# Development of High and Low Predictable English Sentence test

# (EHLPS)

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A dissertation submitted in part fulfillment for the degree of
Master of Science (Audiology)
University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH & HEARING,
MANSAGANGOTHRI, MYSORE-570006
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Parents were my first teachers, and
teachers my second parents..
I am indebted to them
for they have helped me climb
the ladder of knowledge

***This work of mine is dedicated to my***

***MY BELOVED PARENTS***
***&***
***TEACHERS***

## CERTIFICATE

This is to certify that this dissertation entitled **"Development of High and Low Predictable English Sentence test (EHLPS)"** is a bonafide work in part fulfillment for the degree of Master of Science (Audiology) of the student Registration no: 05AUD014. This has been carried under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any diploma or degree.

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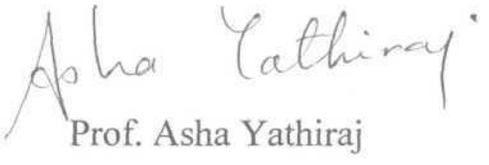
## CERTIFICATE

This is to certify that this dissertation entitled **"Development of High and Low Predictable English Sentence test (EHLPS)"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other university for the award of any diploma or degree.



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## DECLARATION

This is to certify that this master's dissertation entitled **"Development of High and Low Predictable English Sentence test (EHLPS)"** is the result of my own study and has not been submitted earlier to any other university for that award of any degree or diploma.

Registration no. 05AUD014

Mysore
April 2007

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# INTRODUCTION

Speech audiometry is an important element in an audiological test battery. It has come into existence because of some inherent advantage over pure tone audiometry. Everyday listening situations do not involve detecting sound. Pure tone audiometric results provide information on detection of the sound of certain frequency and intensity but not on the receptive auditory communication of the individuals which is given by speech audiometry. Mendel and Danhauer (1997) noted several uses of speech perception tests. These include providing a measure of how well listeners provide information for planning and managing auditory (re)habilitation; a method to monitor listeners' performance throughout the therapeutic process; assess the success of different types of medical and surgical treatments; monitor subjects' performance in research paradigms; classify the degree and type of hearing loss; a baseline measure for other test procedures; and to be used in various forms for research.

The most fundamental purpose of the speech perception tests is the assessment of performance to provide a measure of how well listeners understand speech in a controlled environment as a reflection of how they may perform in everyday listening situations (Giolas & Epstein, 1963). For individuals with hearing impairment, some speech perception tests reflect the degree of communication handicap created by the hearing loss and thus, provide an estimate of the difficulty in understanding continuous discourse (Davis & Silverman, 1970; Epstein, 1978; Schwartz & Surr, 1979; Silverman & Hirsh, 1995). Thus, it has been reported that these tests attempt to predict performance as well as assess it. These predictions have been represented by quantitative measures reflecting performance in realistic listening situations. Also, results on speech perception tests have

been used extensively in research. Most of the research focuses on modifications and improvements of current test materials and/or prosthetic devices. These tests have also been used to predict the effectiveness and ultimate success of the use of particular hearing aids and/or other prosthetic devices such as tactile aids or cochlear implants (Boothroyd, 1968; Martin & Jansen, 1985; Schultz & Schubert, 1969; Webster, 1984).

Some speech perception tests have been used in the planning and management of auditory (re)habilitation by identifying segmental and suprasegmental problems and structuring drills that emphasis these areas (Griffiths, 1967). These tests also have application in assessing the success of different types of medical and surgical treatments which attempt to improve the hearing handicap (Speaks & Jerger, 1965; Silverman & Hirsh, 1955).

To test the speech identification ability of an individual, there are many materials that have been used namely, nonsense syllables, monosyllables, bisyllables and sentences. Each of the above speech material have been noted to have their own advantages and disadvantages mainly to do with redundancy aspect, the scoring of responses, their relation to everyday speech, and test duration. The advantage of nonsense syllables over other materials was that the linguistic cues that contaminated the test performance were eliminated and they were independent of the listeners' vocabulary (Berger, 1969), they are non-redundant (Carhart, 1965) and are easier to construct than meaningful material (Egan, 1948) but nonsense syllables are abstract and very confusing to the listener (Carhart, 1965). Monosyllables have been found to be less analytic units of speech and are more easily repeated than nonsense syllable (Egan, 1948). Carhart (1965) reported that monosyllables are preferred as they are non-redundant and are meaningful,

and also they are not as confusing as nonsense syllables. Further other studies noted that monosyllables can be easily manipulated to represent colloquial speech (Giolas, 1966) and the tester can determine the articulation function rapidly (Boothroyd, 1968). Since some languages do not have concrete monosyllabic words, bisyllables are preferred as they are less analytic than monosyllables and provide additional cues for intelligibility (Hirsh, 1952). Distinctive features are also used as speech material for speech perception test. The advantage of speech identification test using distinctive features over other tests is that they not only gave quantitative account of speech identification but also a qualitative analysis of error patterns, and this information could be used in planning appropriate rehabilitation strategy.

Although there are many meaningful word and nonsense syllable tests available that provides analytic information regarding a patient's speech perception abilities, sentence type stimuli offer additional insight about the individual's performance in more realistic communication situations. Sentence materials are also useful in assessing an individual's ability to process stimuli presented in auditory, visual, or combined modes. Sentences are considered to be more valid indicators of intelligibility and a better representation of spoken communication. The use of single words, especially single syllable words, imposes severe limitations on the capacity to manipulate certain patterns like intonation and co-articulation effects on the ongoing speech. Sentences have face validity as 'natural' and 'meaningful' stimuli for assessing auditory function (Miller, Heise & Lichten, 1951).

Different forms of sentence tests have been developed over the years. Certain sentence tests have been developed with the aim of tapping the perceptual difficulties of those with hearing loss (Mendel & Danhauer, 1997). Other sentence tests have been

constructed to determine difficulties in the perception of high predictable or low predictable sentences. High predictable sentences are those in which the target test words can be guessed from the context, whereas, in low predictable sentences the final word cannot be guessed from the sentence context (Kalikow, Stevens and Elliot, 1977). In our day-to-day life situation, there is a combination of high and low predictable sentences. Hence, it is necessary to evaluate the different difficulty levels of such sentences.

It is evident that there are several types of material used for speech audiometry. Each of them has their specific utility. Sentence tests have noted to be the best indicators of everyday communication.

## Need For the Study

- There is a need to estimate the communication problems of a person having a hearing impairment. Pure tone audiometry does not allow for complete understanding of a person's communicative deficit. Hence, it is essential to use speech tests.
- Normal day-to-day conversation does not take place in monosyllables alone. Sentences could convey information about the difficulty in communication a person would have in a real life situation. Hence, there is a need to use sentences as a part of a speech test battery, while evaluating individuals with a hearing problem.
- There is also a need to have a test that assesses varying levels of difficulty in terms of predictability. This is because in a real life situation, both high predictable and low predictable sentences are used.

## Aims of the Study

> To develop a test material having low and high predictability sentences.

> To obtain data for the newly developed material on a group of normal individuals.

> To compare the scores between low and high predictability sentences.

> To administer the test on a sample of individuals having mild-to-moderate hearing loss and

> To compare the performance of the deviant population with that of the normal population.

# REVIEW OF LITERATURE

Speech is a highly redundant stimulus because the information in it is conveyed in several ways simultaneously (Martin, 1994). A hearing loss involving only part of the auditory frequency range may go undetected in a speech test which is not carefully controlled. It has been noted by Martin (1994) that it was not possible in a single test to sample all types of speech events that might occur in practice. This is because everyday speech communication covered a wide range of spoken material and takes place in a variety of contexts. Hence, it was considered appropriate to determine the kinds of sensory and cognitive processes that were involved in the reception of these kinds of speech material, and to devise tests that assessed the degree to which an individual showed impairment in the utilization of the above mentioned processes.

Fry (1961, cited in Kallikow, Stevens & Elliot, 1977) reported that basically two kinds of operations were involved in the understanding of sentences. One was the reception and initial processing of acoustic information through the auditory system, and the other was the utilization of linguistic information that is stored in memory. He also noted that speech reception depended upon both the condition of the peripheral hearing mechanism and the speech centre of the brain. One component in the decoding of a sentence by a listener was the extraction of a particular set of phonetic features from the acoustic signal. These phonetic features are placed in short term memory, where they are available for further processing. The linguistic information available in the long term memory of a listener includes knowledge of the phonological, lexical and syntactical and semantic constraints that occur in language. The more these kinds of information provide a context for a particular utterance, the less it was considered necessary for the listener to

depend on the detailed properties of the acoustic signal in order to understand the utterance. A test of a listener's ability to understand everyday speech therefore, must assess both the acoustic-phonetic and the linguistic-situational components of the process.

The goal of most speech perception tests is to provide a measure of an individual's performance in everyday listening situations. Silverman and Hirsh (1955) felt that the way to accomplish this was to incorporate sentence-type materials into tests of speech perception. The authors opined that sentences may be more similar to a realistic situation than monosyllabic word or nonsense stimuli, and they contained a considerable amount of redundancy and contextual cues. However, they noted that the presentation of sentences as a measure of speech perception made it difficult to determine whether the subject's responses were a result of perceiving the entire stimulus or the use of closure to fill in the gaps in the areas where they could not actually perceive the individual components of the sentence. Sentences were also problematic because it was found that their novelty usually reduced after they had been used as little as one time.

Mendel and Danhuer (1997) reported that sentences, or parts of them, were perceived through identification of a few key words that convey the meaning of the rest of the sentences; the remaining parts of the sentence might not have to be perceived in order for the response to be correct. Thus, they concluded that although sentence stimuli reflected perception of conversational speech, analytic perception abilities were not assessed clearly with sentence tests.

Despite the inherent problems present in sentence tests, they are continued to be used as their advantages outweigh their disadvantages. There are a host of attributes that require to be controlled while constructing a test. These are discussed in the next section.

## Attributes of Speech Test Materials

There are several aspects present in the stimuli that need to be considered while constructing a sentence test. These aspects have been discussed in experimental studies or reports about speech tests, by various authors.

### *Redundancy and Context*

Due to its redundant nature, speech was found to be a highly efficient means of communication, despite interferences and noise. This arises from the superfluity of rules in the systems which include phonological rules that constrain the occurrence of phonemes to form words, syntactic rules which govern the structure of sentences, and semantic rules which restrict the co-occurrence of words in a sentence. The rules facilitated speech reception by enabling the listener to make intelligent guesses when part of the acoustic signal was masked or missing. Peterson and Lehiste (1962) suggested that the redundancy in speech could be exploited to construct speech test materials which ranged from those with negligible contextual information to those which contained all the redundancy inherent to real speech. If the test material comprised words, such as the CNC word lists, phonological and lexical information contributed to reception. If the material was made up of words of more than one syllable, then possible responses could be narrowed down by drawing on rules which govern admissible sound combinations across syllables and syllable combinations to form words; and in the case of the monosyllabic-trochee-spondee

test given by Erber and Alencewicz (1976), the alternatives are further limited to words with the appropriate stress patterns.

When phrases or sentences were used, the effect of syntactic and semantic contexts could vary depending on whether the words are strung in a random order (eg. The zero predictability sentences developed by Boothroyd & Nittrouer, 1988), or arranged in a syntactically correct sequence (such as the Bamford Kowal Bench sentence lists, 1979). Furthermore, sentences could range from meaningful to semantically anomalous, such as the high and low predictability sentences in the Speech-in-noise (SPIN) test (Kalikow, Stevens & Elliot, 1977). Finally, tests that used paragraph material were similar to everyday speech in their redundancy and contextual information. Speech tests comprising material that is rich in contextual cues tap the subject's knowledge of the world, knowledge of the language, and the ability to use contextual information to perceive speech, in addition to the auditory ability to hear and process acoustic cues. Material with low redundancy and low context tests the listener's ability to perceive acoustic cues. Thus, it is an important consideration especially when subjects may or may not have the requisite knowledge and linguistic and cognitive abilities.

### *Acoustic Context*

It has been noted by Boothroyd and Nittrouer (1988) that the richness of acoustic content of the text item, or the number of cues presented in an item, were related to the phonetic context in which it was presented and to the way in which it was recorded. The way in which the stimuli were recorded affected the amount of acoustic information contained in the test material. Also, it was found that the enunciation of the speaker affected the relative difficulty of a test, especially when monosyllables were used (e.g. the

Hughes recording of the PB-50 word lists. When larger units, such as phrases or sentences were used as stimuli, acoustic cues for signaling individual phonemic contrasts were found to be reduced as the speed of articulation increased, but prosodic information would contribute to the overall speech processing. The acoustic context of the stimuli could also be varied for assessing the perception of particular acoustic features. Natural speech has been modified with computer manipulation to neutralize some cues to a phonetic contrast while retaining others as opined by Revoile, Pickett, Holden, and Talkin (1982). Alternatively, Hazan and Fourcin (1985) reported that carefully designed and controlled synthetic speech closely modeled on natural speech may be used to test perception of major acoustic cues.

### *Sentence Context*

Miller, Heise and Lichten (1951) reported that in a noisy environment words in a sentence context were more intelligible than words spoken in isolation. The benefit of sentence context has been demonstrated by Miller (1962, cited in Mendel and Danhauer, 1997) and Zust and Tschopp (1995). A study done by Zust and Tschopp (1995) aimed to quantify context effects in speech recognition using the Basel Sentence Understanding Test. This test consisted of two types of sentences according to the amount of contextual information: sentences with high predictable (HP) final words and sentences with low predictable (LP) final words. Here the speech recognition threshold for HP and LP sentences were found. The results revealed that the threshold for HP were lower than for LP and the significance of the contextual part of the sentence with respect to the recognition of the whole sentence were different in HP and

LP sentences. These investigators argued that the sentence context imposed constraints on the set of alternative words that were available as responses at a particular location in a sentence, and noted that the intelligibility of words increased when the number of response alternatives decreased. This conclusion was supported and quantified further by Giolas and Duffy (1970) who examined the intelligibility of words in sentences in which the words had various degrees of predictability. Their experiments showed directly that the predictability of a word has an influence on its intelligibility.

### *Phonetic Balance (PB)*

Egan in the year 1948, (cited in Mendel & Danhauer, 1997) constructed a list of monosyllables that were equal in average difficulty equal in range of difficulty and of equal phonetic composition employing English words in common usage. Since there are only a limited number of words that satisfy the balance requirement, equivalent lists were difficult to compile. Boothroyd (1968) suggested an alternative way to obtain PB scores, i.e. to use word lists which contained the same proportion of phonemes (iso-phonemic) in each list. The rationale for using PB test material according to Dillon and Ching (1995) was that if the listeners were unable to perceive a particular phoneme which occurred infrequently in normal everyday speech, then the handicap experienced would not be as severe as it would have been if the material had a more common phoneme. It was also reported by these authors that the transitions from one sound to another also aided in the identification, especially in sound sequences in which there may or may not be a steady state pattern such as those seen in connected speech.

### *Word Familiarity*

Dillon and Ching (1995) opined that the words which are encountered more frequently in real life tend to be recognized better in speech tests than words which are not. The familiarity of a word had to be viewed in the context of the people to whom the test is to be administered. Words which are infrequently used in general language will not be familiar to most people; even words used frequently may not be familiar to young children. The familiarity of words, to the target subjects, would have several effects on the difficulty of speech tests. First, if a test contained a high proportion of relatively unfamiliar words, then the total score would be lower than if more familiar words had been used. Second, if word familiarity was, on the average, higher in one list than in another, then the equivalence of lists for difficulty would be adversely affected. Third, within a list, the range of familiarity of words would affect the range of difficulty of the items within that list. It was also seen that the intelligibility of words in noise was influenced not only by the predictability of the words, but also by their familiarity.

### *Response Set*

Speech tests are often categorized as open response or closed response. In an open response format, the listeners repeat verbally or write down the sound or word(s) that they thought they heard. In a closed set, listeners are presented with a list of responses from which they have to choose one. Miller, Heise, and Lichten (1951) reported that as the size of the response set increased, responding became more difficult for the subject and the score decreased. One advantage of the open response set format is that the tester is able to find out exactly what the subject heard but at the same time, scores will increase if the

same material was repeated to the subject at a later time, especially if the stimuli included meaningful words. The distinction between open and closed response tests became blurred when the closed response set included all the test items that would be possible in an open response set.

### *Number of Lists*

Dillon and Ching (1995) found that in clinical applications, rarely are a large number of lists needed, because clinical time constraints prelude a large amount of speech testing. In experimental settings, however, large number of lists was required to compare a number of experimental conditions. For tests with meaningful material, subjects learnt the material and scores increased with repeated application of particular items. To avoid this it has been recommended by these authors to use "equivalent" lists so that any item is presented only once. They also concluded that greater the number of equivalent lists available, the more flexibly could the test be applied in experiments with many conditions.

### *List Equivalence*

The lists of a speech test were considered to be equivalent if that list could result in same score as any other list when tested under the same test conditions. Edgerton, Danhauer and Rizzo (1981) recommended distributing the test items among the lists such that the items in each list had similar redundancy, phonemic balance and word familiarity in order to achieve list equivalence. Punch and Howard (1985) opined that when the stimuli were meaningful, the measured speech reception threshold reduced as the size of the stimulus set reduced. Edegerton, Danhauer and Rizzo (1981) recommended that

repetition of the same stimuli from list to list was also suitable when the stimuli were nonsense syllables, and in that case, the potential for learning of the stimulus was limited.

## Attributes of Test Recording and Presentation Methods

### *Response Method*

The most common way to elicit a response from the subject is verbal repetition, when speech audiometry is carried out. For open set tests, the only other alternative would be writing down the response. It was observed by Ewertsen (1973, cited in Mendel & Danhauer, 1997) that the verbal responses were misheard by the tester and written response, unless written phonetically, contained spelling errors which again were misinterpreted by the tester as errors of perception. He also found that for subjects with no speech production disorders, the best solution was to have the listener respond verbally and by writing and to watch the subject's lips as well as listen to the stimulus. Prohofsky and Sommers (1995) reported that word recognitions scores improved for closed response format especially when the words are hard.

### *Quantity Scored*

Speech identification tests can be measured and scored in a variety of ways. Phoneme and word scoring were the two methods most commonly used. Olsen, Tasell and Speaks (1997) concluded from their study that phoneme scoring led to a higher score than whole word scoring in isolation, and they added on that each word usually contained more than one phoneme and the score was based on a higher number of items for phoneme scoring rather than for word scoring. The disadvantage of phoneme scoring was that it

placed additional demands on the concentration of the tester. It was noticed by them that when sentences with several key words per sentence were considered rather than monosyllables, scoring became all the more difficult for the tester unless the subject perceived everything correctly. McPherson and Pang-Ching (1979) gave an alternative method of scoring where the number of distinctive features by which the stimuli and the response differed was counted.

### *Monitoring Level and Recording*

The level of an item in a speech test was normally controlled in some way or the other. Dillon and Ching (1995) suggested a slightly sophisticated method by providing the talker with the SPL monitor when the recording of the test material took place. For greater control of levels, it was recommended to measure the level of each item after recording, and to use an attenuator to correct each item to the same level. Hood and Poole (1980) concluded from their experiment that the characteristics of any recorded word articulation material are determined predominantly by the speaker and the recording technique adopted and are largely independent of other factors.

### *Spectral Characteristics of Signal and Noise*

Danhauer, Doyle, Lucks and Ghadialy (1988) have concluded that spectral shape of a speech signal and any masking noise are the key attributes of a speech test. If the speech had been recorded and played back by amplification systems with a flat frequency response, then the long-term rms spectrum would be determined mainly by the person who was chosen as the talker. Considerably more choice was available for the spectrum of the

noise. Some noises had a spectrum similar to that of the speech, which included a babble of talkers, and random (Guassian) noise which intentionally had been spectrally shaped to match the long-term average speech spectrum. The results obtained with a speech test depended a lot on whether the particular combination of signal and noise resulted in a preponderance of low frequency or high frequency energy available.

### *Live Voice versus Recordings*

House, Williams, Hecker and Kryter (1965) found that the clinicians sometime presented the test materials by themselves; either because they considered it to be more interesting for the client or because they considered that the client would need visual cues to be able to attain a satisfactory score. However, the results obtained depended on who did the talking and this was supported by studies done by Penrod (1994) and Hood and Poole (1980). Brandy (1966) viewed that even for a particular talker, the manner in which speech sounds were produced affected the scores obtained and thus, random variations in the intensity or clarity of enunciation decreased the test reliability. If the clinician had a bias about which of several measurement conditions produced the highest score, then the clinician would consciously or unconsciously vary his clarity of presentation, either auditorially or visually, across conditions to help achieve a desired result. To prevent such biases, recorded versions of speech tests were suggested. The other advantages of using recorded tests were that they can be edited to ensure uniformity of presentation level and can also be standardized with normal hearing individuals to ensure that all items have been correctly produced by the talker. Dilllon and Ching (1995) suggested the use of

interactive video laser discs coupled with adaptive presentations to make the recorded stimuli suitable even for small children.

## Listener related factors

### *Linguistic contextual constraints*

Valuable contextual evidence by virtue of phonotactic, lexical, syntactic, semantic and topical constraints are provided by surrounding language patterns. Speech sounds were more easily recognized when they were in the context of meaningful words (Boothroyd and Nittrouer, 1998). Similarly words were more easily recognized in meaningful sentences (Miller, Heise & Lichten, 1951) and sentences in conversational or paragraph context (Hnath-Chisolm, Hanin and Boothroyd, 1985). For normally-hearing subjects, listening in difficult conditions, the combined effect of phonological, lexical, sentential, and topical contexts appeared to be equivalent (Boothryod, 1991).

### *Degree of hearing loss*

Hearing impairment distorts and reduces the acoustic information to the listener, with a consequent reduction in the understanding of speech in all environments. Boothroyd (1984) reported that age at onset interacted with magnitude of hearing loss in terms of their effects on speech perception. A prelingually acquired severe or profound hearing loss was likely to have more serious long-term effects on knowledge and skill than a moderate hearing loss. In 1991, he also reported that some profoundly deaf subjects, without open-set word recognition ability, demonstrated significant access to phonologically significant information when presented with phonetic contrast sets.

*Age at onset of hearing loss*

Among subjects whose hearing loss was acquired in adult life, it was usual to assume uniformity of knowledge and skill, as they apply to auditory speech perception (Boothroyd, 1991). Any test of speech perception accuracy should serve to rank the subjects in terms of both the access to sensory evidence and overall speech perception performance. The problems expected were ceiling and floor effects from tests that were too easy or too difficult. The author also said that when hearing loss was acquired postlingually but during childhood, assumption of uniformity was not maintained and hence, the results on word recognition tests not only reflected the access to sensory evidence but also knowledge and skill of the individual. Knowledge and skill in turn, reflected the exact age at onset, degree of hearing loss, appropriateness of the sensory assistance and educational management.

Another criterion to be kept in mind was that the test tasks should be within the cognitive abilities of young subjects. There was a decline in response speed and in short term memory performance with increasing age which was supported by Broadbent and Heron (1962), and this decline tended to have a negative effect on performance in a sentence understanding task.

So far, the various attributes related to the speech test materials, recording procedures and listener variables were discussed which emphasized the importance of factors which needs to be kept in mind while developing a speech test material. In the next section, the various sentence tests developed for hearing impaired individuals would be discussed. These have been categorized as sentences for speech recognition thresholds,

sentences for speech identification and sentence tests for (central) auditory processing evaluation. A couple of Indian sentence tests that were specifically meant for sloping high frequency hearing loss are also discussed in the following section.

## Sentence Tests

Over the years several sentence tests have been developed. They have been developed either with the intension of determining the speech recognition threshold, speech identification abilities of individuals or to evaluate (central) auditory processing processes. Some of the sentence tests reported in literature is described below.

### 1) Speech Recognition Threshold Tests

a) *PAL Auditory Test No. 12 (Hudgins, Hawkins, Karlin, & Stevens, 1947)*

The purpose of the test was to measure the threshold of intelligibility of speech. It consisted of eight lists of 28 items divided into seven groups of four sentences. The sentences used were short and simple. Each group of sentences was presented 4 dB lower than the previous group. The response format was an open set one with no carrier phrase. A verbal response was elicited from the listener.

b) *Speech Reception Threshold Testing using Sentence Stimuli (Plomp, 1986)*

The test was developed to improve the reliability of SRT testing using sentence stimuli. Ten selected lists of 13 simple meaningful sentences of 8 or 9 syllables each were the stimuli. The sentences had equal chances of correct recognition in noise and approximately equal numbers of phonemes were used per list. It involved an open set task.

c) *Hearing in Noise Test (Nilssom, Soli & Sullivan, 1994)*

The Hearing in Noise Test (HINT) was designed with a purpose of measuring the speech recognition thresholds using sentence stimuli in quiet or in noise. It has an adult version

(HINT) and a child version (HINT-C). HINT consists of 240 sentences of approximately equal length syllables (6 to 8). The sentences were grouped into phonemically balanced lists consisting of ten or twenty sentences. The sentences were equated for difficulty when presented in quiet or in noise. An open set format is utilized. The entire sentence needs to be repeated by the listener and the scoring is based on the correct words identified.

2) Speech Identification Tests

a) *PAL Auditory Test No. 8 (Hudgins, Hawkins, Karlin & Stevens, 1947)*

The purpose of the test was to determine a listener's ability to hear simple sentences in the presence of interfering noise. It consisted of 100 sentences with one word multiple choice responses. Thus, the response obtained was a closed set one. The scoring depended on the correctly identified choice.

b) *CID (CHABA) Everyday Sentences (Silverman & Hirsh, 1955)*

These authors constructed a test, which consisted of 100 sentences of 2-12 words in length to represent everyday American speech. Ten sentences were incorporated in each list of the ten lists with 50 key words considered as the test items in each list. The key words were scored by the tester and it involved an open set task.

c) *Test for Everyday Speech Reception with High predictable and Low predictable Items (Kallikow, Stevens & Elliot, 1977)*

It was a sentence test representing everyday speech in which the listeners' utilization of the linguistic-situational information of speech was assessed and was compared with the utilization of acoustic-phonetic information. Each of the eight lists contained fifty sentences out of which, twenty-five of them were low predictable and the other twenty-

five were high predicable sentences, of 5 to 8 words (6 to 8 syllables) in length. High predictable sentences were those that contained two or three key words that provide semantic links to the final word whereas, low predictable sentences did not contain any semantic clues. These stimuli were presented in the presence of babble noise. The user could use the test sentence and babble at various signal to babble ratios. The listener repeated the final word in the sentence (the key word) which was always a monosyllabic noun. The intension was that the babble served as noise against which the sentences are heard thereby more closely simulating everyday listening condition.

This test has been applied beyond its use in evaluating auditory speech-processing capabilities of the hearing impaired. It provided a measure of the involvement of cognitive and memory processes in speech perception. It also assessed the cognitive and memory processes in individuals suspected of deficiencies in these aspects of speech comprehension. If a small difference was found between high predictable (HP) and low predicable (LP) scores, then some deficiencies in cognitive and memory processes was suspected.

Kallikow et al. also utilized the sentence material in testing the comprehension of English for those who were learning it as a second language. Differences between HP and LP scores at an appropriate S/N ratio was considered to indicate the degree to which the listener has mastered the ability to profit from the semantic, syntactic, and prosodic information provided by the sentence context and to conduct the rapid lexical searches necessary for sentence comprehension.

In addition to providing a practical means for assessing potential deficits in an individual's ability to process speech, work with HP and LP sentences have been found to

lead to insights into the process of sentence decoding by normal listeners. This procedure manipulated various aspects of sentences and determined the effects of these manipulations on listener's performance.

d) *Kent State University (KSU) Speech Discrimination Test (Berger, 1969)*

The test consists of a set of five phonetically similar words that were grouped and embedded within sentences. Each of the five words could be a logical part of the sentence. 150 sentences with 750 key words were used. Eight forms of thirteen sentences each were formed. The key words had one or two syllables but each group of five words had the same number of syllables. The sentence length was confined to four to nine words. Contraction, interrogative, exclamation and declarative sentences were used. Each form was equal in difficulty and within each form difficulty increased from sentence 1 to 13. Key words were scored in this test.

e) *Connected Speech Test (Cox, Alexander & Gilmore, 1987)*

The test was designed with the purpose to serve as a criterion measure in studies of hearing aid benefit, using everyday speech. It was reported to have a high content validity, a large number of equivalent forms and a small error of measurement. It consisted of 48 passages of conversationally produced connected speech. Each passage contained ten simple sentences with 7 to 10 words in length, and 25 key words were used for scoring. All were of equal intelligibility for the listener with normal hearing.

f) *BKB Sentence list (Bench, Koval & Bamford, 1979)*

This is a test used with children in the age range of 8 - 15 years. It used an open set response format and it reflected the natural language usage of children with hearing impairment. It consists of 21 lists of 16 sentences (not more than 7 syllables in each

sentence). Each list contained 50 stimulus words. The simplified version of this test referred to as the Picture-Related BKB Sentence List for children (BKB-PR) was also developed. This simplified version consists of 11 lists of 16 sentences with 50 stimulus words in each list. The scoring was done on the basis of the stimulus words.

g) *Danhauer Beck Sentence Test (Danhauer, Beck, Lucks & Ghadialy, 1988)*

The Danhauer Beck Sentence Test (DBST) was developed for individuals having severe to profound hearing loss and for cochlear implant patients. Three lists of ten sentences and ten questions with a total of 140 syllables were recorded on a video tape. It is recommended that the test can be administered as a test of visual, auditory or auditory and visual recognition.

h) *High Frequency - Kannada Speech Identification Test (HF-KSIT) (Mascarenhas, 2002)*

The HF-KSIT was developed to evaluate adults having a sloping high frequency hearing loss. It consisted of familiar words and sentences mainly having high frequency phonemes. Three lists were complied in which each consist a word subtest and a sentence subtest. This test was a more sensitized test for sharply sloping hearing loss.

i) *High Frequency - English Speech Identification Test (HF-ESIT) (Barick, 2006)*

It was developed to assess the speech identification abilities of adults with high frequency hearing loss. The test consisted of four word lists, each list consisted of 25 words each and four sentences list, having ten meaningful sentences. The content words had high frequency phonemes. The responses were scored in terms of word and phonemes.

3) Sentence Tests for (Central) Auditory Processing Evaluation

a) *Rapidly Alternating Speech Perception test (RASP) (Willeford & Bilger, 1978)*

The RASP test evaluates the integration of segments of speech stimuli which are delivered alternately to the two ears over time, thereby assessing binaural interaction. Willeford and Bilger (1978) and Musiek (1983) used sentences as stimuli. The test has also been conducted using monosyllabic words by Wilson (1994). Sentences are the commonly used stimuli for RASP. Segments of sentences are presented to the patient's two ears in an alternating fashion. The alternation rate of the segments was 300 msec and the stimuli are presented at 40 dB SL.

b) *Synthetic Sentence Identification (Speaks & Jerger, 1965)*

The purpose of the synthetic sentence identification test (SSI) was to assess auditory separation. It determined the correct identification of sentences rather than correct repetition. It consisted of 24 ten sentence message sets. It used artificial sentences created by selecting each successive word on the basis of conditional probabilities on preceding word(s). First, second and third order approximations were developed. The length of the sentences varied from 5 to 9 words. Three separate forms of sentence length were constructed. Ten randomizations of each list could be used with competing messages presented ipsilaterally or contralaterally at different message to competing ratios. On a similar line, Nagaraja (1977) had developed synthetic speech identification test for adults in Kannada language.

c) *Dichotic Sentence Identification* (Fifer, Jerger, Berlin, Tobey & Campbell, 1983)

It is a modification of Synthetic Sentence Identifiation test making use of Contralateral Competing Message (SSI-CCM) test. Binaural integration is assessed by this test. It used

six of the original sentences of the SSI test, but rather than presenting the sentences to one ear and a competing discourse message to the other ear, the sentences are paired and presented dichotically. The test was designed in an effort to develop a measure that would be minimally affected by peripheral hearing loss,

d) *Competing Sentence test (Willeford & Burleigh, 1994)*

The competing sentences test is one of the few dichotic procedures that requires the patient to attend to stimuli being presented to one ear (target sentences) and ignore stimuli being delivered to the other ear (competing sentences). Binaural separation is analyzed using this test. The test is composed of 25 sentence pairs with every sentence having average six to seven words in length. The sentences were presented dichotically with the target sentences presented at 50 dB SL (ref: SRT) and the competing sentences presented at 50 dBSL (ref: SRT). Ten target sentences were presented to each ear with the remaining five sentence pairs for practice.

From the review it is evident that there have been several sentence tests developed for the assessment of individual hearing loss but the tests that include the high and low predictable sentences or words are few in number especially in the Indian context. Hence, it is essential that a high and low predicable sentence list be designed for non-native English speakers.

## METHOD

The aim of the present study was to develop a sentence test to evaluate speech identification abilities, using high and low predictable sentences. In addition, the study also aimed at checking the utility of the test.

The study was done in the following three stages:

Stage I - Development of the test material.

Stage II - Administration of the sentence test on adolescents and young adults to obtain information about the performance of normal individuals.

Stage III - Determine the utility of the test material on individuals with a hearing impairment.

### Participants

- In stage I, ten normal hearing children in the age range of 12 years to 17 years 11 months were used to check for the familiarity of words used in the sentence test. In addition, to classify the sentences as high predictable and low predictable, 10 normal hearing adults (18 years - 30 years) were used.
- For stage II of the study, two groups of normal hearing individuals, each consisting of 20 members was used. One group was in the age range of 12 years to 17 years 11 months and the other in the age range of 18 years to 30 years.
- In stage III, ten subjects having mild-to-moderate sensorineural hearing loss were taken to check the utility of the material.

*Participant Inclusion Criteria for Stages I and II*

To be included in stages I and II of the study, each participant had to meet the following criteria:

- Have English as a medium of instruction for at least 5 years and speak it fluently.
- Have normal hearing (i.e. air conduction and bone conduction thresholds within 15 dBHL with an air-bone gap of less than 10 dB in the frequency range of 250Hz to 8 kHz and 250 Hz to 4 kHz respectively).
- Have normal speech and language.
- Be able to write English.
- Have no history of hearing loss.
- Have no illness on the day of testing.
- Not have any report of a neurological problem.

*Participant Inclusion Criteria for Stage III*

The participant inclusion criterion for stage III was the same as that of stages I and II, except that these subjects had a mild-to-moderate sensorineural hearing loss. Their age ranged from 20 to 55 years.

## Instrumentation

- A dual channel calibrated diagnostic audiometer (Madsen OB 922) was used for establishing hearing thresholds and for administering the test material.
- An immittance audiometer (GSI-Tymstar) was utilized to rule out middle ear problems.
- A Pentium IV computer with the WavePad software was used to record the material.
- Normalization of the speech material was done using the Adobe Audition software.

## Test environment

The testing was done in a sound treated double room. The ambient noise levels of the room were within permissible limits, as recommended by ANSI (1991, cited in Wilber, 1999).

## Procedure

### *Stage I - Development of the Test Material*

Five lists of sentences were developed, each consisting of 10 sentences. The sentences were such that they contained equal number of high and low predictable sentences (Appendix A). The developed material has been titled as High Predictable and Low Predictable English Sentence test for Non-Native English speakers (EHLPS). A

pilot study was done to check for the familiarity of the developed material and to classify them as high and low predictable sentences. Ten normal hearing children aged 12 years was used to check the familiarity of words and ten normal hearing adults were used to assess the predictability of the sentences.

*Evaluation of familiarity of test items:*

The participants were instructed to classify the words on a three point scale as 'highly familiar', 'familiar' or 'not familiar'. They were asked to use the following guidelines while classifying the words:

- 'Highly familiar words' were those words which occur more than 75% in regular communication.
- 'Familiar words' were those words which occur between 50% - 70% in regular communication.
- 'Not familiar words' were those words which occur less than 50% in regular communication.

The words that were considered 'highly familiar' or 'familiar' by 90% of the subjects were utilized for the final construction of the test.

*Evaluation of predictability of test materials*

The adults were instructed to classify the sentences as high predictable or low predictable sentences based on their ability to guess the final word. Each participant was

given a set of sentences where the target word was not provided and they had to guess it. They were instructed to give as many options as possible for the target word. The sentences in which only one option was given, that matched the test stimuli, were considered as highly predictable sentences. In contrast, sentences with more than one target word were considered as low predictable sentences.

*Recording of the material*

A female speaker was used for recording the material onto a computer. The "WavePad" software was used for the recording. The recording was done in a quiet room, using a sampling rate of 16 kHz. Scaling of the signals was done using "Adobe Audition" software, to ensure that the intensity of all the sounds were equal. A 1 kHz calibration tone was recorded prior to each list.

*Stage II - Administration of the Sentence Test on Normal Hearing Individuals*

Administration of the developed sentence test was done on normal hearing individuals in stage II. Prior to the administration of the test, the pure tone thresholds of the participants were obtained. SRT was established using the English paired words developed by Chandrashekara (1972).

The recorded version of the developed test was played on a Pentium IV computer, using WavePad software. The output of the computer was routed to the tape input of the audiometer. The output from the audiometer was played at 40 dBSL with reference to the subject's SRT. The calibration tone was used to adjust the VU meter deflection of the audiometer to zero. The participants heard the recorded material through headphones.

Half the participants were tested in the left ear and half in the right ear, to avoid any ear effect. The participants were asked to write down as well as verbally repeat what they heard. The verbal responses were noted by the experimenter.

### *Stage III- Checking the Utility of the Test Material*

The procedure for stage III was similar to that of stage II. Instead of evaluating normal hearing individuals the test was administered on ten adults with a mild-to-moderate hearing loss. They were tested in their better ear.

## Scoring

The responses from the participants were scored in two different ways. While the first way involved scoring the high predictable or low predicable target words (final words), the second way involved scoring the key words in the sentences. Every correct score was awarded a score of one and every incorrect response got a score of zero. The total number of target words were ten in each list, five for high predictable and the other five for the low predictable sentences, whereas the number of key words varied across each list. List 1 had 28 key words, while lists 2, 3, 4 and 5 had 29, 27, 30 and 27 key words respectively. The raw scores for target words and key words of the subjects were statistically analyzed separately, using the computer software SPSS (version 10.0).

# RESULTS AND DISCUSSION

The data obtained from both normal and individuals with mild-moderate sensorineural hearing loss (deviant group) were analyzed using the statistical package SPSS (version 10.0). The analyses were done using the developed test "English High and Low Predictable Sentence Test" (EHLPS). Two different scores were analyzed per participant, i.e. the target high-low predictable word scores and the key word scores. The analyses were carried out in the following ways:

I) Analyses of data collected from the normal group

   a) The test of significance of difference between

      i) High predictable and low predictable sentence scores within each list

      ii) High predictable and low predictable sentence scores across lists

      iii) HP-LP target word score and key word score.

II) Analyses of data collected from the group with hearing impairment

   a) The test of significance of difference between

      i) High predictable and low predictable sentence scores within each list

      ii) High predictable and low predictable sentence scores across lists

      iii) HP-LP target word score and key word score.

III) Comparison between normal group and deviant group

   a) The test of significance of difference was done for

      i) High and low predictability scores between groups

      ii) Key word scores between groups

I) Analyses of Data from Normal Individuals

i) *High Vs. Low Predictable Sentence Scores within each List*

Descriptive statistics was initially done, where the mean, standard deviation (SD) and 95% confidence interval were calculated. This was done for each of the lists (Table 1). It can be observed from the table that for both high predictable (HP) and low predictable (LP) sentences, the mean scores were either equal to the maximum scores or were just slightly less than the maximum scores. The variability in scores was also nil or minimal, as evident from the SD values.

Table 1: Mean, SD and 95% confidence interval values for High predictable (HP) and Low predictable (LP) sentence scores

| List no | Sentence type | Mean (Max score=5) | SD | Lower bound | Upper bound | Significance |
|---|---|---|---|---|---|---|
| List 1 | HP | 4.85 | .37 | 4.68 | 5.00 | NS |
| | LP | 5.00 | .00 | - | - | |
| List 2 | HP | 5.00 | .00 | - | - | NS |
| | LP | 4.85 | .49 | 4.62 | 5.00 | |
| List 3 | HP | 4.95 | .22 | 4.85 | 5.00 | NS |
| | LP | 5.00 | .00 | - | - | |
| List 4 | HP | 5.00 | .00 | - | - | NS |
| | LP | 4.85 | .37 | 4.68 | 5.00 | |
| List 5 | HP | 5.00 | .00 | - | - | NS |
| | LP | 4.9 | .45 | 4.69 | 5.00 | |

Note. NS = Not significant

Further, to check for the variation between the high and low predictable sentences within each list, paired sample t-test was done. The t values obtained showed no significant difference at the 0.05 level (Table 1).

The findings of the present study are not in agreement with that of Kallikow, Stevens and Elliot (1977). They reported that better performance was noted for HP sentences than the LP sentences. This lack of agreement in finding can be attributed to the difference in testing procedure. The study by Kallikow et al. was done in presence of various signal-to-noise ratios (SNR), whereas the EHLPS was done in a quiet condition. It has been noted by Stuart, Phillips and Green (1995) that normal hearing individuals, who have good speech identification scores in quiet have poorer scores in the presence of noise. Individuals with normal hearing depended more on the contextual cues in adverse listening conditions such as noise, and not in a quiet condition. Had the present study been conducted in the presence of noise, a similar result would have been probably obtained as that of Kallikow et al.

*ii) Difference between High Predictable and Low Predictable Sentence Scores across Lists*

A one-way repeated measure ANOVA was done to check for the variation between the high predictable and low predictable sentences across lists. No significant difference was obtained across the lists between the high predictable sentences [$F(4, 76) = 2.259$, $p > 0.05$] and low predictable sentences [$F(4, 76) = 1.048$, $p > 0.05$]. The above findings indicate that all five lists are similar in terms of HP and LP sentences. Since normal hearing individuals performed equally well on all five tests, any one of them can be used while evaluating the speech identification ability of clients, when HP-LP scoring is done.

*Hi) HP-LP Target word score Vs. Key Word Score*

Repeated measures ANOVA showed a significant difference [F (4, 76) = 3.009, $p < 0.05$] for the key word scores in normal individuals. This was unlike that seen for the HP-LP target word scores (Table 1) where there was no significant difference across lists. This highlights that the lists are equal when they are valued in terms of HP and LP scores, but are unequal when they are scored on the basis of key words. The mean values for both the target HP-LP scoring and key word scoring is given in Table 2. Within each list, the scores for HP-LP words and key words are comparable.

From the Bonferroni's multiple comparison test, it was evident that List 1 and List 3 showed a significant difference while the other pairs of lists did not. The participants obtained significantly lower scores on List 3 when compared to List 1.

Table 2: Mean values for HP-LP target word scores and key-word scores

| **List no** | **HP-LP Target word score** | **Key word score** |
|---|---|---|
| List 1 | 9.85 (98.5%) | 27.6 (97.6%) |
| List 2 | 9.85 (98.5%) | 28.6 (98.7%) |
| List 3 | 9.95 (99.5%) | 26.9 (99.6%) |
| List 4 | 9.85 (98.5%) | 29.7 (99.3%) |
| List 5 | 9.9 (99%) | 26.6 (98.7%) |

Note: Value given in bracket refers to the percentage score.
Maximum HP-LP target word scores was ten
Maximum key word score ranged between 27-30

A possible reason as to why List 1 and List 3 are not equal could be due to the method used in the construction of the lists. While constructing the test, care was taken to equate the target HP-LP words in each sentence in terms of frequency of occurrence of various phonemes. This was not done for the key words as the main aim of the study was to develop and evaluate HP-LP sentences. Further, it is possible that the HP-LP target words were easier to predict in the sentence compared to the other key words in the sentences. Also, the words occurring toward the end of a sentence tend to be more predictable and more likely to be restored and recalled quickly than rest of the words in the sentence. A study by Marslen-Wilson and Welsh (1978) also reported that the words occurring at the end of sentence were easier to predict than the other set of words.

Thus, it is recommended that when key words are being used to score the responses of subjects, the combination of List 1 and 3 should not be used for comparing perceptual outcomes. However, other list combinations can be used for perceptual evaluation of individuals. These combinations include Lists 1, 2, 4 and 5 or Lists 2, 3, 4 and 5.

II) Analysis of data collected from the group with hearing impairment

*i) High Vs. Low Predictable Sentence Scores within each List*

As done with the data obtained from the normal hearing children, the mean, standard deviation (SD) and 95% confidence interval were calculated for each list (Table 3). The mean scores varied only minimally depending on whether the sentence was a high predictable one or a low predictable one. For all five tests, the scores

obtained on the LP sentences were lower. However, the t-test revealed significant difference between the HP and LP sentences for all but List 1 at the 0.05 level or the 0.01 level (Table 3). Also, the variability in scores was comparatively more in LP sentences compared to the HP sentences as seen from the SD values.

Table 3: Mean, Standard deviation and 95% confidence interval values for HP and LP sentence scores in individuals with hearing impairment

| **List no** | | **Mean (Max score = 5)** | **SD** | **Lower bound** | **Upper bound** | **Level of Sig.** |
|---|---|---|---|---|---|---|
| List 1 | HP | 3.55 | **1.21** | 2.73 | 4.36 | 0.831 |
| | LP | 3.45 | **.93** | 2.83 | 4.08 | |
| List 2 | HP | 4.55 | .69 | 4.08 | 5.00 | 0.006** |
| | LP | 3.45 | .93 | 2.83 | 4.08 | |
| List 3 | HP | 4.64 | .50 | 4.30 | 4.98 | 0.019* |
| | LP | 3.55 | 1.29 | 2.68 | 4.41 | |
| List 4 | HP | 4.55 | .52 | 4.19 | 4.90 | 0.000** |
| | LP | 3.18 | **.75** | 2.65 | 3.69 | |
| List 5 | HP | 4.64 | .50 | 4.30 | 4.98 | 0.038* |
| | LP | 3.91 | 1.14 | 3.15 | 4.67 | |

Note. * Significant at .05 level
** Significant at .01 level

From the present study it was revealed that the individuals with a hearing impairment did depend more on the contextual cues rather than the audibility cues. The contextual cues were limited in the LP sentences and hence they obtained comparatively less scores in these sentences.

*ii) Difference between High Predictable and Low Predictable Sentence Scores across Lists*

To check for the variation between the high predictable sentences across lists, one-way repeated measure ANOVA was done with the data obtained from the

individuals with hearing impairment. There was a significant difference between the lists for the high predictable sentences [F (4, 40) = 4.518, $p < 0.05$]. The Bonferroni's multiple comparisons test revealed that List 1 and List 2 had a significant difference and the other pairs of lists did not show a significant difference. The results were not similar for the low predictable sentences across lists. Here, there was no significant difference seen [F (4, 40 = 0.974, $p > 0.05$] indicating with hearing impairment performed similarly on the LP sentence across lists. Probably, with the HP sentences, the individuals were able to guess the target word in certain lists and not so in certain other lists. However, this was not the case with the LP sentences.

*Hi) HP-LP Target Word Score Vs. Key Word Score*

The mean scores for HP-LP target words and key words, expressed in terms of raw scores as well as percentage, are depicted in Table 4. When the key words were considered for scoring in individuals with hearing impairment, it showed a significant difference across lists [F (4, 40) = 4.905, $p < 0.05$]. This is similar to what was observed for the LP sentence scores in the group with hearing impairment. It was seen from the Bonferroni's multiple comparison test that for the key word scores, List 2 and 5 showed a significant difference. Likewise Lists 3 and 5 had a significant difference, while the other lists did not have a significant difference between them.

Table 4: Mean and SD for HP-LP target word scores and key word scores in individuals with a hearing impairment

| List no | Target HP-LP word score | Key word score |
|---|---|---|
| List 1 | **7 (70%)** | 20.09 (71.7%) |
| List 2 | **8 (80%)** | 21.81 (75.1%) |
| List 3 | 8.19 **(81.9%)** | 20.36 (74.7%) |
| List 4 | 7.73 **(77.3%)** | 23.36 (79.3%) |
| List 5 | 8.55 **(85.5%)** | 22.81 (85.1%) |

Note: Value given in bracket refers to the percentage score.
Maximum HP-LP word scores was ten
Maximum key word score ranged between 27-30

The scores were comparable within a list when HP-LP target words and key words scores were used. The similarity in scores was more pronounced in List 1, 4 and 5. Both scoring procedures seem to detect the perceptual problems of individuals with hearing impairment.

Ill) Comparison between Normal Group and the Deviant Group.

*i) High and Low Predictability Sentence Scores between Groups*

The mean HP-LP scores for the two groups are depicted in Table 5. The mean scores obtained by the individuals with hearing impairment were lower when compared to the normal hearing group. To check for the difference between the high and low predictable sentence scores between the two groups, an independent t-test was performed. It was found that there was a significant difference at the 0.01 level

between the two groups for all the Lists for both HP and LP sentences. Only the HP sentences in List 3 were significantly different at the 0.05 level.

Table 5: Mean and t values for HP-LP target words across normal and individuals with hearing impairment (HI)

| List | Sentence type | Groups | Mean (Max score = 5) | t values |
|---|---|---|---|---|
| List 1 | **HP** | Normal | 4.85 | 4.50** |
| | | HI | 3.55 | |
| | **LP** | Normal | 5.00 | 7.50** |
| | | HI | 3.45 | |
| List 2 | **HP** | Normal | 5.00 | 2 99** |
| | | HI | 4.55 | |
| | **LP** | Normal | 4.85 | 5 49** |
| | | HI | 3,45 | |
| List 3 | **HP** | Normal | 4.95 | 2.40* |
| | | HI | 4.64 | |
| | **LP** | Normal | 5.00 | 5.10** |
| | | HI | 3.55 | |
| List 4 | **HP** | Normal | 5.00 | 3 94** |
| | | HI | 4.55 | |
| | **LP** | Normal | 4.85 | 8.36** |
| | | HI | 3.18 | |
| List 5 | **HP** | Normal | 5.00 | 3.27** |
| | | HI | 4.64 | |
| | **LP** | Normal | 4.90 | 3 47** |
| | | HI | 3.91 | |

The finds of the present study are in agreement with that reported in literature. Olsen, Noffsinger and Kurdziel (1975) have documented that speech discrimination scores were comparatively worse in individuals with hearing impairment in quiet. Similarly, Pekkarinen, Salmivalli and Suonpaa (1990) reported that word recognition scores were poorer in their subjects with hearing impairmentjx)mrjared to the normal hearing group in a quiet situation.

Thus, it can be inferred that HP-LP target word scores are sensitive in assessing perceptual problems in individuals with hearing impairment. Both high predictable sentences as well as low predictable sentences are equally sensitive.

*ii) Key Word Scores between Groups*

One-way repeated measure ANOVA was calculated for the key words in the normal and deviant group and it showed a significance difference [$F(4, 116) = 9.067$, $p < 0.05$]. Along with ANOVA, independent t-test was also done to check for difference between key word scoring across both the groups. The t values showed a significant difference at the 0.01 level (Table 6). This shows that key word scoring is also an equally sensitive test procedure to detect perceptual deficits in the hearing impaired population.

Table 6: Mean and t values for key words across normal and (HI) group

| List no | Groups | Mean | t values |
|---|---|---|---|
| List 1 | Normal | 97.66 | 9.90** |
| | HI | 71.75 | |
| List 2 | Normal | 98.78 | 8.52** |
| | HI | 75.19 | |
| List 3 | Normal | 99.63 | 9.36** |
| | HI | 74.74 | |
| List 4 | Normal | 99.33 | 6.80** |
| | HI | 79.36 | |
| List 5 | Normal | 98.70 | 6.41** |
| | HI | 85.10 | |

Note. ** Significant at .01 level

From the statistical analyses of the data from individuals with normal hearing and hearing impairment, the following conclusions can be drawn:

(i) There is no significant difference between the high predictable and low predictable sentence scores in the normal population,

(ii) All the five lists containing high predictable and low predictable sentences were equal.

(iii) There is inequality of lists when key words are scored in normal hearing individuals.

(iv) In individuals with hearing impairment, the LP sentences yielded significantly lower scores than the HP sentences for most of the lists,

(v) The sentence lists were not similar when the key words or target HP-LP words were considered for scoring on subjects with a hearing impairment.

(vi) There was a significant difference between the normal hearing group and individuals with hearing impairment on the EHLPS for both key word and target word scoring.

# SUMMARY AND CONCLUSION

The goal of a good and a valid speech perception test is to provide measure of an individual's performance in day-to-day life situation. Though there are numerous other speech stimuli such as monosyllables, bisyllables, nonsense syllable, and spondees, sentences are considered to be better indicators of intelligibility. Sentences tests also help predict how efficiently a listener can use hearing for communication purpose (Mendel & Danhauer, 1997). In an everyday situation, there is a combination of high and low predictable sentences. High predictable sentences are those in which certain key words help in guessing the rest of the stimuli if part of it is missed out, whereas low predictable sentences are those, which are difficult to guess even with the help of certain key words (Kallikow, Stevens & Elliot, 1977). Thus, there is a need to assess varying levels of difficulty, in terms of predictability in individuals with hearing loss and hence, this low and high predictable sentence test was developed.

The present study was carried out with the aim of developing an English High Predictable Low Predictable Sentence test for Non-native English speakers (EHLPS). The study was carried out in three stages. In the first stage, the material for the sentence test was developed which had five lists of sentences each containing a combination of five high and five low predictable sentences. Familiarization of the test was done on ten normal hearing individuals in the age range of 12 years to 17 years 11 months and the familiar words were selected to make the test. In addition, to classify the sentences as high predictable and low predictable, 10 normal hearing adults (18 years - 30 years) were used. The test was administered on 20 normal hearing individuals and 11 individuals

with mild-to-moderate sensorineural hearing loss. The responses were scored in terms of target high predictable /low words and key words in the sentences.

The statistical analysis of the data revealed the following conclusions:

(i) There is no significant difference between the high predictable and low predictable sentence scores in the normal population,

(ii) All the five lists containing high predictable and low predictable sentences were equal.

(iii) There is inequality of lists when key words are scored in normal hearing individuals.

(iv) In individuals with hearing impairment, the LP sentences yielded significantly lower scores than the HP sentences for most of the lists,

(v) The sentence lists were not similar when the key words or target HP-LP words were considered for scoring on subjects with a hearing impairment,

(vi) There was a significant difference between the normal hearing group and individuals with hearing impairment on the EHLPS for both key word and target word scoring.

From the above findings it may be concluded that EHLPS is a sensitive test for the assessment of auditory perceptual difficulty in individuals having a hearing problem. The test would provide information about the auditory perceptual problems present in individuals in an everyday situation.

Implications of the study:

- The test is a sensitive measure to determine the everyday auditory perceptual problems in individuals having a hearing loss.
- This test may also be used as a part of a diagnostic test battery as well as in the selection of appropriate amplification devices for the hearing impaired individuals.
- Since the developed test has multiple lists, it can be used for pre and post therapy evaluation in individuals having auditory perceptual problems.
- It could be used in the presence of noise to detect subtle perceptual problems in individuals.

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**List 5**

1) A **dog** has four **legs.**
2) **He** was **assigned** the **task.**
3) **A rainbow** has **seven colours.**
4) I **met** with a **car accident.**
5) The **sun rises in** the **east.**
6) The **door** was **wide open.**
7) **I** made the **call** from a **booth.**
8) **Stop playing** with your **hands.**
9) **Help me in arranging** the **books.**
10) We should have **considered** the **matter.**

Note: *Words in bold are the key words and words underlined are the HP-LP target words.*

APPENDIX - A

**English High Predictable Low Predictable Sentence test for Non-native English speakers (EHLPS)**

**Listl**

1) **A year** has **twelve months.**
2) **I hit** the **ball** with a **bat**
3) The **sport shirt** has **short sleeves.**
4) I was made to **lift** my **bag.**
5) The **baby slept** with **closed eyes.**
6) She **baked** his **birthday cake.**
7) The **room** is always kept **neat.**
8) Put a **battery** in the **clock.**
9) **February** has **28 days.**
10) He looks **different** with a **beard.**

**List 2**

1) She just **heard** a **loud scream.**
2) The **peacock** is our **national bird.**
3) **He** had a **bath** with **hot water.**
4) The **heavy rains** caused a **flood.**
5) The **baby** has **chubby cheeks.**
6) I have got a **new dress.**
7) He **wiped** the **mirror** with a **sponge.**
8) **He eats** using his **right hand.**
9) **A day** has **24 hours.**
10) **Give** her a few **slices of bread.**

**List 3**

1) The **dogs** were **tied to** the **gate.**
2) She has **to pay** the **tuition fees.**
3) **We** got **drenched in** the **rain.**
4) I need to **fill ink in my pen.**
5) **He prefers** to have **tea.**
6) I got **stuck in** the **lift**
7) **Lotus is our national flower**
8) The **bomb exploded with** a **blast.**
9) The **barber cut** his **hair.**
10) She **opened** the **room** with a **key.**

**List 4**

1) The **cricket match** ended in a **draw.**
2) The **bomb exploded with** a **blast.**
3) **He stuck** the **paper** with **glue.**
4) **In autumn,** the **trees** shed their **leaves.**
5) **Sunday is** a **holiday.**
6) Every morning **I** brush my **teeth.**
7) There are 7 days in a **week.**
8) She hit the water with a **splash.**
9) He was asked to unlock the **door.**
10) We could consider the **request.**

**List 5**

1) A **dog** has four **legs.**
2) **He** was **assigned** the **task.**
3) **A rainbow** has **seven colours.**
4) **I met** with a **car accident.**
5) The **sun rises in** the **east.**
6) The **door** was **wide open.**
7) **I** made the **call** from a **booth.**
8) **Stop playing** with your **hands.**
9) **Help me in arranging** the **books.**
10) We should have **considered** the **matter.**

Note: *Words in bold are the key words and words underlined are the HP-LP target words.*