A SPEECH PERCEPTION TEST FOR ENGLISH SPEAKING HEARING IMPAIRED INDIAN PRESCHOOLERS

Register No. M9918

Independent Project submitted as part fulfillment for the First year M. Sc. (Speech and Hearing), submitted to the University of Mysore, Mysore.

All India Institute of Speech and Hearing
MYSORE-570 006.

MAY 2000

All India Institute of Speech and Hearing
MYSORE-570 006.

CERTIFICATE

This is to certify that this Independent Project entitled **"A SPEECH PERCEPTION TEST FOR ENGLISH SPEAKING HEARING IMPAIRED INDIAN PRESCHOOLERS"** is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearmg)of the student with *Register No.* M9918

DIRECTOR,
All India Institute of Speech & Hearing
Mysore - 570 006

Mysore
May, 2000

CERTIFICATE

This is to certify that this independent project entitled **"A SPEECH PERCEPTION TEST FOR ENGLISH SPEAKING HEARING IMPAIRED INDIAN PRESCHOOLERS"** has been prepared under my guidance and supervision.

Asha Yathiraj.

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May, 2000

DECLARATION

This Independent Project entitled "A SPEECH PERCEPTION TEST FOR ENGLISH SPEAKING HEARING IMPAIRED INDIAN PRESCHOOLERS" is the result of my own study under the guidance of Dr. ASHA YATHIRAJ, Reader in Audiology, AIISH, Mysore, and has not been submitted earlier at any University for any other diploma or degree.

Mysore

May, 2000

Register No. M9918

Dedicated

to

Amma and Vappa

You encouraged me to dream and prayed for my dreams to come true . . . .

First and foremost, I would like to thank Dr. Asha Yathiraj, Reader in Audiology, All India Institute of Speech and Hearing, Mysore. Madam your esteemed corrections and guidance has helped me complete this study. *Thank you.*

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

CHAPTER 1

INTRODUCTION

The sounds of speech constitute a distinctive class drawn from sets of sounds that can be produced by the human vocal mechanism. The sound of speech are distinctive. A signal is heard as either speech or non-speech and once heard as speech elicits characteristic perceptual Junctions. (Studdert-Kennedy, 1976).

The poetic phrase "words written in water" evokes an ephemeral and transitory image. Speech is no less transitory. The spoken message is a rapidly decaying acoustic disturbance in an ocean of air. The listener who would try to capture this signal must follow its temporal course in the environment that are often noisy, reverbent and otherwise disruptive. (Kent 1992).

If the listeners are not quick to grab the meaning, they do not perceive what they heard and the signal disappears. Speech perception is a complex process that allows us to concentrate on our goal of making sense out of speech (Ryalls, 1996).

Speech perception is a part of communication process. Speech and language provides the vehicle for the transmission of idas from one person to another and it plays a key role in the process.(Boothbroyd, 1991).

A. variety of mechanisms (neurologic, physiologic, linguistic, etc.,) are involved in speech perception which enables the listener to extract acoustic signals. This ongoing signal must be split into a series of language units such as phrases, words, syllables.

After the message is spoken, a neural image of retained to support its linguistic interpretation, and if necessary, its reinterpretation. The prevailing view among those who study speech perception seems to be that it is "just one segment after another". There is a considerable disagreement of exactly what the segment is. Suggestions range

from some small acoustic segment to phonemes to a sound sequence of about 200 msec duration and syllables to words, or even phrase or clause. (Kent 1992).

It is doubtful if any one unit satisfactorily accounts for all the data on speech processing (Kent, 1992). There are two direction to the resolution of the problem:

1. Two or more units can be considered as potentially involved and then they can either interact or one of them can be selected depending on their relative suitability in a listening situation.

2. We might propose that auditors' processing is not strictly and solely a matter of sequential with recognition.

Speech perception is not a simple entity that can be evaluated with a single metric. It is an inferential process involving interactions among several factors. Some of these factors are found in the speech stimulus, some in its context and some in the knowledge and skills of the perceiver.

All these factors has to be considered while constructing speech identification tests. Special consideration has to be given when constructing tests for the paediatric population.

SPEECH TESTS FOR PAEDIATRIC POPULATION:

Speech audiometry is a more natural way pure tone audiometry in measuring the auditive ability in the child (Martony et al, 1970). It has came into existence because of some inherent advantage over pure tone audiometry. Some of the reasons which proves the use of speech as stimuli for assessing young children are:

1. Speech audiometry helps in early detection of slight losses which are otherwise over looked (Martony et al 1970).

2. Speech is by far the most important class of sound that one hears (Martony et al, 1970).
3. A child pays close attention to verbal stimuli than non-verbal stimuli (Hardy & Bordley, 1957).
4. Speech items have higher face validity than non speech items (Bunch, 1934).
5. A child finds speech tests easier and less abstract than puretone tests and are willing to participate (Olsen and Matkin, 1979).

Speech audiometry serves a number of useful and valuable functions. Measurements made during speech audiometry includes tests for speech detection, speech reception and speech discrimination as well as most comfortable and uncomfortable loudness levels. Thus it is an important element in the audiological test battery (Boothroyd, 1991).

Results of the speech audiometric tests aid the clinician in such matters as aural (re) habilitation, referral for medical treatment, education placement and very importantly selection of hearing aids.

Efforts to develop speech materials suitable for paediatric speech audiometry dates back to at least the 1940's, concurrent with the pioneering work of Carhart & Hudgins and their colleagues (1979). Haskins (1949) developed word materials for speech audiometry in children with limited number of test items representative of the vocabulary of kindergarten children. Watson (1957) used same principle of test construction to generate word and sentence paediatric speech audiometric materials.

Siegenthaler (1975) advanced paediatric speech intelligibility testing by emphasising that response paradigms, as well as test items should be modified 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, 1977; Elliott and Katz, 1980; Moog & Geers 1990). Some of

them have been developed for the Indian population, Abrol, 1970; Kapur, 1971; Swarnalatha, 1972; De, 1973; Mayadevi, 1974; Samuel, 1976; Mathew, 1996; Rout, 1996; Vandana, 1998; Prakash 1999.

The present study was aimed to construct an English word list for Indian children in the age range of 2 to 5 years.

AIM OF **THE STUDY:**

The objectives of the present study were:

1. To develop a speech perception test for English speaking hearing - impaired Indian children.
2. To establish whether young hearing impaired children perceive only the supra segmental aspects of speech on both supra segmental and segmental aspect of speech.
3. To study the effect of age on the speech perception scores.
4. To study the effect of gender on the speech perception scores.

NEED FOR A SPEECH IDENTIFICATION TEST FOR YOUNG, INDIAN - ENGLISH SPEAKING CHILDREN:

It is ideal to have speech identification tests in all languages as the individuals perception of speech is influenced by his first language or mother tongue (Singh 1966; Sing & Black, 1966). But there are some practical difficulties in achieving this ideal. This is because in India, there are fifteen official languages and as many as 1652 dialects (Manorama year book, 1990).

Another problem in the use of speech identification tests in Indian language is that the tests should be well versed with all those languages and dialect variations in

order to be able to score either oral or written responses of the subject. In addition, owing to the small number of speech and hearing centers, one gets cases from various region where different language are in usage. Therefore, a test of regional language would also be of limited utility. Hence English serves as a better alternative for test materials for speech intelligibility tests in the paediatric population. The following are some of the reasons that justify the use of English as a language of testing in Indian population:

1. English is being taught right from the kindergarten and nursery schools.
2. English is spoken by many people in India and therefore it is a common language to a large population and thus more children are exposed to English even before they attend school.
3. Most audiologist in India know English.
4. Each center to clients from various language backgrounds including English.

NEED FOR THE STUDY:

Various researchers have attempted to develop materials for speech identification tests for the Indian population. However, most of them have aimed at developing work lists for adults. Mayadevi (1974) and Malini (1981) standardised monosyllabic word lists for adult. Swarnalatha (1972) developed materials for both adults and children.

While testing speech identification in children, one must consider the respective modality to be used. Researchers have recommended use of a picture pointing, closed-set task for children (Ross & Lerman, 1970; Erber, 1977; Elliott & Katz, 1980; Moog & Geers, 1990; Rout, 1996;Mathew, 1996; Vandana 1998;Prakash 1999).

There were some tests developed and standardised for Indian population which did not have the pictorial representation of the word list (Swarnalatha, 1972) and tests were developed for older children (Rout, 1996; Mathew 1996; Vandana, 1998; Prakasb. 1999) and no test is available for children as young as 2 years old. Moreover, none of the

tests standardisd for Indian population has considered the pattern perception. Thus the need for developing a test of speech perception for the paediatric Indian population is stressed.

The present provides tests for differentiating between word of varying syllable length i.e, syllable categorization and word identification. The test involves a picture pointing task, a scoring sheet and normative data for the use of speech perception in Indian children.

The developed test could be used for the following reasons:

1. To evaluate speech perception in those children with limited language levels.
2. It aids in the understanding of communication capabilities to help professionals clarify the direction to be taken in evaluation or (re) habilitation.
3. To decide regarding the choice of an appropriate device to be worn by the child.
4. To evaluate the progress of hearing impaired children after auditory training.

CHAPTER-2

REVIEW OF LITERATURE

Speech audiometry is an important component of the paediatric audiological evaluation to assess the child's ability to identify the speech stimulus. The audiogram provides no information on how well (or badly) a child may be able to process the time relationships which are so important to speech intelligibility. A child's ability to identify speech stimuli may not be well correlated with his ability to detect puretones (Erber, 1980; Ross & Randolph, 1990). Speech audiometiy helps in earlier detection of even slight losses, otherwise over looked and to determine his social adequacy index. (Carhart 1965).

Tnese seems to be a considerable audiometer range with which prediction of speech perception performance can be inaccurate for which actual speech perception testing is required. Such tests are important for both diagnostic and prognostic purposes. (Erber, 1980; Ross & Randolph, 1990).

APPLICATIONS OF SPEECH TESTS:

There are various applications of these speech tests. Some of which are reported by Carhart, 1968 and Plant & Spens, 1995.

1. There are useful in confirming the audiograms.
2. They are helpful in describing the relative intelligibility and the rating method.
3. They are useful in the differential diagnosis of retro-cochlears vs peripheral disorders.
4. They are useful in establishing hearing aid candidacy.
5. They are helpful in evaluation of monoaural, binaural and the side of fitting of amplification devices.
6. They help to evaluate aided and unaided differences.
7. They help to evaluate relative effectiveness of hearing aid electro-acoustics.

8. They also help in determing the amount of auditory training that is required.
9. They also help in predicting real world communication effectiveness.
10. They may be used to see if synthetic speech correlates with it. If there is a correlation synthetic speech can be used to understand fundamental speech perception abilities.

VARIABLE AFFECTING EVALUATION OF PAEDIATRIC HEARING IMPAIRED POPULATION:

The following section reviews the various factors that must be considered while evaluating the performance of the paediatric population on speech perception task. These factors can be grouped under the following:

I. Variability of the material for testing.

a. Stimulus material.
b. Acoustic cues in speech.
c. Phonetic vs phonemic balance.
d. Number of test items.
e. Word familiarity.
f. Closed set vs open set format
g. Test retest reliability.

II. Variability at the level of transmission:

a. Room acoustics and reverberation.
b. Presentation level.
c. Response method.
d. Recorded vs monitored live voice testing.
e. Talker variability
f. Carrier phrase.
g. Number of times the stimuli are presented.

DDL Variability at the level of Reception:

a. Age at onset of hearing loss.

b. Current age of the chid.

c. Degree of hearing loss.

d. Individual variability.

e. Amount of training obtained by the children.

I. VARIABILITY OF THE MATERIAL USED FOR TESTING:

Even before the advent of discrimination tests and electronic audiometers, informal testing of speech understanding was done by simply speaking to the person and making judgements about his ability to understand (Penrod, 1972). Traditionally all materials of speech audiometry have been lists of single words either monosyllabic (the PB word) or bisyllabic (the spondee lists) (Watson, 1957).

The ideal auditory perception test for the prelingually hearing impaired children should be designed with three goals in mind according to Carhart (1965). These include:

1. It should provide for the assessment of speech understanding in people who demonstrate a wide range of auditory skills.
2. The test should be designed so the individual can respond non verbally if necessary.
3. It should provide a base of information from which aural rehabilitation can evolve.

There are many variables have to be considered while selecting the test material for the evaluation of speech performance, especially in the childrea

a. Stimulus Materials:

Traditional approach to the quantitative study of speech intelligibility have employed a wide variety of verbal materials ranging from the very analytic to reasonably synthetic. They have included nonsense syllables, phonemically balanced monosyllable words, bi-syllable words (including both spondaic and unselected stress patterns).

Sentences and continuted discourse (Fletcher & Steinberg, 1929; Fletcher, 1929; Miller & Weiner & Stevens 1946; Hudgins et al 1947 & Egan 1948).

Erber (1979) categorised the material as the following:

1. Phonemes, syllable and words.
2. Phrases and sentences. (Erber, 1979).

The phonemes, syllables and words are widely used as test materials (Hudgins, 1954; Watson, 1957; Boothroyd, 1968; Erber, 1971; Ross, Kissler, Philips & Lerman, 1972; Danielsen 1973; Cramer & Erber, 1974; Erber 1974b; Erber, 1979; Boothroyd, 1995). The advantage of such brief stimuli are as follows:

a. Many can be presented within a short time.
b. They are easily scored right or wrong.
c. They can be presented within a closed-set format.

The drawbacks of such stimuli are as follows:

a. They do not form the typical content context fo everyday speech communication.
b. Child's performance may be related to his or her perception of connected speech.

Nonsense Syllable:

Information about a person's ability to recognise the individual phonetic elements of a language could be obtained simply by presenting these individual phoneme and asking the observer to repeat what he hears. The most usual spoken units are combinations of,

a. A consonant followed by a vowel
b. A vowel followed by a consonant
c. A vowel between two consonants (Boothroyd, 1991).

Hirsb. (1952) recommends the use of nonsense syllables as they are devoid of meaning and hence their intelligibility is no way dependent upon the vocabulary of the

observer. Fletcher & Steinberg (1930) stated the advantage of the nonsense syllable as that they permit detailed analysis of the type of phonemic errors made by the listener why testing and additionally, the effects of word familiarity and memory is also reduced.

Hirsh (1952) and Fletcher & Steinberg (1930) stated few major advantages with the use of nonsense syllables. They are,

- ✓ Nonsense syllables permit detailed analysis of the type of phonemic errors made by the listners while testing.
- ✓ The effective of word familiarity and memory are reduced with the use of nonsense syllables.
- ✓ Hearing aid assessment and aural rehabilitation at which time phonemic error analysis may be important.
- ✓ Nonsense syllables are more sensitive to minimal loss.
- ✓ The use of nonsense syllable eliminates the linguistic cues, that may contaminate the test performance.

Carhart (1965) reported that the nonsense syllables are non-redundant, a property essential for a test of speech identification. It is easier to construct lists of comparable difficulty using non-sense syllables than by using meaningful material (Egan, 1948).

Researchers have stated various disadvantages in the use of nonsense syllable for the evaluation. Some of them are:

- ➢ Lists of nonsense syllables have limitations in any testing program because of the difficulty encountered in eliciting appropriate responses.
- ➢ Nonsense syllables are unfamiliar to the children.
- ➢ They are abstract and are very confusing to the listener.
- ➢ They need special training to be read out in the intended way.
- ➢ The subjects always has an unconscious tendency to look for a meaning in the sound presented to him and to reproduce it as a known term.

(Hirsh, 1952 & Carhart, 1965)

Tyler (1995) states that it is not possible to fully understand speech perception ability by studying responses to isolated non-speech segments. Particularly for young children, speech is a more meaningful stimuli, and is therefore more likely to capture and hold their attention, when extensive testing is required.

There are some situations where the use of non speech stimuli may be helpful such as removing the effects of vocabulary or producing a simple test for young prelingually deafened children.

Various studies have been done using the nonsense syllable as test material. Edgerton & Danhauer (1979) developed a nonsense syllable test (NST) consisting of seven test modules with 9 syllables in each module and the three vowels /i/, /a/ & *Iu/*. Danhauer et al (1984) assessed the performance of children's phonemic perception for age range of 8 8-14.8 yars. Butte et al (1987) & Dubino et al (1982) reported excellent predictive relations between the NST errors and the weighted pure tone averages for slight to marked sensori neural hearing loss.

Nonsense syllable tests may be made easier by an increase in phonetic context, such as when the vowel context in know in a VCV test; or by limiting the number of phonemes tested, such as the Ling 7 sound test (Ling, 1976).

Plant (1984) & Boothroyd (1986) recommended the usage of nonsense syllables as test item for those children older than 6 years and 5 years respectively. Among the Indian studies for the paediatric population, Mayadevi (1974) had recommended the usage of nonsense syllable for evaluation of children above 15 years. This readily eliminates the need to control the influence of receptive language ability on test performance and the need to consider the effect of extra auditory (cognitive) factors on children's performance.

From the review it can be noted that nonsense syllables are usually not used Children, especially younger Children- However, they have been used with older children.

Monosyllable Words:

Monosyllabic words are less analytic unit of speech and as more easily repeated than non-sense syllables (Egan, 1948). Monosyllables are preferred because they are non-redundant and are meaningful, not as confusing as nonsense syllables (Carhart, 1965).

Giolas (1975) supported the use of monosyllables as it is possible to construct word lists that are highly familiar and can be easily manipulated to represent colloquial speech. Tobias (1964) stated that monosyllabic words are useful in that they are a specificform of speech because they are a good representation of every day conversational speech. Boothroyd (1968) states that the use of monosyllabic words enables the tester to determine the articulation function rapidly.

The phonetically balanced kindergarten - 50's test (Hasktns 1949) is a conventional speech perception test using monosyllables and was constructed using normal hearing adults. Sanderson - Leepa & Rintelmann (1976) state that the normal hearing preschoolers, at 3 1/2 years of age, yielded lower scores than older children. Thus it can be used with youngsters of receptive vocabulary age of atleast that of normal hearing kindergasten children.

Schwartz (1971), Hodgson (1973) & Sanderlon - Leepa & Rintlman (1976) reported that an item analyses for eachof the four lists of the WIPI test (Ross & Lerman 1970) would be useful clinical information especially for testing pre-school age children. A similar item analysis was not accomplished for the PBK-50 (Haskins 1949).

There are many monyllabic speech identification tests that are popularly in use, such as Kendall Toy Test (Kendall, 1953) intended for very young children, i.e., three to five years; the word intelligibility by picture identification (WIPI) (Ross & Lerman, 1970) appropriate for children whose receptive vocabulary is 4 years or greater; the Monosyllabic Trochee and Spondee test (MTS) (Erber & Alenwicz, 1976) for children in

the age range of 6 years and above; the Discrimination by Identification of Pictures (DIP) (Siegenthaler & Haspiel, 1966) for children in the age range of 3-8 years; North-Western University children's perception of speech - NU-CHIPS, (Elliott & Katz, 1980) appropriate for children as young as 3 years of age; The early speech perception test (ESP) (Moog & Geers, 1990) for the age range of 2-5 years.

Many of the test materials constructed for the Indian population utilise monosyllabic words as stimulus. Some of them are given by Swamalatha(1972) for children in the age range of 7-15 years; Rout (1996) to be tested on children in the age range 6 to 8 years; Mathev. (1996), Vandana (1998) and Prakash (1999) in the age range of 3-6 years.

Bisyllable Words:

There are some languages without concrete monosyllable words. In such launguages the bisyllabic list for speech identification is used. These words are more popular as stimuli for speech reception threshold than for identification testing because of the redundant cues they provide. They are less analytic than the monosyllables and also provide additional acoustic cues. (Hirsh, 1952).

Bisyllabic words have been found to yield higher intelligibility than monosyllabic words under the same conditions. But it does not give an accurate measure of a person's speech intelligibility as there is greater amount of redundancy present in these stimuli. (Penrod, 1990).

Huges et al., (1947) put fourth certain criteria in construction tests with disyllabic words. They are:

a. The words used should be familiar to the listeners.
b. The test items should be dissimilar in phonetic construction.
c. They should be normal representation of speech sounds of the language.

d. They should have similar audibility values.

There are various speech identification test using bi-syllabic words as stimulus material, such as, children's Spanish word discrimination Test (Comstock & Martin, 1984); Monosyllabic Trochee Spondee Test (MTS) (Erber & Alenwicz, 1976); Glendonald Auditory screening procedure (Erber, 1982); Plott Test (Plant, 1984); Early speech perception (ESP) (Moog & Geers, 1990);. Speech perception test in Tamil & - Telugu, (Kapur, 1971);. Disyllabic speech test in Malayalam, (Kapur, 1971);. A picture test of speech perception in Malayalam, (Mathew, 1996);. Speech identification test for Kannada speaking children. (Vandana, 1998).

Sentences:

The phrases and sentences are very desirable as test materials because they represent what a hearing impaired child normally encounters in daily conversation. (Speaks, Tarker, Harris & Kuhl, 1972; Wilcox & Tobin, 1974; Sims, 1975).

Sentences are considered to be more valid indicators of intelligibility. The relation between word lists used in the measurement of intelligibility and the continuous flow of words encountered in conversations is not clear. They somehow do no typically assess word recognition. The clinicians should thus use larger linguistic units such as sentences, rather than single words to assess intelligibility. Eventhough sentences represent the spoken communication they are not frequently used, because of the difficulty involved in the construction of such tests. (Penrod, 1972).

Many of the sentence tests are been constructed for the adults, such as sentence intelligibility lists at Bell Telephone Laboratories, Fletcher & Steinberg (1930); Kent State University (KSU), Berger (1969).

Jerger et al., (1980, 1981) described the use of realistic speech material including sentences to control the reception language factor in children by incorporating the actual responses of normal youngsters between the age of 3 and 6 years. This is the paediatric speech intelligibility (PSI) test recommended to be used even for very young children as young as 21/2 to 3 years old.

The sentence tests constructed for the paediatric population are as follows, the paediatric speec intelligibility test (PSI) (Jerger et al., 1980); The BKB sentence list (Bench, Kowal & Banford, 1979); A sentence test for measuring speech discrimination in children (Weber & Redell, 1976); synthetic speech identification test in Kannada (Nagaraja, 1977); The common objects Token Test: A sentence test for profoundly hearing impaired children (Plant & Moore, 1992).

In conclusion for the evaluation of paediatric population their age, language level and the purpose of testing should be considered while selecting the test to be administered.

b. PHONETIC VS PHONEMIC BALANCE:

The speech tests constructed can be either be 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. Egan's(1948) phonetically balanced lists were devised to meet the following criteria:

a. Monosyllabic words.
b. Equal average difficulty
c. Range of difficulty.
d. Phonetic composition of each list.

The requirement of phonetic balance was the most difficult to meet since definitive study of spoken English existed. Hirsh et al., (1952) report of frequently occuring words in print and the report of French et al., (1930); Denes (1965); Mines et al., (1978) of the most frequently occuring sounds in telephone conversations.

The necessity of phonetic balance has been questioned, and there is no agreement on this point. Tobias (1964) indicated that the phonemic balance is an interesting but unnecessary component. Carhart (1965) stated that, in general as long as the test item is meaningful monosyllable for the patients and their phonetic distribution is appropriately diversified, one 50 word compilation is relatively equivalent to another.

Phonemic balance is normally measured seperately for initial and final consonants and is based only on the distribution of phonemes in monosyllables in spoken language. (Dillon & Ching, 1995) Lehiste and Peterson (1959) refers phonemic balancing as the apperance of a phoneme in a list with respect to its frequency of occurance in a particular language.

Most of the speech tests were phonemically balanced word lists. The rationale for using a 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. (Dillon & Ching, 1995).

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

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

Haskins (1949) developed a list of 50 PB words, all within the vocabulary of small children. These phonemically balanced word list are from a kindergarten level vocabulary for children as young as 3 years of age.

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 the evaluation of paediatric population.

c. ACOUSTIC FREQUENCY COMPOSITION:

The frequency content of the speech signal is factor capable of affecting speech audiometry performance. French & Steinberg (1947) demonstrated the importance of high frequencies for correct identification of CVC syllables. Similar findings are seen as reported by Hirsh et al., (1954) using filtered CIW-22 monosyllables.

The prominent role of high frequencies energy with respect to speech understanding becomes even more conspicuous when one examines the relativephonetic power of individual speech sounds. It is the high frequency energy that contains the least power and yet it is these sounds which provide the major contributions of intelligibility. (Fletcher, 1929).

The frequency of the test material should be evenly distributed as low, mid and high frequency sounds. Most phonemically or phonetically balanced tests incorporate this. Ling's seven sound tests (1976) though not phonetical or phonemically balanced also includes low, mid and high frequency speech sounds.

d. NUMBER OF TEST ITEM:

A test must be reliable enough to measure significant differences (Boothryod, 1991). The reliability of a test is partly related to the number of items: a test with more items is more reliable than the same test with fewer items. (Thornton & Raffia, 1978).

The test construction is affected by the limited language abilities of the hearing impaired children, the restricted word knowledge of children with profound hearing impaired, especially if the hems must be picturised to elicit a response from the child (Osberger, 1995). Thus a test for paedia population may have as few as 5 test items. (Erber, 1980). A limited number of items requires relatively large changes in performance for statistical significance to be reached. It also requires a number of equivalent lists of forms that can be developed (Osberger, 1995).

The number of item is the primary determinant of test reliability and is thus one most important charactristics of speech test. (Dillon & Ching, 1995). This creates problem while testing young children with short attention span. For this reason many tests have been designed with a small number of test items, 20 or less. Sometimes test can be repeated two or three times and the scores added. (Thornton & Raffin, 1978).

There are many tests available for children with varied number of items ranging from five (Auditory number test (ANT) Erber, 1980; McCormick Toy test (1977) to as many as fifty (North-western University children's perception of speech (NU CHIPS) Elliott & Katz, 1980). The choice of these depend on the purpose of the test.

Among the tests standardised for Indian population, the tests that have the least number of items, i.e., 50 are those given by Mathew (1996), Rout (1996), Vandana

(1998) and Prakash (1999) and the maximum number of items i.e., 100 was given by Abrol(1971).

The review indicates that it is preferrable to use a phonemically balanced and adequate number of items for the evaluation of very young children. Most of the tests test older children have 50 test items and test for younger age group children have items as low as 5. The above studies conclude that the number of times should be less to retain the attention span and at the sametime it should be valid.

e. WORD FAMILIARITY:

One of the important variables that can affect the scores of the speech tests is the familiarity of the words to the target subjects. There is no doubt that the use of item that are not in the vocabulary of the patient can have a marked effect on performance. It is the responsibility of the audiologist to select materials that are 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 mismanagement (House, 1957; Hutton & Weaver, 1959; Owens, 1961; Carhart, 1965; Epstein & Owens, 1969).

Plant & Spens (1995) state that the familiarity of words will have several effects on the difficulty of speech tests:

a. If a test contains a high proportion of relatively unfamiliar words, then the total score will be lower than if more familiar words had been used.

b. If word familiarity, is on the average higher in one list than in another, then the equivalence of lists for difficulty will be adversely affected.

c. Within a list, a range of familiarity of words will affect the range of difficulty of the items within that list.

Myklebust (1964) reported that children who have a profound hearing loss since birth will usually have a much narrower vocabulary than normal children of their own age. Thus the familiarity of a word needs to be viewed in the context of the people whom test is to be administered.

Rosenwig & Postman (1957) reported that when the stimulus word is marked in noise only a part of it is discriminated and the subjects language tends to favour a small number of competing responses relatively high in frequency of occurance.

Pollack, Rubenstein & Decker (1959) & Egan (1957) found practice effect reduced the influence of word frequency. Owns (1961) stated that a person with high intelligence and superior verbal ability would find more test words familiar and can take advantage of available phonetic cues resulting in higher discrimination score than a person with lower level of intelligence and low verbalability.

Schuhz (1964) showed a marked tendency for highly familiar words to be substituted for incorrectly identified words. Devaraj (1983) has reported similar findings on English speaking Indians. Thus it is recommended that the test item should be familiar while evaluating the hearing impaired children as the vocabulary can have a marked effect of the speech identification scores.

f. CLOSED SET VS OPEN SET FORMAT:

Speech tests are often categorised as open response or closed response. In closed response format, the response alternatives are provided so that the child can correctly identify the stimulus item based on perception of event a part of the word which distinguishes it from the others. They are generally easier than open sets, where the listener repeats verbally as write down the sound that they thought they heard. The

scores based on perception of words may vary greatly depending on the nature of the task. (Dillon &Ching, 1995).

Miller et al (1951) & 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 difficult the task and lower the scores. The difficulty of open set tasks also varies with the amoung information in the stimulus and its familiarity.

Levitt & Resnick (1978) have given two advantages of closed set response as follows:

1. Incorrect response can be analysed to provide useful diagnostic information.
2. The experimenter can tailor the choice of response fails to meet specific needs.

The closed set response format have been finding increasingly wide application in research studies on speech perception in the hearing impaired (Schultz, 1964; Owens & Schibert, 1968; Pickett et al 1970; House, Williams, Hecker & Kryter, 1965; Bilger & Wang 1976). This is used in the testing of young children where pointing to one of several pictures is a common response mode.

Profoundly deaf children, who use hearing aids typically are able to understand words presented auditorily only in situations in which the choices are known and represent broad acoustic differences. Such children are rarely able to understand words presented open-set without response choices available. (Moog & Geers, 1991).

Martin (1987) reported that whatever, might be the response method, it must be remembered that speech tests of hearing should investigate the listener's high function, not their speech production on their mental, physical, linguistic or educational abilities.

Owens, Benedict & Schubert (1971) & Owens & Schubert (1977) insists on using a multiple choice (or closed set) format because it permits clearest isolation of phonemes and it would equalize the number of response alternatives for all parts. Miller, Heise Litchen (1951) & Pollack, Rubenstein & Decker, (1959), recommend control on word familiarity.

Hodgson (1973) & Sanderson - Leepa & Rintelmann (1976) compared the speech discrimination performance of children in the age range of three and one - half and five and one-half on the word intelligibility by picture identification. (WIPI), a closed message set test requiring no verbal response and the PBK-50 (Haskins, 1949) an open message set test. They reported that children in the age range of three and three and one-half years scored better on the WIPI test than the PBK-50 test. But for children in the age range of five and five one-half years, both WIPI and PBK 50 appear to be appropriate tools, provided the children have good speech and normal language development.

There are many tests for speech perception in children ranging from 2 to 6 years old (Toy test for young children who have English has 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 tests standardised for Indian population there were open set response tests for children as young as 5 years old (PB word list in Hindi, Abrol, 1971; speech perception test in Tamil and Telugu, Kapur, 1971) to 10 years old. (A common discrimination tests for Indian languages, Mayadevi, 1974).

The tests that used close set response for children range from 2 years old (Early Speech Perception test, Moog & Geers, 1990) to 10 years old (NU-CHIPS (Elliott & Katz, 1980). The closed set response test for 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 apt for children as young as 2 years of age. However, as children get older, an open set task can be used.

g. TEST-RETEST RELIABILITY:

Speech identification tests measure and express the scores in a variety of ways. For a test to serve a useful purpose, a test must be able to place a subject in an appropriate category of subjects on differentiate his performance in a variety of listening situations. In the first of the these cases, the clinicians must be concerned with two source of errors.

1. The relation between test performance and the para meter of interest. (Diagnostic category or extent of communicative impairment).

2. Consistency across alternate forms of the test (Thornton & Raffin, 1978).

According to Boothroyd (1991), 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 tests have been designed with a small number of items, 20 or less. However, it is usually insufficient to evaluate differences between tests, particularly if chance performance on the test is 25% (a four-choice test) or 50% (a two choice test) correct.

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

Egan (1948) suggested the variability of a test score is a function of the test score itself. He pointed out that when different forms of a test are used to compare performance across list, conditions and the clinician cannot always determine whether differences in scores are a result of differences in test conditions or differences in test forms. Thus tests with greater reliability scores should be preferred.

The above variabilities should be considered during the construction of speech perception tests.

II. VARIABILITY AT THE LEVEL OF TRANSMISSION

a. **ROOM** ACOUSTICS AND REVERBERATION:

Sound reaching a listener in a reverberent field is composed of energy, while the direct signal will decrease in intensity according to inverse square law (Roller & Crum, 1974). The reverberant energy that is maintained by the room's surfaces will build up and may even exceed the intensity of the direct sound. (Finitzo-Hieber & Tillmanl978).

According to Lochner & Burger (1964) there is a complete integration of the reverberance or reflected sound with the direct signal up to about 30 msec and atleast partial integration between 30 and 80 msec.

In a room with a reverberant time of 1.2msec or ever 0.4 msec, the reflected energy may change some of the important aspects of a speech signals and interfere with speech intelligibility by producing a "time-smearing" or distortion of the original signal (Houtgast & Steeneken, 1972).

Several evidence suggest that the acoustical environment in classrooms can affect the achievement and performance of the hearing impaired children. (Ross & Giolas, 1971; Ross, 1972; Crum & Matkin, 1976; Finitzo-Hieber & Tillman, 1978).

Nabelek & Pickett (1974) studied the influence of noise and reverberation on binaural and monoaural speech discrimination through hearing aids and reported a binaural advantage of 3dB for the normal listeners and 1.5dB for the hearing impaired group was independent of reverberation time.

People with normal hearing typically require an S/N ratio of + 6dB for the reception of intelligible speech. Due to auditory distortion of the hearing loss itself, persons with a hearing problem need an S/N ratio of +20dB (Gengel, 1971; Hawkins, 1984). It is a well established fact that in the presence of noise with normal hearing and hearing impaired individuals have difficulty in understanding speech (Ross et al., 1965; Olsen & Tillman, 1968; Olsen, Noffsinger & Kurdziel, 1975; Ross, 1978).

Gengel (1971) found that the children having a moderate to severe sensori neural hearing loss required a S/N ratio of atleast + lOdB and preferably + 20dB to function effectively. Thus the noise level should not be more than 40dB on the C scale or 30dBA, presuming that the average speech level at a distance of 3 feet to 15 feet would be 60dBSPL. Fourcin et al., (1980) recommended similar noise levels.

Testing should be carried out at appropriate room situations and noise level.

b. PRESENTATION LEVEL:

A measure of word recognition ability to an optimal presentation level is used to determine the degree of clarity with which the child hears speech (Hodgson, 1973). The effects of presentation levels on understanding of different stimulus materials can easily be visualised by employing the performance intensity (PI) functions. (Carhart, 1965; Boothroyd, 1968). It is not always practical to obtain an articulation function in routine testing (Boothroyd, 1968). Thus it has been suggested for routine testing purposes, speech intelligibility be obtained at one particular level.

Carhart (1965) pointed out that by making use of just 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 presentation level of the stimulus depends on the purpose of the test. It can be increased decreased or kept same to obtain desired measure.

Moog & Geers (1990) state that the test should be administered over a high quality amplification initially, the clinician estimate both the child's detection threshold and preferred listening level for speech using a bracketing procedure. During testing, the child is encouraged to listen to speech stimuli at least 20dB above his detection level (Erber & Witt, 1977). The hearing impaired listener generally required speech amplified to 20-30dB above threshold (Gengel & Foust, 1975).

Live voice should always be presented while the examiner is viewing his output on a sound level meter or vu meter or through an audiometer. The overall level should be 70dBA (Geers & Moog, 1988, 1989).

Researchers who used speech sounds or monosyllabic words as stimuli showed that children with moderate to severe hearing losses typically require acoustic speech levels 20 to 40dB above then speech detection levels to obtain maximum auditory or auditory-visual recognition scores (Numbers & Hudgins 1948; Hudgins 1954; Pickles, 1957; Watson 1957; Dahle 1979; Gengel 1974).

The influence of sensation level (SL) speech perception has not been demonstrated to clearly for children with profound hearing losses. These children may be distinguished further on the basis of their recognition of simple speech material, example spondee words (Erber 1974 a). The profoundly hearing impaired children score low and phoneme or word recognition tests, regardless of the acoustic stimulus level (Number & Hudgins 1948; Hudgins 1954;/Watson 1957; Erber 1971).

Researcher's have stated various presentation levels at which the speech identification scores reaches the maximum. Giolas (1975) obtained a maximum score at 60dBSPL, Tillman & Carhart (1966) at 32dBSL, Katz & Elliott (1980), Abrol (1971), Mayadevi (1974), Gosh (1988) at Kapur (1971) Swamalatha (1972) Mathew (1996), Rout(1996), Vandana (1998) & Prakash (1999).

c. RESPONSE METHOD:

Penrod (1972) that the response mode may also adversely affect speech discrimination scores i.e. oral/ written responses. The response made is a variable that should be considered while administrated any sp indent test (Penrod, 1972). The response modes that have been used include oral responses, written responses or picture printing.

With written responses factors to be considered are legibility of writing, eye-hand co-ordination, spelling ability visual acquity and the available time Written responses generally require more time. With either talk-back or written responses, auditor error may affect the scores (Merrell & Atkinson, 1965). Written responses have been advocated as a means of eliminating auditor error (Northern & Hattler, 1974).

The standard speech audiometric tests which were developed for adults, require echoic or written responses, thus limiting their use for evaluating children, especially for those who exhibit disordered and / or delayed language. These consideration have led to the development of several speech-hearing tests involving picture pointing tasks, requiring a closed-set picture pointing response to a word stimulus. For example, the threshold fay identification of pictures (MP) tests (Siegenlthaer & Haspiel 1966) and the word inteffigibility (WEPI) tests (Ross & Lerman 1970).

The responses method for speech test should be one that enables the evaluation of receptive language and not the physical, cognitive or writing skills of the child. For hearing impaired young children picture pointing is recommended as response method.

d. RECORDED VS MONITORED LIVE VOICE TESTING:

Speech tests may be administered by means of phonographic or tape-recorded presentations and by monitored live voice (MLV) (Penrod, 1972). Taylor (1985) noted that recorded test materials are preferable over live-voice materials for a number of reasons:

1. The acoustical characteristics of the recorded stimulus can be measured or analysed
2. There is less opportunity for bias introduced by the talker unintentionally showing down or talking more clearly or loudly.
3 The same test conditions can be exactly repeated to the child at another time or to another child.
4. In monitored live voice, the talker often familiar to the child and this may inflate performance.
5 The talker could mispronounce the word.

Carhart (1946, p46) indicated that "phonolographic presentation increases the stability of the condition but tends to reduce the flexibility of the technique" but was of the opinion that both procedures had clinical utility. 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

Taylor(1985) reported that some children respond more consistently to tester in live voice than difficult to test recorded material. Live voice data are more acceptable and are better than no data at all, provided that the data are truely representative of the child's performance.

The use of monitored live voice has been prevalent due to its flexibility, rapidity and ease of administration. A great deal of importance should be given to the talker variability (French & Steinberg 1947; Hirsh et al 1954; Palmer 1991; Silverman & Hirsh 1955; Carhart 1965; Brandy 1966; Kruel et al 1969; Tillman & Olsen 1975; Gengel & Kupperman 1980).

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

It is recommended to use the monitored live voice with young children due to the flexibility involved.

Moog & Geers (1990) recommend the use of computerised speech tests which take into account the advantages of both live and recorded voice testing.

The history of the use of computer in health care came into picture with the burst of micro computers in the 1980's. A revolution in audiometry equipment soon followed. Micro-computer systems are becoming highly more useful for hearing testing (Stach, 1988).

Early applications of computers in speech audiometry involved simple control over signal presentation level, (Wittich et al., 1971). Recently, development of computer based speech audiometry has progressed in two directions:

1. The use of the computer as a digital tape player.
2. The use of the computer for audiomating adaptive speech audiometric procedures. (Stach, 1988).

Speech signals can be presented at a pace that is consistent with an individual patients response time and can be repeated with ease, thus impacting positively on test efficiency. By using a micro computer as a digital tape player, live voice testing can be mimicked and the procedural limitations inherent in conventionally recorded materials can be eliminated. (Stach, 1988).

Advantages using a computer based speech audiometry includes:

1. Digital representations of speech signals do not deteriorate over time(Campbell, 1974).
2. Sophisticated alterations such as time compression can be made relatively easily(CampbelL 1974).
3. Inter-laboratory consistency will improve substantially(Campbell, 1974).
4. Control over stimulus presentation can be enhanced. (Campbell, 1974).
5. Stimulus presentation can be easily randomised by the computer. (Stach, 1988).
6. Test-retest reliability comparisons within the computers threshold reveals high correlations and small discrepancies (Campbell, 1974; Cook & Creech, 1983).

There are number of inherent problems in the use of analog magnetic tape players and thus majority of speech audiometry is still carried out using live-voice testing which is a concept with procedural limitations. (Kamm et al., 1980; Martin & Sides, 1985).

Stach (1988) reported two major disadvantages of micro-computer based systems. Such as,

1. Personal or professional choice may be limited.
2. They often require substantial initial capital outlay. An integrated system is necessarily expensive and the cost/benefit ratio requires careful considerations.

Moog & Geers (1990) have used computerised form of the early speech perception (ESP) test for children in the age range of 2-5 years. Thus, from the review on recorded vs monitored live voice testing, it can be noted that most experts recommend the use of recorded material. However monitored live voice is found to be more flexible. The advantages of both recorded and monitored live voice can be got by the use of computer-recorded speech material.

e. TALKER VARIABILITY:

Not much attention has been paid to the role of the tester in speech discrimination test. The linguistic background of the tester, his familiarity with the test words, his hearing acquity, his attention, fatigue and criteria for scoring the responses are significant variables. (Merrell & Aktinson, 1965; Markides, 1978).

The source of talker variability on live voice presentation such as speaker's fundamental frequency, voice characteristics and stress pattern becomes apparent during the development of the speech perception test for children. (Moog & Geers 1990).

The words that are expected to be represent equal stress, so that correct identification can be based only on perception of spectral cues, may actually be identified on the basis of supra segmental cues unintentionally added by the speaker Geers (1994) reports the above in the study on children.

Pisoni (1992) stated 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 voice. When tests items are spoken by more than one talker, listeners performed poorer on speech intelligibility tasks. (Creelman, 1957; Peters, 1995).

Single talker's presentation of the same words will vary at different times (Brandy, 1966). Kruel et al (1969) reported that the scores for repeated testing for either of the two talkers on different occasions are not significantly different.

Peters (1995); Cole, Colheart & Allfard (1974) found that the response latencies to 'same' judgments were slower when target words were produced by two different

voices. Balota & Chumbley (1984) reported response latencies to be fester for words in single talker condition than words in multiple talker condition.

Similar finding were found in children in the age range of 3-5 years by Pisconi & Martin (1986), Mulleni k, Pisconi & Martin (1989).

Windbalm (1990) claims that talkers can adjust their speech intelligibility according to the conversational situation such as, when they converse in noisy environment or when they communicate with someone who has a significant hearing loss.

Anecdotal reports and research findings indicate that a talker's speech intelligibility can influence the speech perception performances of individuals who receive the spoken message. Experimentally, several investigations have demonstrated that difference exist in speech intelligibility across talkers. (Creelman, 1957; Hood & Poole, 1980; Kruel, Bell & Nixon, 1969; Mullenix, Pisconi & Martin, 1989; Magnuson &Nusbaum,(1993).

It is also pointed out that the text result obtained by different talkers are not reading comparable unless the equivalency of talker has been demonstrated (Carhant 1965) using the same unfamiliar talker across different children and across different test sessions for the same child would reduce different talker variability. (Taylor, 1985).

Most of the research on talker variability, suggest that all speech tests should be carried out with minimal talker variability.

f. CARRIER PHRASE:

Carrier phrase is one of the variables that has influence on speech identification scores. Use of carrier phrase in speech audiometry is assumed to alert the listener for the test word and allows the announcer to monitor his voice, but usually the exact context of the carrier phrase is not considered important. (Egan, 1944; Carhart, 1952). Peterson 1970 and Gladstone & Siegenthaler, 1972 have reported the influence of a preceding phoneme on a succeeding one and that this influences the intelligibility of speech.

Fletcher & Steinberg (1930) reported increase in score of the identification of CVC syllables when using an introduction sentence. Kruel et al (1969) reported similar findings employing the modified Rhyme test. Northern & Hattler (1974) found that when a carrier phrase was omitted discrimination scores were worse. 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.

Kreul & Moll (1972) have speculated that the carrier phrase contains acoustic cues for some manner of articulation distinction for initial consonants and also for the tongue advancement cues for syllabic nuclie of the test word. When the test material is presented in a carrier phrase, the effects in phonemes adjacement to the test item can help identify the target.

Gladstone & Siegenthaler (1972) compared the effect of the 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 scores with a long vowel /ei/ at the end as it has greater potential for being influenced by the phonemes of the word and follow and gave additional cues to intelligibility.

Lynn & Brotman (1987) also agreed that the carrier phrase "you will say...." contains perceptual cues that may assist the listener in identifying initial sounds.

McCormick (1977) recommended using the phrase "show me....." in the evaluation of monosyllable word identification in the Toy discrimination test.

(Mathew 1996) in the picture test of speech perception in Malayaam had used "point to....." for children in the age range of 3-6.5 years. Prakash (1999) had used "show me...." as a carrier phrase for children in the age range of 3-6.5 years in the picture identification test for children in Tamil.

In conclusion it is recommended to use carrier phrase that alerts the children and those that does not affect the acoustic characteristics of the stimuli.

g. **NUMBER OF TIME THE STIMULI ARE PRESENTED:**

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

Repeating the test stimulus creates two problems:

1. If some children receive repetitions and others do not, it provides an unfair advantage for the former group.
2. Even if all children receive the same number of repetitions, these many be individual differences, unrelated to the information provided by the amplification system, that confount the results. (Boothroyd, 1995).

Millers (1981) reported altered perception and categorisation of signal with changing speaking rate. Nygaord, Sommers & Pisoni (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 poorer scores. Similar findings were obtained by Mullenix & Pisoni & Martin (1989).

Northern & Downs (1974) have reported that initially the carrier phrase can be presented at 50dBHL or greater and depending on the response, the intensity can be increased, decreased or kept the same.

III. VARIABILITY AT THE LEVEL OF RECEPTION:

a. AGE AT ONSET OF HEARING LOSS:

One of the most important factors in speech perception in children is their exposure to speech in the first 2 to 3 years of life. During this early period the child is exposed to hundreds of thousands, perhaps millions, of speech utterances that begin to form templates of these meaningful acoustical signals in the brain.

Tyler, 1995 categorises deafness based on age of onset of profound deafness. They are:

1. Children can be bom with a profound hearing loss and never develop a speech memory. (Congenital).
2. Children can lose their hearing after only a limited exposure to speech (prelingual - non congenital).
3. Children may lose their hearing after the speech memory has been firmly established. (Post-lingual).

Stevenson (1977) stated that whether the handicap of hearing loss is prelingual or post lingual the effect it has on the individual is the same i.e., difficulty to communicate with the hearing and speaking world.

Boothroyd (1984) stated that when hearing loss is present at birth, or acquired post-lingually all aspects of knowledge and skill are at considerable risk and marked population heterogenity should be assumed. A prelingually acquired severe or profound

hearing loss is likely to have more serious long term effects in speech perception than others-

There exist great inter child variability in the amount of speech memory children develop for a given amount of exposure to spoken language. Some children may develop useful memory if deafhed at 1 year, others may have a poor speech memory if deafened at 3 years children who have been deaf for many years may forget some of the speech sounds they once heard. (Boothroyd 1984).

Severe congenital or prelingual deafness have a greater impact on language, voice and articulation beause the individuals does not develop communication in a natural way. This individual does not have the acoustic stimulation of language and accurate feed back of his own speech procedures (Katz & White 1982; Ballantyne, 1970). To facilitate optimum language development in hearing impaired children, the acquisition of receptive language utiliated early, perferable by 4 months but no later than 6 months. (Pappas, 1985).

It is well known that the language and communication skills of hearing impaired are, on the average much poorer than these of their normal hearing peers (Levitt & McGarr 1988).

Thus the age of onset of hearing loss must be considered as an important factor for the construction of speech test material.

b. CURRENT AGE OF THE CHILD:

Speech perception tests should not be influenced by factors unrelated to perceptual abilities, particularly, limitations imposed by childrens vocabulary, physical abilities etc., (Tyler 1995).

It is necessary to ensure that the test words are within the vocabulary of the child. Otherwise an error would not reflect the inability of the child to perceive or recognise the stimulus rather a limitation in the vocabulary of the child.

Children must understand what is required of them, the response must be within their physical abilities and the test should measure the perceptual abilities and not their concentration. Test sessions lasting more than 10 to 15 minutes are quite difficult for very small children. Many do not have the memory capabilities to listen and respond to a 4 to 6 items, sentences or choices. (Boothroyd, 1991). Thus immediate picture pointing responses can be used for very young children (Ross & Lerman 1970).

Boothroyd (1991) strictly states that children who do not fulfill these requirements should not be tested. Thus for children with very limited language abilities, Finitzo-Hieber et al 1980 described the sound effects recognition Test (SERT) which uses 10 familiar environmental sounds (such as a dog barking, toilet flushing, mother singing etc.,) to evaluate the very young children.

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

It is important to construct test having age appropriate test material. Further, when a test is being selected for administration on a child, it should be done, keeping a chronological of the child.

It becomes very important to be clear about what aspect of speech perception is to be tested and to design a test accordingly. The task should be within the cognitive capabilities of the young subjects, their language capabilities and should be interesting enough to guarantee full participation. The attentional demands should not be too great (Tyler 1995).

It becomes difficult to accomplish these goals because few assumptions can be made about the existence of a knowledge and skills needed to perform speech tests. The younger the child, most difficult it becomes to meet these criteria. Otherwise there is no way of knowing whether poor performance is due to speech perception or to task related difficulties. (Tyler, 1995).

c DEGREE OF HEARING LOSS:

The pure-tone audiogram does not appear to be a good predictor of word recognition ability for subjects with more than 85dBHL. It is also suggested that subjects with similar pure tone thresholds and configuration can vary considerably in their word recognition ability and vice versa (Beasley & Rosenwasser, 1950; Mullins & Bangs. 1957; Kryter, Williams & Green, 1962; Young & Gibbons, 1962; Elliott & Katz, 1983; Ross et al, 1972).

Comparing the normal hearing and hearing impaired, it was found by many researchers, (Scharf, 1978; Hirsh, 1950; Mackeith & Coles, 1971; Tonning 1971) that reduced frequency analyses in the hearing impaired lead to poor speech intelligibility.

Research has demonstrated that those, children with hearing loss above the moderate degree differe considerably in auditory capacity. (Erber 1974; Risberg, 1976). Mostly moderately and severly hearing impaired children indicate through their responses to sound that they can hear, although the sensations may be grossly distorted (Pickett et al., 1972, Risberg, 1977; Boothroyd, 1978).

Profoundly deaf children seem to perceive little more than the gross time and intensity pattern in acoustic speech signals (Erber 1972b). Their responses suggest that they perceive only the rhythric patterns of amplified sound delivered to their ears (Erber 1974b, 1978, Zieser & Erber 1977).

Thus a speech test that is constructed for the hearing impaired, should evaluate both segmental and suprasegmental aspects of speech so that it is able to evaluate the various perceptual abilities of the hearing impaired with varying the degrees of loss.

e. INDIVIDUAL VARIABILITY:

Tests should represent the true performance of the child in natural situations because this is the ultimate communication environment (Boothryod 1991). This is a difficult requirement because it is necessary to develop tests that are independent of confounding variables like cognition memory, vocabulary and grammer.

Hearing impaired children often exhibit neurological or other physical differences as part of the etiology and the resultant behaviours may influence the child's attention skills, visual abnormality, motor development or perceptual skills and normally in attentiveness, seizures and occassional abusive behaviour. (Deconde 1984).

The child's intellectual ability greatly influence the rate of learning and the learning potential. Learning abilities would definately affect the language capabilities of the children (De Conde, 1984).

The socio economic factors influence the development of the child as the same opportunities and programs may not be available for all children. (De Conde 1984). Thus the test which minimises the individual variability should be selected for evaluation of paediatric population.

f. AMOUNT OF TRAINING OBTAINED BY THE CHILDREN:

If the child has been trained on or is overly familiar with the specific test items, the results obtained may over estimate the child's true speech perception abilities.

not be representative of their overall speech perception ability. This also places trained children at an unfair advantage over untrained children. (Tyler 1995).

Complications can also occur when the child is very familiar with the test items. This is particularly a problem when the number of items is small and children can anticipate some of the test items (Boothroyd 1986).

Tyler (1995) noted that it is appropriate to train the child on the same items 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 & Geers (1990) recommend 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.

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

Thus it is recommended to use single word in a closed set picture pointing task for very young hearing impaired children. The test items should be constructed taking into consideration the age at which hearing loss occured, the current age, the child's linguistic capabilities, etc.

CHAPTER 3

METHODOLOGY

The aim of the present study was to construct a coloured picture test of speech perception for hearing impaired children in the age range of 2-5 years. It consists of monosyllable, bi-syllable and tri-byllable words. The test evaluated two aspects, syllable rate and word identification.

The study was carried out in two phases, Phase I for the construction of the test items and Phase II for evaluating the hearing impaired children on the test constructed.

PHASE-I:

This phase involved the construction of the test items which included the following:

a. Development of the material and
b. Carrying out a pilot study to check the familiarity of the test items on normal hearing children in the age range of 2-5 years.

Development of the test material:

The word list used in the study was selected from books for children in the age range of 2-5 years and from the parents and teachers of the target group.

Eighyeight words were collected which included 39 monosyllable, 38 bi-syllable and 11 tri-syllable words. The words were picturised and coloured on flash cards by an artist. These words, were then checked for familiarity on English speaking normal hearing children in the age range of 2-5 years.

Subjects for the pilot study:

Forty normal hearing subtests were selected based on the following criteria:-

1. The subjects were in the age range of 2-5years. There were 20 subject each in age range of 2-3 years and 3-5 years.
2. There were equal number of males and females in each of the age groups.
3. The children had to be exposed to English for atleast one year prior to being tested.
4. The children had no history of ear infection.
5. There was no history of any other disorders or impairments such as speech and language impairment, mental retardation, etc.
6. There was no complaint of any illness on the day of testing,

Procedure for the pilot study:

The pilot study was carried out to ensure that the forty normal hearing subjects were familiar with the eighty eight words that were collected.

Each child was made to sit facing the examiner who presented the cards one by one. Children in the age group 2-3 years shown toys since the younger group got too distracted with the toys, the use of them was abandoned and they, two were shown pictures. The child was required to name items that were presented. If the child was not able to name the spontaneously, the response was elicited by giving some cues regarding the appearance or usuage of the item. For example, for the word "cup" the given clue would be "what do you use to drink milk?". If the child could not name the item still, the next item was presented.

A word was considered familiar only if 90% of the children could identify and name the pictures correctly. Thus forty words were chosen for the age range of 3-5 years with 20, 12 and 8 monosyllabic, bisyllabic and tri-syllabic words respectively. The

similarly twenty-seven words were selected for the age range of 2-3 years with 10,12 and 5 monosyllabic, bi-syllabic and tri-syllabic words respectively. The words thus obtained was used to construct two versions of the test, version I and version II for the age of 2-3 years and 3-5 years respectively. The two versions were based on the vocabulary of the children of the respective age groups. The test was named as "A speech perception test for English speaking hearing impaired pre-schoolers". The detailes of the two versions are given below:-

VERSION -1:

This was developed for children in the age group of 2-3 years i.e., the younger age group. Out of the twenty seven words selected as being familiar to this age group, sixteen words were selected. The choice of these items were based on the frequency distribution. Each of the sub-test had speech sounds representing low, middle and high frequencies. (Appendix I).

The words thus chosen was used in the construction of two subjects for the version I. The words selector were picturised and coloured by an artist.(Appendix V) It is important to state that some of the words were repeated. For example, the word 'ball' was used in the syllable categorization test and also for monosyllable word identification sub-tests. The two tests for this version were as follows:

1. Syllabic categorization Test
2. Word Identification Test
    a. Bi-syllable word identification sub test
    b. Mono-syllabic word identification sub test

The syllable categorization sub-test consisted of 3 words in each of the syllabic group (monosyllable, bi-syllable and tri-syllable). The Bi-syllable word identification and the mono-syllable word identification sub-tests consisted of six words each.(3.1)

TABLE -3.1: Number of items in each test/sub-test in the Version **I :-**

SUBTEST	NO. OF WORDS
Syllable categorization test	9
Bisyllable word identification sub-test	6
Monosyllable word identification sub-test	6

8. VERSION-II:

This version was developed for children in the age range of 3-5 years for i.e., the olders age group. Out of the forty words selected as being familiar for this age group, sixteen words were selected. The choice of these items were based on the frequency distribution. Each of the sub-test had speech sounds representing low, middle and high frequencies. (Appendix II).The items thus selected were picturised and coloured by an artist.(Appendixc VI).

There are two tests in the Version II,

1. Syllable Categorization Test
2. Word Identification Test which includes
    a. Bi-syllabic word identification sub-test.
    b. Monosyllabic word identification subtest.
    c. Vowel identification sub-test.

The syllable categorization test consisted of 4 words in each of the syllabic word group. The bi-syllabic and monosyllabic word identification sub-test consisted of 10 words each. The vowel identification sub-test consisted of 6 words. (Table 3.2).

TABLE - 3.2: NO. OF WORDS IN EACH SUB-TEST IN THE VERSION II.

SUBTEST	NO. OF WORDS
Syllable Categorization Test	12
Bisyllable Word Identification Sub test	10
Monosyllabic Word Identification Sub test	10
Vowel Identification Sub test	6

SCORE SHEET FOR THE TEST:

The scoring sheet for syllable identification was in the form of a confusion matrix, the stimuli along the horizontal axis and the response along the vertical axis. (Appendix III & IV).

The scoring sheet for all the word identification sub-tests are similar to each other. It had three columns, to one note the response to audio-visual mode of presentation and the other two for trial I and Trial II is auditory-only presentation. The responses were marked correct ( ) or incorrect (x)

PHASE - II:

This phase involved the administration of the constructed test on the hearing impaired children in the age group, 2-5 years.

SUBJECTS FOR THE MAIN STUDY:

Thirty-six hearing impaired children were selected based on the followmg criteria:

1. They were in the age range of 2-5 years.
2. They were 9 males, in both the age groups there were 11 females for the age group of 3-5 years and 7 females for 2-3 years group. Thus there were equal number of subjects from both the sexes i.e., 18 males and 18 females.(Table 3.3)

Table 3.3 Distribution of males and females in the both the age groups

AGE RANGE (in years)	MALES	FEMALES
2-3	9	7
3-5	9	11

3. The subjects had to be exposed to English for atleast six months prior to being tested.
4. The subjects who had responses 40 dB or greater in the better ear to warble tones / speech material were selected. This response was based on Behavioural observation Audiometry or Play Audiometry.
5. There was no additional handicap such as mental retardation, other man hearing impairment.
6. There was no complaint of any illness on the day of testing.
7. The children should be aware of normal conversation with their prescribed and hearing aids.

Test Environment:

The data was collected in a sound treated two room set-up. The ambient noise level measured was found to be within the permissible limits recommended by ANSI/1991.

Some of the children who were not co-operative in the test environment were tested in a quiet room situation, maximally free of distractions.

Instrumentation:

The data for the hearing impaired was collected using monitored live voice on a dual channel clinical audiometer Madsen OB822. The output of the audiometer was fed to the loudspeakers.

Administration of the test:

a. In Sound treated room:

There were 9 subjects who were tested in the two room set up. There were seated on their mother's lap at a distance of one meter from the loudspeaker which was placed at a 45° azimuth. The picturised items were placed before them on the table. The words were presented one by one at a presentation level of 50dBHL and the live voice presentation was monitored through the vu meter.

b. In quiet room situation:

There were 27 subjects who were tested in the quiet room situation. They were seated at a distance of 2 feet from the examiner and the test material was placed in front of the subject. The stimulus words were presented one by one at normal conversation level (60 dBSPL).

The subjects were instructed either in English or were demonstrated the activity depending upon their age and language abilities.

Initially for both the environment the care giver was asked as to whether the subjects were familiar with the test items. If they could not carry out the activity with audio-visual cues, they were given training using the test items until they could readily carryout the activity with audio visual mode of presentation.

For the final testing, the test items were presented initially once with audio-visual cues and twice with only auditory cues. The visual signals were cut off by using an embroidery hoop fitted with an a paque cloth which did dampen the acoustic signal. It was as certained that the child was attentive prior to presentation of each signal. The subjects were required to point out to the item picturised.

Out of the 9 subjects who were tested in the sound treated room, 4 of them who were co-operative were tests in both the environments to ensure that reliable and similar results are being obtained in both conditions.

The test items were randomly presented for each of the test / subtest. Invariably, the testing was started by evaluating the syllable categorization followed by the Word Identification Test. Within the Word Identification Test, bisyllables were tested initially followed by monosyllables and vowel identification (the vowel identification was not carried out for the younger age group). The entire testing was carried out in several sessions. The duration of each sessions did not exceeded 15-20 minutes. Depending on the attention span of the child the number of sessions ranged from two session to five session.

SCORING:

The responses for each child was recorded on the scoring sheets provided for the respective age groups. The number of correct responses for each subtest was computed and noted in the scoring sheet. Each correct maximum response was given a score of 0.5
detail of the scoring is given in appendix IV & III

STATISTICAL ANALYSIS:

The data collected from the thirty six subjects were analysed using statistical procedures.

CHAPTER 4

RESULTS AND DISCUSSION

The objective of the present study was to construct a test of speech perception in English for the hearing impaired children in the age range of 2-5 years.

The study was carried out a obtain the following information on the 36 hearing impaired subjects:

A. Performance of the subjects on the syllable categories and the word identification subtests for Version I and Version II
B. The effect of gender on speech perception score.
C. The effect of age on speech perception score.
D. Reliability between the trials, I & II in auditory only made for Version I and Version II of the test.

The first three objects were analysed using the mean, SD range and the paired t-test. The fourth objective, i.e., the correlation between the two trials, trial I and II in auditory only mode was done using Carl Pearlson's co-relation coefficient (Grovetter, 1987).

A. PERFORMANCE OF THE SUBJECTS ON THE SYLLABLE CATEGORIES AND THE WORD IDENTIFIATION SUBTESTS:

VERSION -I:

Version I was developed for the younger age group i.e., 2-3 years. It consisted of the two tests:

I. Syllable Categorization Test and
II. Word Identification Test which includes
    a. Bisyllable Word Identification Subtest
    b. Monosyllable Word Identification Subtest

The tests were administered on 16 hearing impaired subjects in the age range of 2-3 years.

Results and Discussions of Mean, SD and Range.

The mean, standard deviation and the range of the speech perception scores was calculated for all the subjects in the age range of 2-3 years. (Table-4.1).

Table - 4.1: Maximum scores, Mean, SD and range of speech perception scores for sixteen hearing impaired sujects.

SUBJECTS	MAXIMUM SCORE	MEAN	SD	RANGE
Syllable Categorization Test	9	5.75	1.6	3.5-9
Bisyllable Word Identification Subtest	6	2.87	1.1	1.5-4
Monosyllable Word Identification Subtest	6	2.06	0.7	1.3-5

Graph-4.1: Mean Speech Perception Scores for the age group of 2-3 years for all the sub-tests

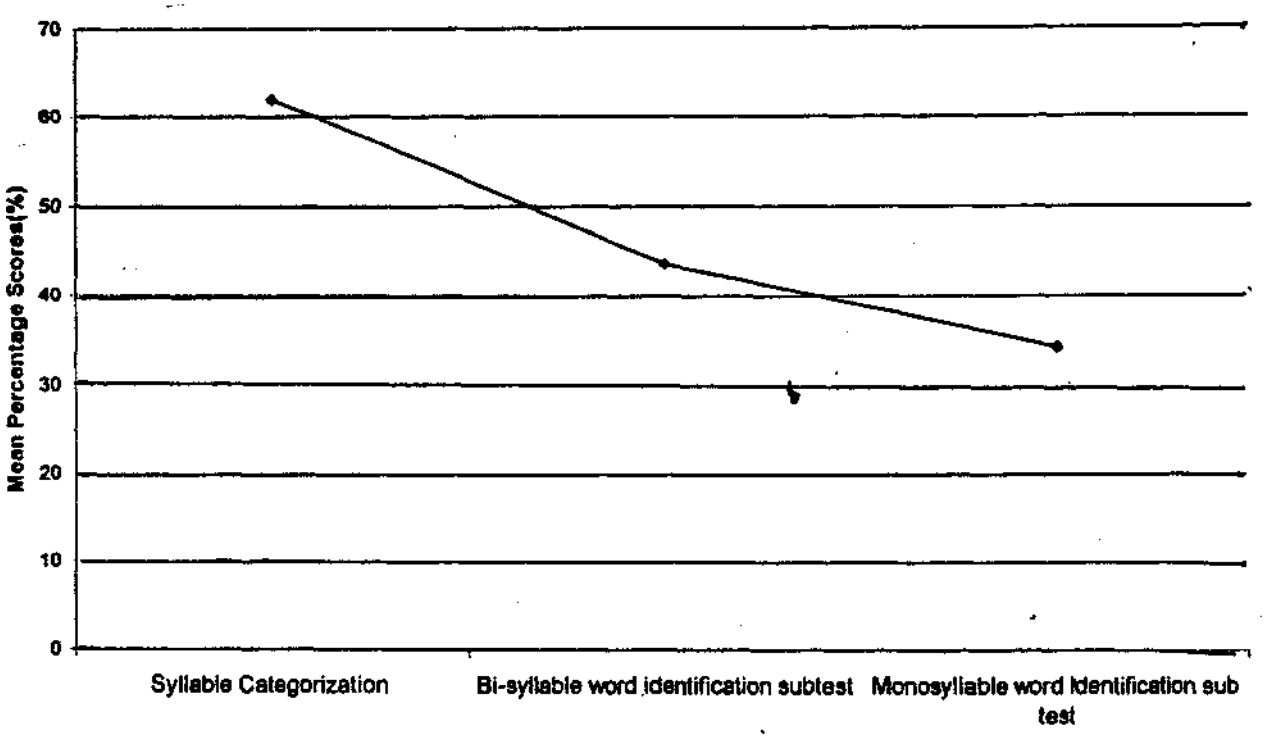


Table-4.2: Significance of difference between means for the various subtests in the Version — I.

SOURCE	T-VALUE	PROBABILITY LEVEL
Syllable categorization Test Bisyllable Word Identification Subtest	*4.* 7	0.01
Syllable Categorization Test Monosyllable Word Identification Sub test	10.27	0.01
Bisyllable Word Identification Subtest Monosyllable Word Identification Subtest	1.09	0.05

As the mean values for the various tests / subtests differed, the percentage scores were computed for comparison. The Fig.4. 1 reveals that the scores obtained by the subjects was maximum (62%) for the Syllable Categorization Test followed by the Word Identification Tests. Within the Word Identification Subtest, the subjects got higher scores on the Bisyllable Word Identification Subtest (43.7%) and the least was obtained for the Monosyllable Word Identification (34.3%).

From the Table. 4.1 it can be noted that the standard deviation was maximum (1.6) for the Syllable Categorisation Test indicating that the variability in the scores obtained by the subjects, were greater than the Bisyllable Word Identification Subtest (1.1) and the Monosyllable Word Identification Subtest (0.6).

Similarly, the range of scores for the subjects was greater in the Syllable Categorisation Test (3.5-9). The scores ranged was large indicating that the test is able to differentiate subjects with good syllable categorisation abilities from those with poor abilities. However, in the Word Identification Subtests, the maximum score obtained by the subjects was closer to the median score. It is possible that with further training and maturation, the children may obtain higher scores on this test.

Results and Discussion of paired 't' test:

Table:4.2, revealed that the mean percentage scores on the Syllable Categorisation Test was significantly greater when compared to both the subtests of the Word Identification Tests (significant at the 0.01 level). Further the Bisyllable Word Identification Subtest was significantly greater than the Monosyllable Word Identification Subtest at the 0.05 level.

The above results reveal that the subects found the Syllable Categorization Test to be easier than the Word Identification Subtests. The former task mainly required the subjects to identify suprasegmental information while the latter required them to identify segmental information also. Similar findings have been noted by Martony, Risberg, Spens & Agelfors, 1972; Erber, 1974; Zieser & Erber, 1977; Bilger & Wang, 1976; Hack & Erber, 1982; Moog & Geers, 1990.

VERSION - II:

Version II was developed for the younger age group i.e., 3-5 years. It consisted of two tests

1. Syllable Categorization Test and
2. Word Identification Tests which includes
    a. Bi Syllable Word Identification Subtest
    b. Monosyllable Word Identification Subtest
    c. Vowel Identification Subtest

The test was administered on 20 hearing impaired subjects in the age range of 3-5 years.

Results and Discussions of Mean, SD and Range:

The mean, standard deviation and the range of the speech perception scores was calculated for all the subjects in the age range of 3-5 years (Table-4.3).

Table-4.3: Maximum scores, Mean, SD and range of hearing speech impaired perception scores for sixteen hearing impaired subjects.

SUBJECTS	MAXIMUM SCORE	MEAN	SD	RANGE
Syllable categorization Tests	12	7	1.87	4-11
Bisyllable identification Subtests	10	3.8	1.37	1.5-7
Monosyllable identification Subtests	10	2.82	1.11	1.5-5.5
Vowel identification Subtests	6	1.82	0.81	0.5-4

Graph-4.2: Mean Speech Perception Scores for the age group of 3-6 years for all the subtests

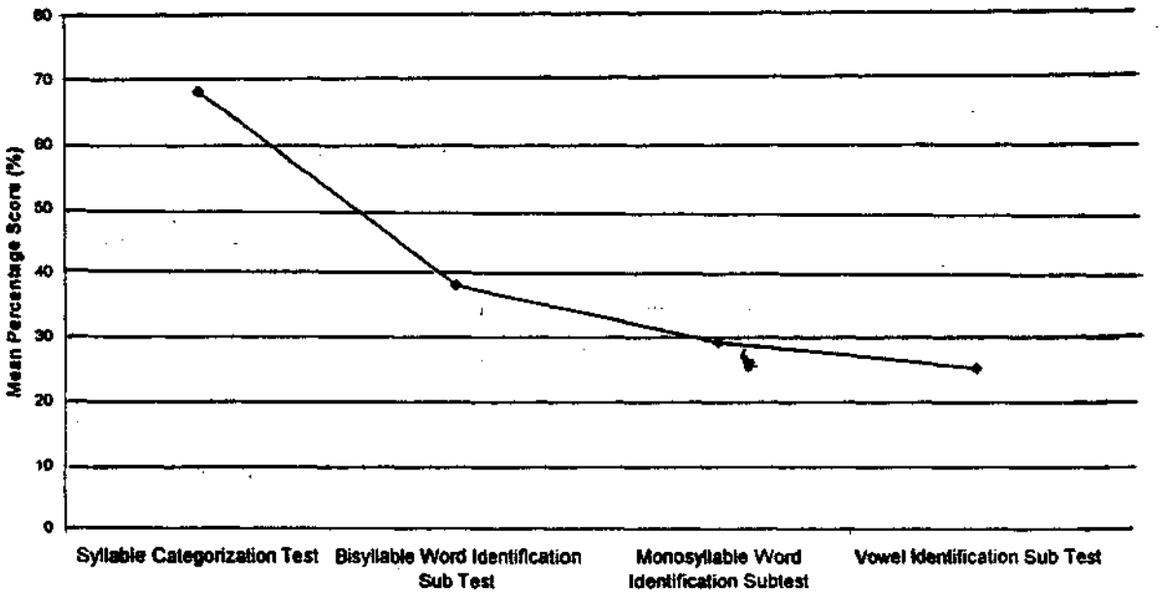


Table-4.4: Significance of difference between means for the various subtests in the Version -II

SOURCE	T-VALUE	PROBABILITY LEVEL
Syllable Categorization Tests Bisyllable Identification Subtests	1.36	**0.01**
Syllable Categorization Test Monosyllable Identification Subtest	12.92	0.01
Bisyllable Identification Subtest Monosyllable Identification Subtest	16.02	0.01
Bi-syllable Word Identification Sub test Vowel Identification Subtest	9.41	0.01
Monosyllable Word Identification Subtest Vowel Identification Subtest	7.11	0.01

As the mean values for the various tests / subtests differed, the percentage scores were computed for comparison. The Fig.4.3 reveals that the scores obtained by the subjects was maximum (68.2%) for the Syllable Categorization Test followed by the Word Identification Tests. Within the Word Identification Subtest, the subjects got higher scores on the BisyUable Word Identification Subtest (38.0%) and the score (29.1%) was obtained for the Monosyllable Word Identification. The least score was obtained for Vowel Identification Subtest (25%).

From the Table. 4.3 it can be noted that the standard deviation was maximum (1.87) for the Syllable Categorisation Test indicating that the variability in the scores

obtained by the subjects were greater than the Bisyllable Word Identification Subtest (1.37), Monosyllable Word Identification Subtest (1.11) and Vowel Identification Subtest (0.81).

Similarly, the subjects scored a greater range in the Syllable Categorisation Test (4-11). As seen in version I the Syllable Categorisation Test was able to differentiate subjects with good syllable categorisation abilities from those with poor abilities. Further it can be seen that change in the Word Identification Subtests, the maximum score obtained by the subjects was closer to the median score denoting that it is possible that with further training and maturation, the children may obtain higher scores on this test.

Results and Discussion of paired 't' test:

From Table:4.4, it can be seen that the mean percentage scores on the Syllable Categorisation Test was significantly greater when compared to all the three sub tests of the Word Identification Test (significant at the 0.01 level).

Similar to the version I, the above results also revealed that the subjects in the age range of 3-5 years found the Syllable Categorization Test to be easier than the Word Identification Subtests. This could be because the Syllable Categorization Test requires the subjects to identify suprasegmental information while for the word identification, the segmental information is also required. Similar findings have been noted by Martony, Risberg, Spens & Agelfors, 1972; Erber, 1974a; Zieser & Erber, 1977; Bilger & Wang, 1976; Moog & Geers, 1990.

B. EFFECT OF GENDER ON SPEECH PERCEPTION SCORE:

The study included 18 males and 18 females. There were nine males in each of the age subgroups. Among the females, there were seven in the 2-3 years sub-groups and 11 in 3- 5 years subgroup. (Refer to Table-3.3)

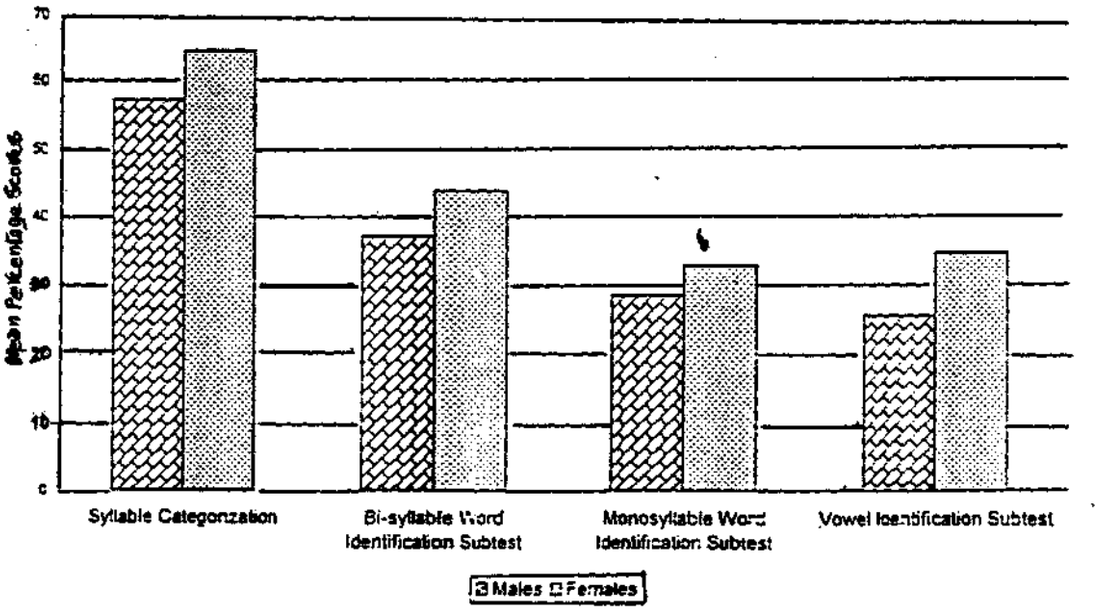
The mean, standard deviation and range were calculated. In addition, the t-test was administered to obtain the significance of difference of the means for the males and females. This was done for all the test/subtests. (Table-4.5)

Table - 4.5: Mean, SD, Range and significance in differential of means for males and females

SUBTEST	GROUP	MAXIMUM ATTAINABLE SCORES	MEAN	SD	RANGE	PROBABILI--TY LEVEL
Syllable Categoriation Test	Males Females	12	6 (57.2 %) 6.6 (64.5%)	1.6 1.02	3.5-9 4-11	0.16*
Bi-syllable Word Identification Subtest	Males Females	10	2.88 (37.2%) 3.66 (43.8%)	0.93 1.45	1.5-4.5 1.5-7	0.13*
Monosyllable Word Identification Subtest	Males Females	10	2.19(28.5%) 2.69 (32.7%)	0.84 0.07	1-4 1-5	0.14*
Vowel Identification Subtest	Males Females	6	1.96(25.8%) 2.4 (34.5%)	0.71 0.61	0.5-4 1.5-5.5	0.6*

* Not significant at 0.01 or 0.05 levels of probability.

Graph - 4.3: Mean Speech Perception Scores of Males and Females for various test/subtest



From the Table 4.5 and Graph 4.3, it can be noted that the female subjects consistently obtained better scores than the male subjects in all the scores test / subtests. However the difference was not statistically significant at either the 0.01 or 0.05 levels.

This result is in contradiction with other studies (Rout, 1996; Mathew, 1996; Vandana, 1998), who found females to perform significantly better than males. The difference could be attributed to the subjects studied. The present study included only hearing impaired children while the studies carried out by Rout, 1996; Mathew, 1996; Vandana, 1998 was done on normal hearing children. The intensive speech and language training received by the hearing impaired children could have overcome the sex differences that are usually seen in normal hearing children.

C. EFFECT OF AGE ON SPEECH PERCEPTION SCORE:

Out of the 36 subjects involved in the study, 16 subjects were in the age range of 2-3 years and 20 subjects in the age range of 3-5 years. The younger age group under went the following test/ subtests.

a. Syllable Categorisation Test.
b. Bisyllable Identification Subtest
c. Monosyllable Identification Subtest.

The older age group were subjected to

1. Syllable Categorisation Test
2. Word Identification Test which includes,
    a. Bisyllable Word Identification SubTest
    b. Monosyllable Word Identification Sub test
    c. Vowel Identification Subtest.

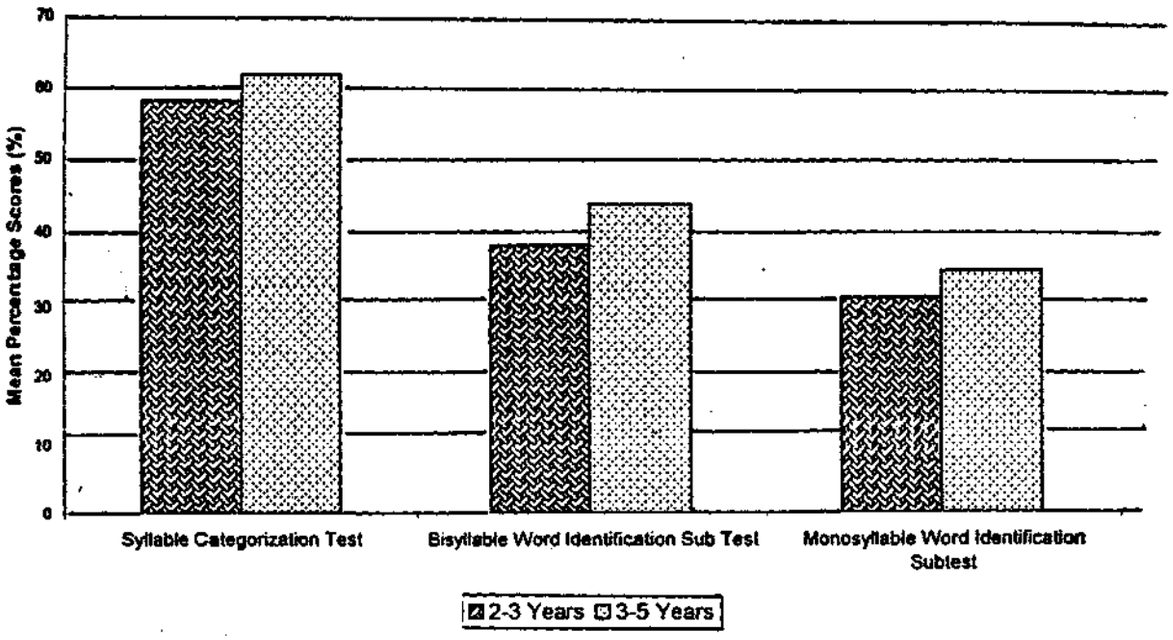
The mean, standard deviation, range of scores and the paired t-test findings for the two age groups were calculated and tabulated (Table4.6), for the 3 tests / subtests that were administered to both groups.

Table - *4.6:* Maximum scores, Mean, SD, Range and summary of t-test findings for the two age groups:

SUBTEST	GROUP	MAXIMUM SCORE	MEAN	SD	RANGE	PROBABILITY LEVEL
Syllable Categorization Test	2 - 3 YEARS 3 - 5 YEARS	9 10	5.75 (58.2%) 7 (62%)	1.6 1.87	3.5-9 4-11	0.01*
Bisyllable Word Identification Subtest	2 - 3 YEARS 3 - 5 YEARS	6 10	2.87 (38%) 3.8 (43.7%)	1.1 1.37	1.5-4 1.5-7	0.14**
Monosyllable Word Identification Subtest	2 - 3 YEARS 3 - 5 YEARS	6 10	2.06 (30.7%) 2.82 (34.3%)	0.7 1.11	1.3-5 1.5-5.5	0.16**

** Not significant at 0.01 or 0.05 levels of probability

Graph-4.4: Mean Speech Perception scores for the two age groups, I.e,2-3 years & 3-5 years



From the Table4.6, it can be noted that the older age group scored better that the younger age group in all the tests / subtests. The greater scores 62%, 43% and 34.3% were obtained by the older age group as against 58.2%, 38.0% and 30.7% scored by the younger age group in the Syllable Categorization Test, Bisylalble Word Identification and Monosyllable Word Identification Subtests respectively.

The Table.4.6 also shows that there was significant difference between the groups for syllable categorisation (level 0.01) and no significant difference between the two groups for the word identification subtests. This shows that the both the age groups found the word identification test to be equally difficult. This is probably because the word identification required more perception of segmental cues than the Syllable Categorization Test.

D. TO CHECK FOR TEST RELIABILITY BETWEEN TWO TRIALS, TRIAL I AND TRIAL-II:

The Pearlson's correlation coefficient was employed to check the reliability between the two auditory only trials for both the age groups and the results were tabulated.

Table-4.7: Results for correlation coefficient for the tests in the age group of 2-3 years and 3-5 years.

SUBTEST	**CORRELATION COEFFECIENT**	
	2-3 YEARS	**3-5 YEARS**
Syllable Categorization Test	**0.7**	0.74
Bisyliable Word Identification Subtest	**0.6**	**0.6**
Monosyllable Word Identification Subtest	0.63	0.65
Vowel Identification Subtest	-	0.69

The results show a high correlation for all the subtests in both the age groups.

From the study ,the following conclusions were drawn:-

1. Both the age groups i.e 2-3 years and 3-5 years, performed better in the Syllable Categorization Test then the Word Identification Subtests. Among the Word Identification Subtests, they seem to perform better in the Bisyliable Word Identification Subtest then the Monosyllable Word Identification and vowel Identification Subtests.

2. The females of the both age groups consistently performed belter in all the subtests, but the difference was not statistically significant.

3. The subjects in the older age group performed better than the younger age group in all the subtests, the difference being not statistically significant.

4. The two trials, Trial I and Trial II in the auditory - only mode was correlating indicating that the children were not randomly picking up the picturised word items.

CHAPTER V

SUMMARY AND CONCLUSION

The study was carried out to construct a coloured picture test of speech perception for the hearing impaired children in the age range of 2-5 years. The test evaluates two aspects, viz., Syllable Categorization and Word Identification. The Word Identification test included Bisyllable, Monosyllable and Vowel Identification Subtests. There were two versions of the test, Version I, Constructed to evaluate children in the age range of 2-3 years and Version II, to evaluate children in the age range of 3-5 years.

The purpose of constructing the test was to:

1. Evaluate speech perception in those children with limited language levels.
2. This evaluation could help decide regarding the choice of appropriate device to be worn by the child.
3. To evaluate the progress of hearing impaired children after auditory training.

The main objective of the study was construct a speech perception test for hearing impaired children that would evaluate Syllable Categorization as well as Word Identification abilities. The test should have a hierarchy of tasks that would evaluate a very simple perception activity to more complex activities that is appropriate for the target group. There were two Versions, Version I and Version II. The difference between Version I and II was in terms of number of subtests in the Word Identification Test and the number of test items. The Version I had two Word Identification Subtests (Bisyllable and Monosyllable Word Identification Subtests), while Version II had three subtests (Bisyllable, Monosyllable and Vowel Identification Subtests.

The study was carried out in two phases. Phase I included the construction of the test material. To construct the test a pilot study was carried out on normal hearing children.

A fairly large list of words are checked for familiarity with 40 normal hearing, 2-5 year old children. Only items that were highly familiar to the children were selected for the tests. Care was taken to see that each test / subtest contained low frequency, mid frequency and high frequency speech stimuli. The syllable categorization test hold monosylalbles, bisyllable categorization test had monosyllables, bisyllables and trisyllables. Two Versions of the test was constructed for different age groups.

The second phase, Phase II was carried out to evaluate the performance of 36 hearing impaired children on the test constructed. Out of these 36 subtests, 16 were in the age range 2-3 years and 20 in the age range of 3-5 years.

The study evaluated the following:

a. Comparison of Version I (meant for 2 to 3 years old) with Version II (meant for 3 to 5 year olds).

b. Comparison of the scores obtained by males and females.

Following results were obtained from the present study:

On administration of the tests, both the age groups, 2-3 years and 3-5 years performed similarly on various subtests.

a. In the younger age group i.e., 2-3 years the speech perception scores decreased with increasing task difficulty. They obtained maximum score on Syllable Categorization Test followed by the Bisyllable Word Identification Subtest and the least score was obtained for the Monosyllable Word Identification Subtest.

b. Similar results were seen for the older age group (3-5 years). However, they obtained the least scores for the lowest Identification Word Subtests.

c. In both the age groups there was significant statistical difference between the perception scores of all the subtests.

d. The female subjects performed better than the male subjects in all the subtests, but the difference between the scores of males and females were not statistically significant.

e. Comparison of the performance between the two age groups, 2-3 years and 3-5 years indicated, that for the Syllable Categorization Test, the scores were better for the older age group than the younger age group. The scores for the Word Identification Subtests were not statistically significant.

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

. 1. The developed test material can be administered on hearing impaired children in the age range of 2-5 years, who were exposed to English for a period of 6 months or 1 year prior to being tested.

2. Version I 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.

3. The Version II of this test can be used for children of 3-5 years age and also those younger children with higher language abilities.

4. 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 disadvantages of lack of vocabulary to carryout the test. Hence, it can be also first Speech Identification Test administered on a hearing impaired child.

5. The reliability of performance of the children can be checked by comparing the scores on the two trials of the test. The scores should not differ considerably between the two trials.
6. The test can be used to determine the candidacy for the appropriate amplification system.
7. The material can be used to evaluate the pre therapy and post therapy performances of the children.
8. It can be used with children with delayed and / or deviant language abilities, example mental retardation, cerebral palsy, etc.

RECOMMENDATIONS FOR FURTHER RESEARCH:

The implications of the test for further research are as follows:

1. Comparison of the performance at different signal to noise ratios.
2. To study the performance of subjects with varying degrees of hearing loss.
3. The material can be used to evaluate the effectiveness of auditory training program.
4. To compare the performance of children using various amplification systems, example cochlear implant vs. hearing aids.
5. To compare the performance of deviant populations with age matched normal population This would give a better insight into the understanding of speech perception abilities in the deviant population such as mental retarded, cerebral

palsy, autistic, dyslexia and those children with central auditory processing disorder.

6. Similar methodology can be adopted to develop and standardize speech perception tests in Indian languages.

7. The whole test can be fed into a software and a computer based speech perception testing can be developed and standardized. This can reduce the tester / talker variability that one comes across in live voice testing.

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APPENDIX I

VERSION I

SYLLABLE CATEGORIZATION TEST

Ball

Car

Shoe

Apple

Auto

Ice-cream

Elephant

Umbrella

Banana

WORD IDENTDFICATION TEST

BI-SYLLABLE WORD IDENTIFICATION SUB TEST

Flower

Carrot

Auto

Apple

Ice-cream

Cycle

MONOSYLLABLE WORD IDENTIFICATION SUB TEST

Train

House

Fish

Car

Ball

Pen

APPENDIX II

VERSIONII

SYLLABLE CATEGORIZATION TEST

Ball

Car

Dog

Shoe

Apple

Auto

Ice-cream

Cycle

Elephant

Umbrella

Banana

Tomato

WORD IDENTIFICATION TEST

BI-SYLLABLE WORD IDENTIFICATION SUB TEST

Bucket

Flower

Carrot

Tiger

Auto

Ice-cream

Penal

Apple

Orange

Cycle

MONOSYLLABLE WORD IDENTIFICATION SUB TEST

Ball

Car

Shoe

Dog

Train

House

Pen

Watch

Fish

Cat

VOWEL IDENTIFICATION SUBTEST

Boat

Ball

Book

Bed

Bat

Bus

APPENDIX III

SCORE SHEET - VERSION I

Name	:	Audiological findings:
Age/Sex	:	
Age at which	:	Hearing aid:
Hearing loss identified	;	
Age at which started wearing hearing aid		

SYLLABLE CATEGORIZATION TEST

Trial :I

	Ball	Car	Shoe	Apple	Auto	Ice-Cream	Elep--hant	Umbr--ella	Banana
Ball									
Car									
Shoe									
Apple									
Auto									
Cream									
Elephant									
Umbrella									
Banana									

Total Score

Trial :II

	Ball	Car	Shoe	Apple	Auto	Ice-Cream	Elep--hant	Umbr--ella	Banana
Ball									
Car									
Shoe									
Apple									
Auto									
Cream									
Elephant									
Umbrella									
Banana									

Total Score_____

WORD IDENTIFICATION TEST

Bisyllable Word Identification Subtest

	AV	Al	A2
Flower			
Carrot			
Auto			
Apple			
Ice Cream			
Cycle			
Total Scores			

Monosyllable Word Identification Subtest

	AV	Al	A2
Train			
House			
Fish			
Car			
Ball			
Pen			
Total Scores			

APPENDIX IV
SCORE SHEET - VERSION II

Name	:
Age/Sex	:
Age at which	:
Hearing loss identified	:
Age at which started wearing hearing aid	:

Audiological findings:

Hearing aid:

SYLLABLE CATEGORIZATION TEST

Trial :I

	Ball	Car	Shoe	Dog	Apple	Auto	Ice-Cream	Cycle	Elep-hant	Umbr-ella	Banana	Tomato
BalJ												
Car												
Shoe												
Dog												
Apple												
Auto												
Ice Cream												
Cycle												
Elephant												
Umbrella												
Banana												
Tomato												

Total Score _____

Trial :II

	Ball	Car	Shoe	Dog	Apple	Auto	Ice-Cream	Cvcle	Elep-hant	Umbr-ella	Banana	Tomato
Ball												
Car												
Shoe												
Dog												
Apple												
Auto												
Ice Cream												
Cycle												
Elephant												
Umbrella												
Banana												
Tomato												

Total Score

WORD IDENTIFICATION TEST

Bisyllable Word Identification Subtest

	AV	Al	A2
Flower			
Carrot -			
Auto			
Apple			
Ice Cream			
Bucket			
Pencil			
Orange			
Tiger			
Cycle			
Total Scores			

Monosyllable Word Identification Subtest

	AV	Al	A2
Train			
House			
Fish			
Car			
Ball			
Watch			
Shoe			
Dog			
Cat			
Pen			
Total Scores			

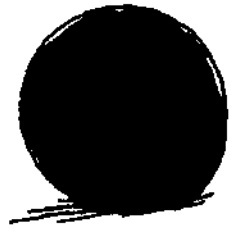
Vowel Identification Subtest

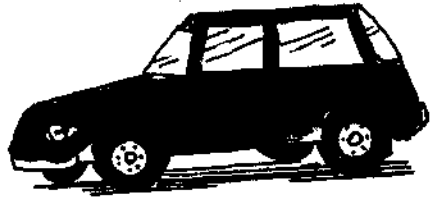
Boat	AV	Al	A2
Ball			
Book			
Bed			
Bat			
Bus			
Total Scores			

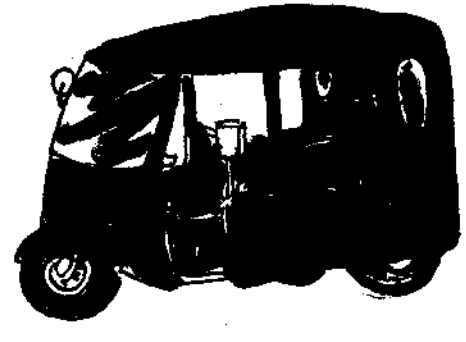
APPENDIX V

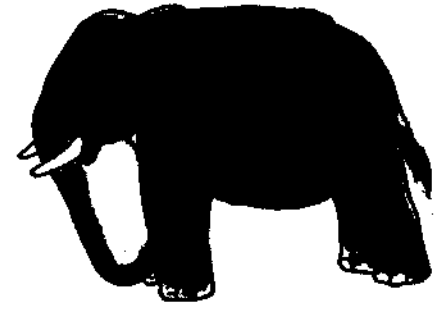
VERSION I

SYLLABLE CATEGORIZATION TEST





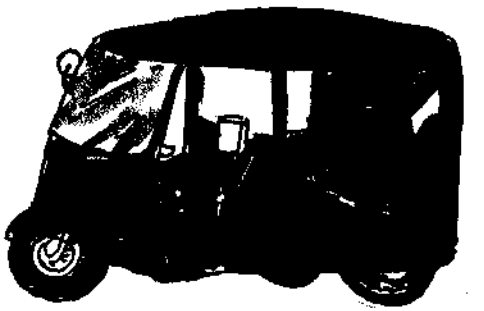


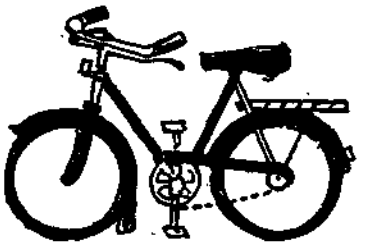


WORD IDENTIFICATION TEST

BISYLLABLE WORD IDENTIFICATION

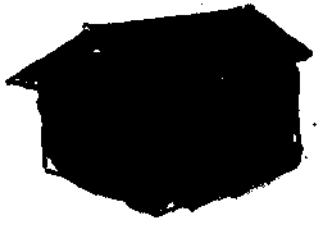
SUBTEST

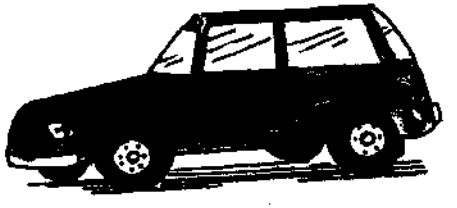


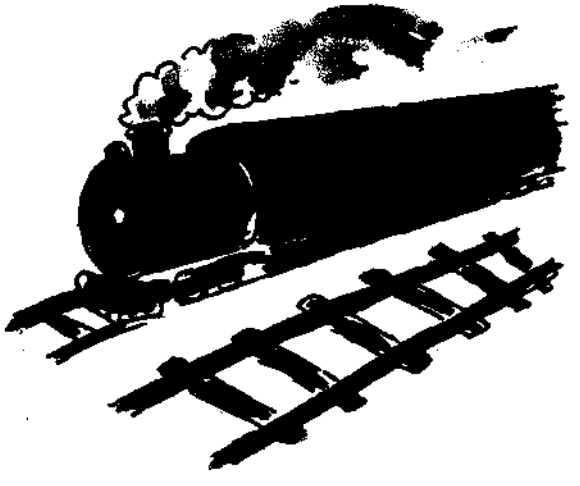


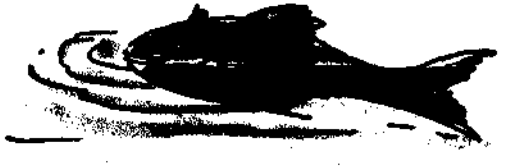
MONO SYLLABLE WORD

IDENTIFICATION SUBTEST





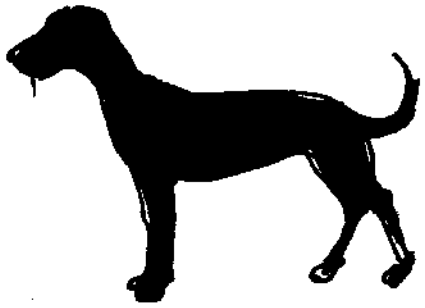


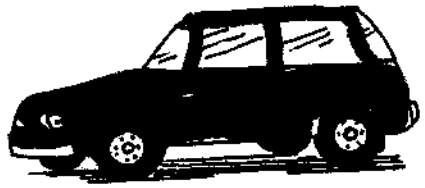


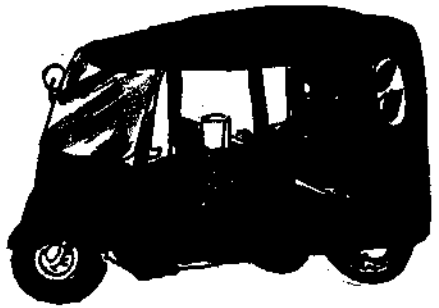
APPENDIX VI

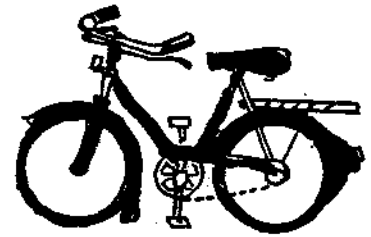
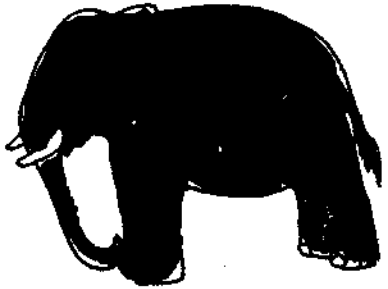
VERSION II

SYLLABLE CATEGORIZATION TEST





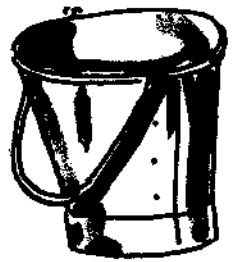



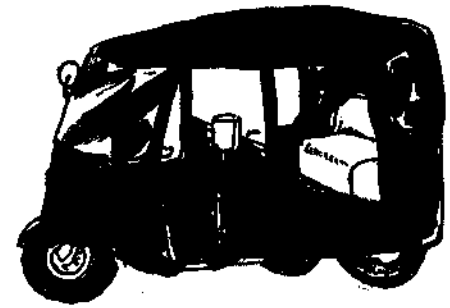



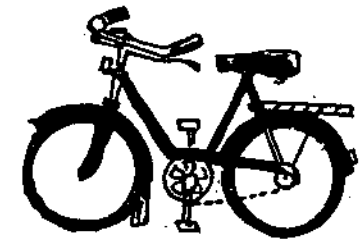

WORD IDENTIFICATION TEST

BISYLLABLE WORD IDENTIFICATION

SUBTEST

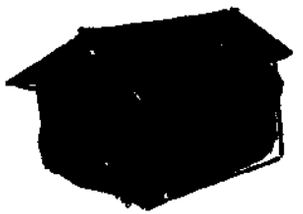


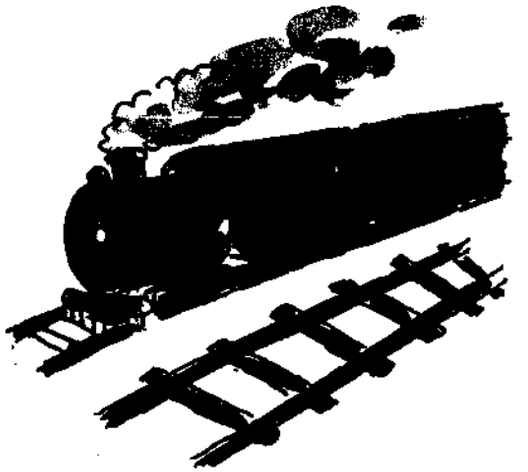




MONO SYLLABLE WORD

IDENTIFICATION SUBTEST





VOWEL IDENTIFICATION SUBTEST