard version.

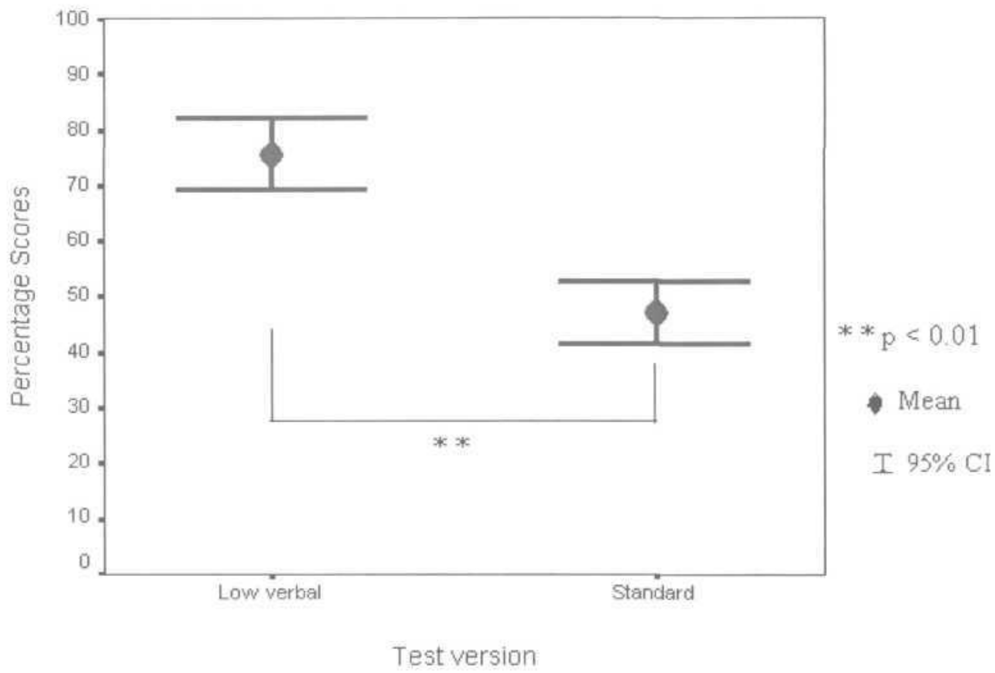


Figure 7: Mean scores, 95% confidence interval and significance level for the word identification tests between low verbal version and standard version.

The analyses of the data obtained on the low verbal version and standard version of the 'Early Speech perception test in Malayalam', revealed the following information:

For the *low verbal version* of the test the overall mean scores on the pattern perception test was significantly better than the overall word identification scores. However, there was no significant difference between the bisyllabic and trisyllabic word identification test scores.

For the *standard version* the mean percentage scores of overall pattern perception test was significantly better than word identification test scores. Likewise, 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.

On comparing the *low verbal version and standard version* it was observed 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 better in the older group compared to the younger group.

# Chapter 5

# DISCUSSION

The results of the study are discussed in relation to findings obtained for the low verbal version meant for children aged 2 to 3 years and the standard version meant for children aged 3 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 subjects 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, 1976; 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 test.

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.

The similarity in performance of the younger children of the present study, in the identification of bisyllabic and trisyllabic words, indicates that they found both equally easy. Hence, it is recommended that in case children are not cooperative for the entire test, either one of these subtests could be used, during evaluation. However, it could be preferable that both subtests be administered to improve the reliability of the test findings.

**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 & Wang, 1976; Risberg, 1976; Hack & Erber, 1982). Better pattern perception over word identification was also reported by Moog & Geers (1990), Begum (2000) and Tamilmani (2002).

It was also found that the mean percentage scores for the polysyllabic pattern perception test were significantly better than the mean trisyllabic pattern perception test. Further, the trisyllabic pattern perception test was significantly better than the mean bisyllabic pattern perception test.

It was found in the present study that the bisyllabic word identification score were 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. However, formant discrimination was elevated in the F2 region by almost 100%, where the greater hearing loss occurred, rather than in the Fl 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 present study revealed that the older group performed significantly better 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 et al. (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.

Thus, from the findings of the current study it is recommended that each version of the test (low verbal and standard version) be used for the appropriate groups. The choice of version should be selected not just based on the age of the children, but also based on their vocabulary. For those children who have limited vocabulary, the test may be administered after appropriate training. However, the audiologist is recommended to mention whether the responses are influenced by training or not, as the responses are likely to vary depending on this. It is also recommended that as quickly as possible the standard version of the test should be administered.

# Chapter 6

## SUMMARY AND CONCLUSIONS

There is a need to evaluate speech perception abilities as early as possible, in children with hearing impairment. This needs to be done despite them having a low vocabulary level. The present study was carried out to construct an 'Early Speech Perception Test in Malayalam' for children with hearing impairment in the age range of 2 to 5 years. Two versions were developed. The *low verbal version* (version I) was constructed to evaluate children in the age range of 2 to 3 years and the *standard version* (version II) to evaluate children in the age range of 3 to 5 years. Both the versions evaluate two aspects, i.e. syllable categorization and word identification. The difference between the *low verbal version* and *the standard version* was in terms of the type of subtests in the word identification tests and the number of test items.

The study was carried out in two phases. Phase I included the construction of the test material. To construct the test material a pilot study was carried out on 30 normal hearing children in the age range of 2 to 5 years. Only items that were familiar to 90% of the children were selected for the tests. Care was taken to see that each test and subtests contained low, mid and high frequency speech stimuli.

The second phase of the study was carried out to evaluate the performance of 20 children with hearing impairment on the test constructed. Out of these 20 children 10 were in the age rang of 2 to 3 years and 10 in the age range of 3 to5 years.

The analyses of the data obtained on the low verbal version and standard version of the 'Early Speech perception test in Malayalam' revealed the following information:

For the *low verbal version* of the test the overall mean scores on the pattern perception test was significantly better than the overall word identification scores. However, there was no significant difference between the bisyllabic and trisyllabic word identification test scores.

For the *standard version* the mean percentage scores of overall pattern perception test was significantly better than word identification test scores. Likewise, 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.

On comparing the *low verbal version* and *standard version* it was observed 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 better in the older group compared to the younger group.

From the findings of the present study the following can be inferred:

The developed test material can be administered on children with hearing impairment in the age range of 2 to5 years who are exposed to Malayalam for a period of 6 months or 1 year prior to being tested.

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.
- 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.
- The reliability of performance of children can be checked by comparing the scores of the two trials of the tests. The scores should not differ considerably between the two trials.
- The test can be used to determine the appropriate candidacy for the amplification system
- The material can be used to evaluate the performance of pre-therapy and post-therapy performance of children with hearing impairment
- It can be used with children with delayed and / or deviant language abilities, such as mental retardation and cerebral palsy.

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# APPENDIX I

## LOW VERBAL VERSION

### Pattern Perception Test

ആ..........................ɑ:

വാ വാ വാ വാ വാ vɑ vɑ vɑ vɑ vɑ

### Word Identification Test

*Bisyllabic Word Identification Subtest*

കണ്ണ് kannu

പൂച്ച pu:tʃɑ

പശു paʃu

മാങ്ങ maŋɑ

*Trisyllabic Word Identification Subtest*

കസേര kasera

തവള tavala

പൂമ്പാറ്റ pu:mbta

കടുവ kaduva

## APPENDIX II

## STANDARD VERSION

### Pattern Perception Test

*Bisyllabic pattern perception test*

കണ്ണ് kannu

മാല mɒla

മുട്ട mutta

പാമ്പ് pambɘ

*Trisyllabic pattern perception test*

പൂമ്പാറ്റ pu:mbta

കുതിര kutira

വിമാനം vimanam

മത്തങ്ങ matŋa

*Polysyllabic pattern perception test*

കാളവണ്ടി kaḷvandi

തലമുടി talamudi

അലമാര alamara

മുന്തിരിങ്ങ muntiriŋa

*Bisyllabic word identification subtest*

മാങ്ങ maŋa

കുട kuda

| | |
|---|---|
| പന്നി | panni |
| വായ | vaja |
| കയ് | kajə |
| പല്ല് | pallə |
| ചക്ക | tʃaḳa |
| പട്ടി | patti |
| പൂച്ച | pu:tʃa |
| പശു | paʃu |
| മൂങ്ങ | mu:ŋa |
| ചെവി | tʃevi |

***Vowel idenification test***

| | |
|---|---|
| പട്ടി | pati |
| പെട്ടി | peti |
| പുട്ട് | pu:tə |
| പൂട്ട് | putə |
| പാറ | paṭa |
| പൊട്ട് | pottə |
| പിന്ന് | pinnə |
| പീലി | pɪli |
| പേന | pe:na |
| പൈസ | pæjsa |

## APPENDIX III

## SCORE SHEET

## LOW VERBAL VERSION (VERSION I)

Name:

Age/Sex:

Age at which hearing loss identified:

Age at which started wearing hearing aid:

Audiological findings:

Hearing aid:

**Pattern perception test**

| | TRIAL | A1 | A2 |
|---|---|---|---|
| a: | | | |
| va va va va va | | | |

Toatal score:

**Bisyllabic word identification subtest**

| | AV | Al | A2 |
|---|---|---|---|
| kannu | | | |
| pu:tʃa | | | |
| paɟu | | | |
| ma:ŋa | | | |

Toatal score:

**Trisyllabic word identification subtest**

| | AV | Al | A2 |
|---|---|---|---|
| tavala | | | |
| kasera | | | |
| pu:mbta | | | |
| kaduva | | | |

Toatal score:

# APPENDIX IV

## SCORE SHEET

## STANDARD VERSION (VERSION II)

Name:

Age/Sex:

Age at which hearing loss identified:

Age at which started wearing hearing aid:

Audiological findings:

**Pattern perception test**

| | | |
|---|---|---|
| kannu | | |
| pɑmbɘ | | |
| mutta | | |
| mɒlɑ | | |

| | | |
|---|---|---|
| pu:mbta | | |
| kutira | | |
| mɑt̪ŋɑ | | |
| vimanam | | |

| | | |
|---|---|---|
| kaɭvandi | | |
| talamudi | | |
| alamara | | |
| muntiriŋɑ | | |

Toatal score:

***Bisyllabic word identification subtest***

| | AV | A1 | A2 |
|---|---|---|---|
| maːŋa | | | |
| kuda | | | |
| panni | | | |
| vaja | | | |
| kajɔ | | | |
| pallɔ | | | |
| tʃaka | | | |
| puːtʃa | | | |
| paʃu | | | |
| patti | | | |
| muːŋa | | | |
| tʃevi | | | |

**Vowel identification subtest**

| | AV | A1 | A2 |
|---|---|---|---|
| pɑti | | | |
| pɑṭɑ | | | |
| putɘ | | | |
| pu:tɘ | | | |
| peti | | | |
| pottɘ | | | |
| pinnɘ | | | |
| pɪli | | | |
| pe:nɑ | | | |
| pæjsɑ | | | |

Total score:

**APPENDIX V**

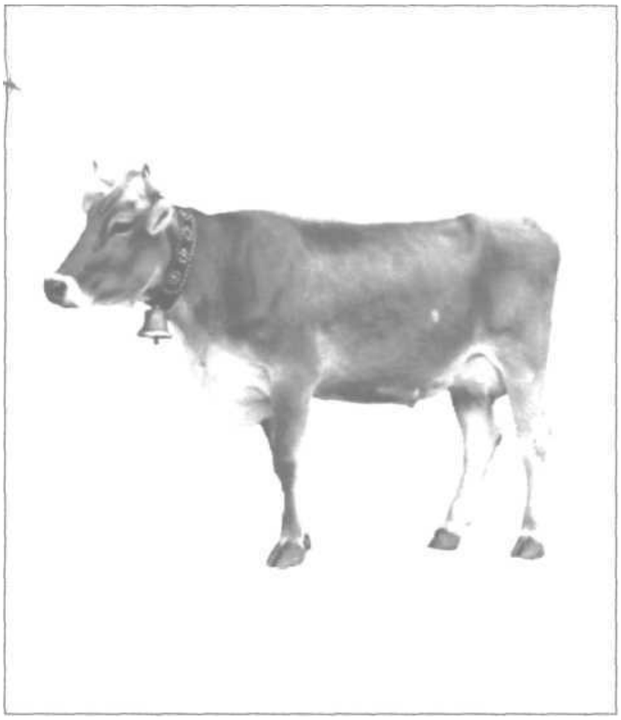
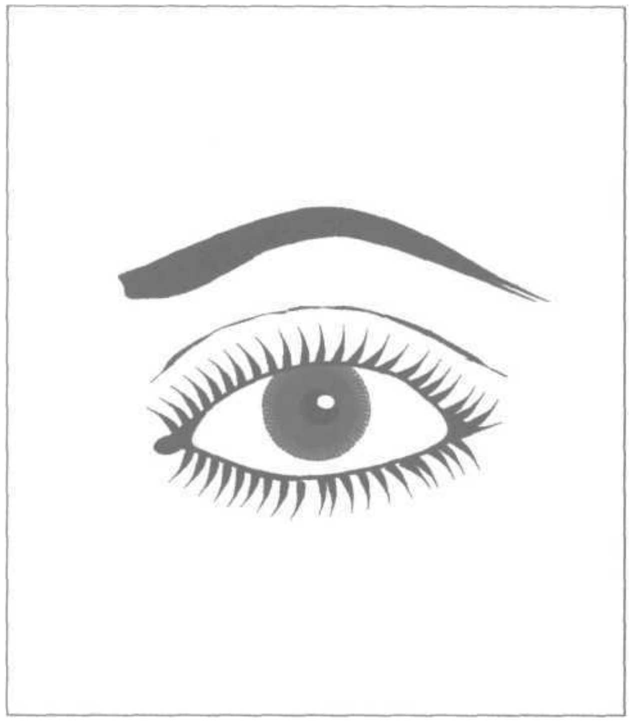
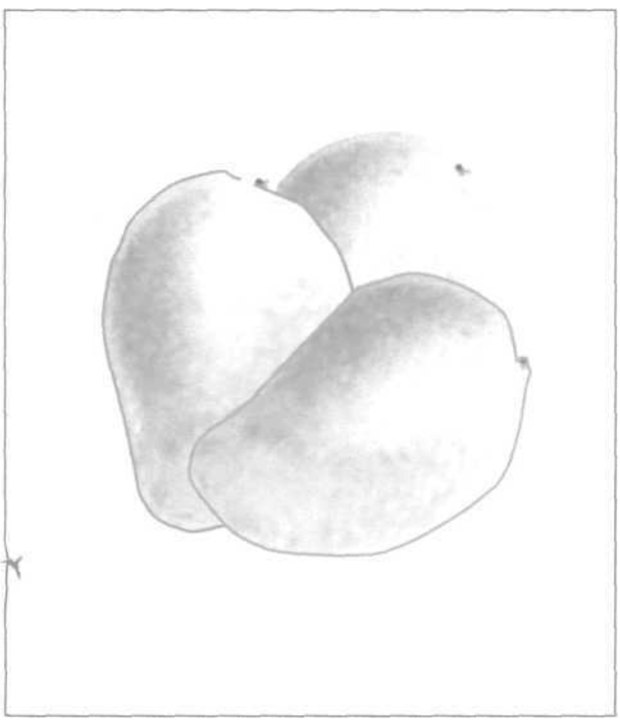
# PATTERN PERCEPTION TEST

## VERSION-I

# WORD IDENTIFICATION TEST:

## BISYLLABIC WORD IDENTIFICATION SUBTEST

## VERSION-I


# WORD IDENTIFICATION TEST:

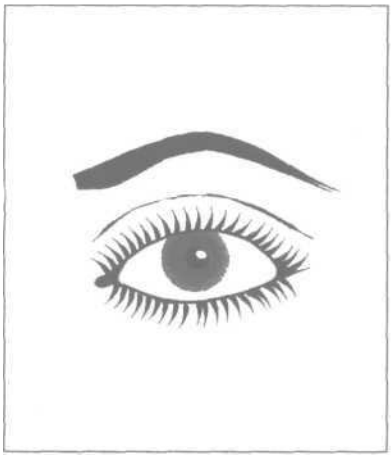
## TRISYLLABIC WORD IDENTIFICATION SUBTEST

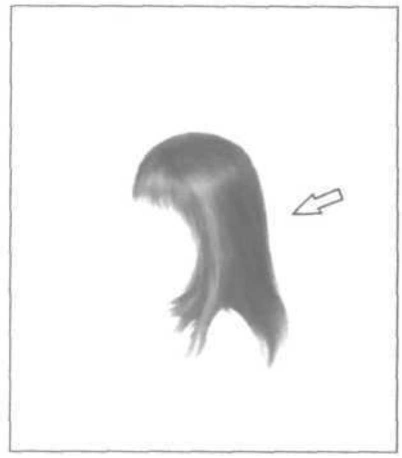
VERSION-I

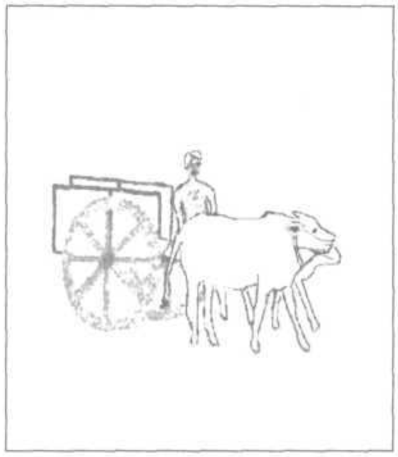
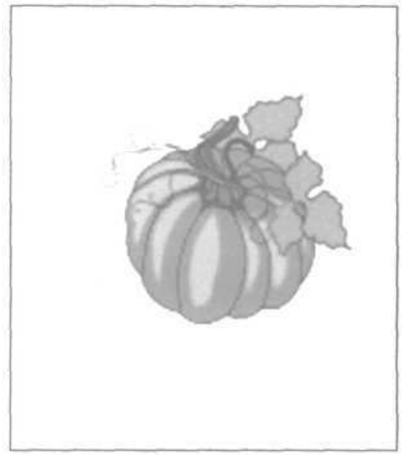


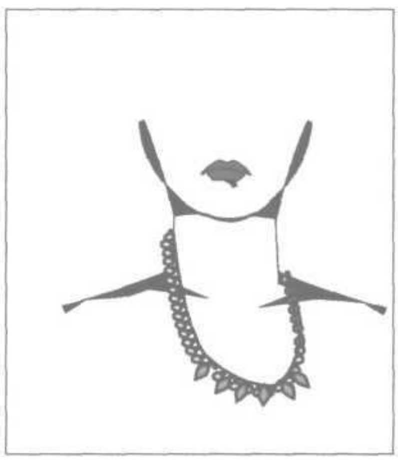
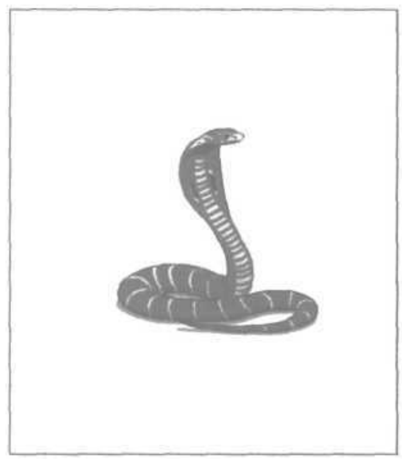

# PATTERN PERCEPTION TEST

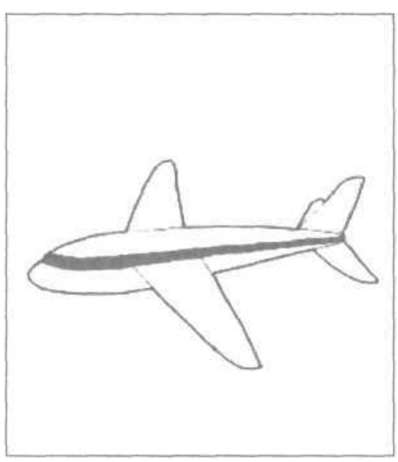
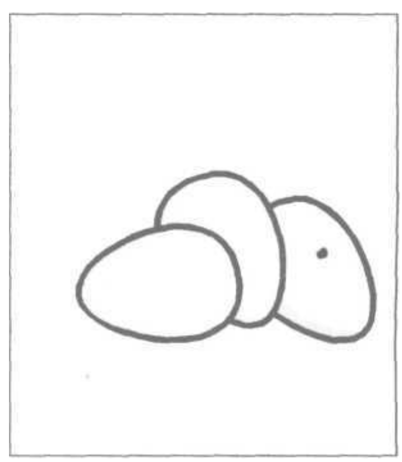
VERSION-II





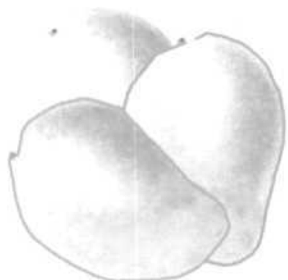
# WORD IDENTIFICATION TEST:

## BISYLLABIC WORD IDENTIFICATION SUBTEST

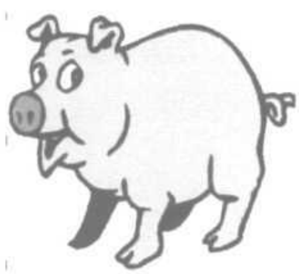
## VERSION-II









# WORD IDENTIFICATION TEST:

## VOWEL IDENTIFICATION SUBTEST

VERSION-II