DEVELOPMENT AND STANDARDIZATION OF SENTENCE TEST IN KANNADA LANGUAGE FOR ADULTS

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Contents

Abstract

Objective: The present study aimed to develop and standardize sentence identification test in Kannada language. ***Design:*** Normative research. ***Sample:*** 133 participants with normal hearing sensitivity. ***Method:*** Sentences in Kannada language were selected from various sources. These sentences were evaluated for naturalness, predictability and equivalency on 33 participants. Sentences which were considered natural, low in predictability and equivalent were used to construct 30 lists with 10 sentences each. Standardization of the material and list equivalency were assessed on 100 listeners with normal hearing ability. ***Results:*** Based on ratings of naturalness and predictability**,** 564 sentences were considered as natural and low predictable sentences. Of these, 316 sentences were found to be having equal difficulty based on performance-SNR function. These sentences were used for construction of 30 lists. Repeated measures ANOVA and Bonferroni post hoc test revealed List 1, 3, 15, 16 and 30 to be significantly different from at least one of the other lists. After removing these lists, the mean identification score at -5 dB SNR was 54 percent. Clinical utility of the test was also assessed. Individuals with mild, moderate, moderately-severe, and severe degrees of hearing loss were assessed. ***Conclusions:*** The Kannada sentence identification test consists of 25 equivalent lists, which will be useful for speech intelligibility measures in various applications. The developed sentence material is also sensitive to differences in speech identification abilities across different degrees of hearing loss.

CHAPTER 1

INTRODUCTION

Speech is the most sophisticated form of communication that is quite unique to human. The measurement of speech perception provides useful information in assessing communication difficulties experienced by listeners with hearing loss. The scope of speech perception tests extend even to rehabilitation, targeted particularly for the assessment and monitoring of an individual's speech perception ability before and after fitting of hearing aids or cochlear implants (Mueller, 2001). Further, it aids in choosing appropriate amplification and for counselling (Wilson, Burks & Weakley, 2005; Wilson & McArdle, 2005).

There are a variety of test materials such as nonsense syllables, monosyllables, bisyllables and sentences that can assess speech perception abilities of individuals. Each of them has their own advantages and disadvantages, primarily due to their relation to everyday speech communication, the redundancy aspects, the scoring of responses and test duration (Tyler, 1994). More commonly used speech stimuli are monosyllabic or bisyllabic words and sentences. Carhart (1965) preferred monosyllabic words owing to their non-redundancy and meaningfulness. He also stated that they are not as confusing as nonsense syllables. In addition, as all languages do not have concrete monosyllabic words, bisyllables are preferred and they provide additional cues for intelligibility than monosyllables (Hirsh, 1952). On the other hand, monosyllabic words when presented at constant intensity levels do not truly represent realistic communication. Sentences articulated with natural dynamics have much larger dynamic range when compared to monosyllabic words, thus a more realistic representation of speech communication (Villchur, 1982).

While there exists many meaningful word and nonsense syllable tests, the sentence type of stimuli have the advantage of offering additional insight regarding the individual's performance in more realistic communication scenarios. They are considered to be valid indicators of intelligibility and are a better representation of verbal communication (Tyler, 1994). Further, it is expected that sentence test material will elicit better accuracy and effectiveness in measuring speech reception thresholds, because sentence material result in much steeper intelligibility function in contrast to tests using single words (Kollmeier & Wesselkamp, 1997). The capacity to manipulate certain patterns like intonation and coarticulation effects on the ongoing speech is severely limited when using single words, especially monosyllables (Killion et al., 2004). Miller, Heise, and Lichten (1951) noted that sentences have face validity as 'natural' and 'meaningful' stimuli for assessing auditory function.

1.1 Existing sentence tests in foreign languages

The use of sentence material dates to the 1930s, when Fletcher and Steinberg devised sentence intelligibility lists following the format of simple interrogative or imperative sentences. The sentences never became widely used clinically because of the problems related to familiarity and difficulty of the test material (Hirsh, 1952). One of the first sentence tests to receive widespread clinical acceptance was the *Central* Institute of Deaf (CID) Everyday Sentences Test developed by Silverman and Hirsh (1955). The CID test uses a target-word format, meaning that although the subject must repeat the entire sentence during testing. Scoring is based on correct recognition of key words.

Plomp and Mimpen (1979) developed a sentence test for the Dutch language by first evaluating the intelligibility of all sentences at an intermediate speech level. For the composition of the actual test lists they only employed those sentences that yielded intelligibility close to the average intelligibility of all sentences. Thus, a high homogeneity of the sentences both within each test list and across all test lists was achieved. A similar approach was employed for the hearing-in-noise test (HINT), which was developed at The House Ear Institute and provides a reliable measure of reception threshold for sentences (RTS) in quiet and in background noise (Nilsson, Sullivan, & Soli, 1990; Nilsson, Soli & Sullivan, 1993; Nilsson Soli & Sullivan, 1994). The HINT was designed for testing binaural listening in the sound field allowing for the assessment of amplification.

The HINT consists of 25 equivalent ten-sentence lists and speech spectrum noise. The sentences were revised to remove British idioms, equate sentence length and alter verb tenses. The lists of sentences were normalized for naturalness, difficulty and reliability (Nilsson et al., 1994). The speech stimuli are simple sentences with little contextual information, closely approximating performance intensity slopes for speech intelligibility word lists

(Nilsson, Soli & Sullivan, 1995). The HINT makes use of speech spectrum noise that was generated by spectrally matching the white noise to the long-term average spectrum of the stimulus sentences so that the signal-to-noise ratio is approximately equal at all frequencies. An adaptive method is used for measuring the reception thresholds for sentences in quiet or in noise. The adaptive procedure avoids the ceiling and floor effects associated with most word recognition tests, which are presented at a fixed level (Nilsson, Soli & Sullivan, 1994). There are many other languages such as Danish (Neilsen & Dau, 2009), Mandarin (Wong et al. 2007), Cantonese (Wong & Soli, 2005) in which HINT is available.

Similarly, in German language, a sentence test called ‘‘Marburger Satztest’’ has been developed (Niemeyer, 1967). It consists of ten test lists with ten sentences that are each phonemically balanced. However, the semantic construction is partially unusual and incomplete which has resulted in a relatively poor acceptance of this test in the German language. Moreover, the standardized recording of the sentence test by a schooled speaker is over-articulated and does not reflect an everyday communication situation. The test lists yield approximately the same intelligibility in quiet. However, the equivalence of the test lists and the homogeneity of the sentence intelligibility in noise was not considered when constructing the test.

In German language, another sentence test has been developed by Kollmeier and Wesselkamp (1997). Though this test does not follow the same adaptive procedure used in HINT test, this test also evades the flooring and ceiling effects by providing SNR-50. This test consists of 20 test lists with ten sentences that are each phonemically balanced. The construction of these 20 lists comprised of various steps. The first step was a pilot study to arrive at SNR yielding 50% correct identification of key words of 324 sentences. These 324 sentences were then grouped into six groups, each group having sentences with similar intelligibility based on the results of the pilot study. Speech intelligibility measurements were again carried out on these six groups of sentences and a two-point discrimination function was derived. Based on the derived discrimination function, 20 phonemically balanced sentence lists were then formed from those sentences. Performance-Intensity discrimination functions calculated for these final 20 lists revealed that 50% sentences scores could be obtained at a SNR of -6.1 dB.

This test has been found to have several clinical applications such as assessment of binaural interaction in individuals with normal hearing sensitivity and hearing impairment, assessment of benefits of binaural hearing aids (Peissig & Kollmeier, 1997) and monitoring the progress of the children with cochlear implant after training. From the above it is clear that, over the years, different forms of sentence tests have been developed, keeping in mind the perceptual difficulties of those with hearing loss (Mendel & Danhauer, 1997). In addition, the native language of an individual is another important factor affecting the speech perception of an individual (Delattre, 1964). This necessitates a need for development of speech material in native languages. Hence, administering speech test in the native language of the individual is considered to be ideal.

1.2 Sentence tests available in Indian languages

India is a multilingual country having several regional languages. In the Indian context, material developed by Rahana and Yathiraj (2007) for Indian English (non native English speakers) is available. They constructed sentences with high predictability and low predictability in English. Each list had 10 sentences, consisting of 5 sentences with high predictability and another 5 sentences with low predictability. They reported a mean list score of around 80% for the Mild-Moderate hearing loss group. Another test material available is a sentence test in Kannada has been developed by Avinash, Meti and Kumar (2010), this has a limited number of sentences which can be used for routinely in clinics, and however, is not a standardized test. Further, this has a limited number of sentences (seven equivalent lists having seven sentences each).

1.3 Need for the study

It has been reported that the mother tongue of an individual influences his/her perception of speech and that participants consistently had better and optimum discrimination scores in their mother tongue as compared to other languages (Delattre, 1964). Hence, it is important to have speech material in the mother tongue of an individual.

India is a multilingual country with several languages. All India Institute of Speech and Hearing is situated in Karnataka, a state in South India. Kannada is the official language spoken in this state. The Institute renders clinical services to individuals with communication disorders. The services for individuals with hearing impairment include assessment of hearing sensitivity, fitment of various hearing devices and rehabilitation of individuals with hearing impairment. It is required that a battery of test be administered for assessment, fitting of devices and monitoring the progress of management. Speech identification tests are important tools in the battery in the assessment of hearing and comparing performance of hearing devices and/or settings (Mueller, 2001).

Majority of the service seekers visiting the Institute are speakers of Kannada language. This necessitates development of sentence test in Kannada language for assessment of hearing and hearing device fitment.

Apart from clinical services, research studies also mandate the use of many sentence lists. Primarily, improvements in hearing aid technology have increased the number of hearing aid parameters. Research into the effect of each of the parameter/algorithm requires a large number of sentence lists (Gatehouse, 1992), in order to avoid practice effect. The QuickSIN (Speech in Noise) test in Kannada language developed by Avinash, Meti, and Kumar (2010) included 12 lists with seven sentences each, from a pool of 60 sentences after familiarity rating. The noise used was eight talker speech babble. The lists of the test have been constructed such that each sentence was presented at SNR in the following order: +20 dB, +10 dB, +5 dB, 0 dB, -5 dB and -10 dB, to 30 individual with normal hearing sensitivity. They reported that at -6.17 dB SNR, 50% speech identification scores could be identified and only seven lists were equivalent out of 12 lists. Hence, this test has a limited number of sentence lists (seven equivalent lists having seven sentences each). Further, this test has some sentences occurring more than one time causing a possibility of practice effect. Everyday communication demands listeners to understand speech in varying degrees of noise. It has been proven that listeners with sensorineural hearing loss (SNHL) exhibit greater degree of difficulty in understanding speech than do listeners with normal hearing in the background noise under the similar circumstances (Dubno, Dirks & Morgan, 1984) and, also, speech intelligibility measures are inherently limited by ceiling effects when presented in quiet condition. Hence, the study aims to develop a large set of sentence lists, a maximum of 30 lists, adapting the procedure used by Kollmeier and Wesselkamp (1997) to achieve sentence as well as list equivalency in the presence of noise and to provide normative for the developed lists. The specific objectives are:

- To develop large set of sentence material in Kannada for adults,
- To standardize the sentence lists, and
- To assess the clinical utility in individuals with hearing loss.

CHAPTER 2

METHOD

The aim of the study was to develop and standardize sentence lists in Kannada language. The study also aimed at assessing the clinical utility of the standardized sentence lists in individuals with different degrees of hearing loss.

The study was carried out in three phases:

Phase I - Development of sentence lists in Kannada language

Phase II - Standardization of sentence lists and assessment of list equivalency and

Phase III – Assessment of clinical utility

2.1 Phase I: Development of sentence lists in Kannada language

The development of the sentence lists consisted of following steps.

2.1.1 Selection of sentences

2.1.2 Recording and editing of sentences

2.1.3 Determination of global SNR

2.1.4 Sentence equivalency

2.1.5 Phonetic balancing and list creation

2.1.1 Selection of the sentences

Sentences were selected from a large database. The sources were mainly back files of major Kannada newspapers/magazines and day-to-day conversation. The following criteria were used for selection of sentences.

A sentence was chosen if,

a) the total number of words ranged from four to six
b) the number of syllables not exceeding fourteen to sixteen
c) it contained familiar and equally difficult words
d) it did not contain punctuation characters
e) it represented conversational speech
f) it did not contain proverbs, exclamations, proper names, or questions
g) it was complete (i.e., contained a verb) and was syntactically and grammatically correct, and
h) it had semantically neutral content.

A total of 700 sentences were selected based on the above mentioned criteria. In each of these sentences, four key words (defined as those words which were deemed to be important for sentence comprehension) were identified by ten adult native speakers of Kannada. Naturalness rating [on a five point rating scale (5 = Natural and 1 = Artificial)] and predictability was then done by the same ten participants. Any sentence that did not receive a mean rating of at least four was removed.

Predictable sentences were defined as those in which the key words could be guessed from a single word or the whole sentence could be inferred from the context. The participants were asked to guess the possible words that could possibly occur when they were presented with the key words. If the number of words guessed were more than two, then, those sentences were considered to be less predictable. Predictability was assessed since sentences with high predictability may elevate intelligibility scores compared to sentences with low predictability (McGarr, 1981; Garcia & Cannito, 1996; Garcia & Dagenais, 1998; Barreto & Ortiz, 2010). Based on all the above ratings, 564 sentences were shortlisted and audio recorded.

2.1.2 Recording, editing and noise mixing

2.1.2.1 Recording

A female speaker (aged 21 years) was selected from a group of three native speakers based on (a speech sample recorded by all the three speakers) their ability to sustain constant vocal effort while maintaining clear articulation and neutral intonation. Recordings were made in a sound treated room using Shure SM48 cardioid dynamic vocal microphone placed in front of the speaker at a distance of around 0.5 m. Each sentence was recorded directly into an individual sound file using Computerized Speech Lab (CSL) software, which also allowed filtering and amplitude monitoring. The waveforms were digitized with a 16 bit A/D converter at a sampling frequency of 44100 Hz.

2.1.2.2 Editing

The digitized waveforms were then edited using Adobe Audition (v 3.0) by eliminating silent intervals at the beginning and at the end of each waveform. Other unwanted sounds, such as breathing noise and lip smacks, were also removed. The mean-squared amplitudes of the signals were equated to 60 dB (relative to one sample unit in a 16-bit digital representation). For calibration purposes, a 1000 Hz tone of 30 second duration was generated at a level equal to the root mean square average intensity of sentences.

2.1.2.3 Mixing sentences with noise

The recorded 564 sentences were concatenated and spectrally analyzed to derive its long-term average speech spectrum (LTASS). The LTASS was then used to design an infinite impulse response (IIR) filter in MATLAB software (v 7.12). White noise was then subjected to the designed IIR filter parameters to obtain a noise with spectral characteristics similar to previously recorded speech sample. Figure 2.1 shows the LTASS of speech and the spectrum of the filtered noise. The 564 sentences were then mixed with the generated spectrally shaped noise at different SNRs. This was achieved using a program written on a MATLAB platform given by Gnanateja and Pavan

(2012). This program calculates the RMS amplitude of the speech and noise signals in 50 millisecond bins and mixes them both in the specified signal-to-noise ratios.

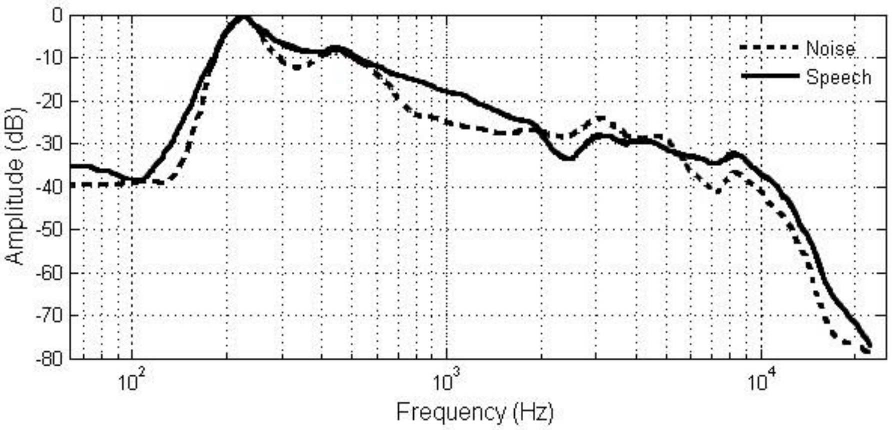

Figure 2.1.LTASS of sentences and spectrally shaped noise.

2.1.3 Determination of global SNR

Speech intelligibility measures are inherently limited by the floor and ceiling effects. To overcome these limitations that are associated with tests presented at a fixed level, adaptive procedures are used (Nilsson, Soli & Sullivan, 1993). Adaptive procedure may be utilized to arrive at global SNR. Global SNR was defined as the SNR which yields an average total intelligibility score of 50% (Kollmeier & Wesselkamp, 1997).The important advantage of determining and using global SNR is the minimization of ceiling and floor effects. This SNR was used to get a 50% point in the sigmoid curve and was used to determine sentence equivalency in the pilot study which follows. The following methodology was adopted.

2.1.3.1 Participants

A total of eight native Kannada speaking male and female listeners (four males and four females) participated. Their ages ranged from 18 to 35 years (mean age of 26.2 years, SD = 4.89). All the participants had normal hearing sensitivity and normal middle ear function.

2.1.3.2 Procedure

The participants were seated in a sound treated room. Normal hearing sensitivity was confirmed by routine clinical audiometry. Normal hearing sensitivity was defined as air conduction pure tone thresholds within 15 dB HL across 250 Hz to 8000 Hz and bone conduction thresholds within 15 dB HL across 250 Hz to 4000 Hz. Further, the participants had 'A' type of tympanogram and had ipsilateral and contralateral reflexes at normal levels.

The sentence material was presented monaurally to a randomly chosen ear at the most comfortable level. The sentences were played through a personal computer, connected to a calibrated audiometer. The sentences were delivered through Sennheiser HDA 200 closed dynamic headphones. The headphone was used since it had a good frequency response and offered good comfort.

The sentences were delivered at SNRs ranging from -7 dB SNR to 0 dB SNR at 1 dB SNR intervals. The subjects were instructed to repeat back the sentences as accurately as possible. Listeners practiced with ten randomly selected trial sentences and were provided with feedback regarding their performance before the start of the actual test runs. The words correctly identified by the subjects were marked on a printed response sheet by the experimenter. Each sentence was scored based on the number of correctly identified key words. The words were considered as correct responses for errors such as contractions, spelled out contractions, identifiable mispronounced words, and changes in plurality. The experiments by Giolas & Duffy (1973) and Hinkle (1979) permits such exemptions to scoring procedure. Since each sentence had four key words, the maximum possible score was 4. The responses were noted on printed score sheet. Based on this, an average score for the 564 sentences was then calculated.

The results of the pilot study revealed scores of approximately 75% correct (mean raw score = 2.95) at -3 dB SNR, 50% correct (mean raw score = 2.19) at -5 dB SNR and 30% correct (mean raw score = 1.20) at -7dB SNR. Based on the obtained results, -5 dB SNR was chosen as the global SNR. Hence, for the sentence equivalency assessment testing was done at -5 dB SNR (global SNR, -3 dB SNR (2 SNRs above the global SNR) and at -7 dB SNR (2 SNRs below the global SNR)

2.1.4 Sentence Equivalency

To arrive at sentences to be incorporated into lists that are similar to each other, an initial process of sentence equivalency was carried out using the procedure given below. The equivalency was assessed because, even though the sentences had equal RMS amplitudes, their intelligibility exhibited in the presence of spectrally shaped noise would not essentially be equal. Further, the phonemes used, familiarity of words, as well as intonation and intensity variations influence speech perception in noise (Nillson et al., 1994).

2.1.4.1 Participants

Another group of 15 native Kannada speaking male and female participants were chosen. Their ages ranged from 18 to 48 years with a mean age of 25.8 years (SD = 9.05). All the participants had normal hearing sensitivity.

2.1.4.2 Procedure

The participants were tested in a sound treated room. Normal hearing sensitivity was confirmed by routine clinical audiometry. Their air conduction pure tone thresholds were within 15 dB HL across 250 Hz to 8000 Hz and bone conduction thresholds within 15 dB HL across 250 Hz to 4000 Hz. Further, the participants had ‘A’ type of tympanogram and had ipsilateral and contralateral reflexes at normal levels.

Sentence equivalency was assessed at three SNRs, that is at -5 dB SNR (global SNR) and two SNRs on either side of the global SNR at 2 dB SNR intervals. These two SNRs, -3 dB SNR and -7 dB SNR were chosen to obtain the values near the ceiling and floor parts of the sigmoid curve respectively. Stimuli at each SNR were presented to five participants at their most comfortable level. The subjects were asked to repeat back the sentences as accurately as possible and the responses were recorded on a printed sheet. Scoring of the responses were done and assessed for equivalency. The mean values of correctly identified key words at -3, -5 and -7 dB were obtained. The number of correctly identified key words for each sentence was compared with this mean. Sentences with scores above or below mean were eliminated. Following this process, a total of 316 sentences of equivalent difficulty were shortlisted and included in the final lists. As the aim was to prepare a maximum of 30 lists, a total of 30 sentence lists, with ten sentences each, were prepared such that they were phonemically balanced. The remaining 16 sentences were used as practice items.

Phonetic balancing and list creation

Phonetic balancing was done to make sure that each list was capable of yielding results representative of the subject's language comprehension ability. The sentences were phonetically balanced based on the frequency of occurrence of the phonemes in Kannada language (Ramakrishna et al., 1961). The sentences were distributed to 30 lists in such a manner that the frequency of occurrence of the phonemes in each list is matched that of the Kannada language as close as possible. After balancing, 25 phonetically balanced lists were thus created, each list containing ten sentences. Five lists were created with 10 sentences each that were not as accurately phonetically balanced as the previous 25 lists were (due to lesser choice of words at the end). However, all the lists included all the phonemes of the language. The remaining 16 sentences were used for familiarization.

2.2 Phase II: Standardization and assessment of list equivalency

The sentence lists were standardized over a group of participants with normal hearing sensitivity, so as to determine the normative performance. Further, evaluation was done to determine the repeatability, and thus the reliability, of the sentence lists measured with different lists.

2.2.1 Participants

In total, 100 participants with normal hearing were included in this part of the study. The age ranged from 18 to 55 years (with the mean age of 29.4 years, SD = 9.16 years).The participants were seated in a sound treated room. Normal hearing sensitivity was confirmed by routine clinical audiometry. Normal hearing sensitivity was defined as air conduction pure tone thresholds within 15 dB HL across 250 Hz to 8000 Hz and bone conduction thresholds within 15 dB HL across 250 Hz to 4000 Hz. Further, the participants had ‘A’ type of tympanogram and had ipsilateral and contralateral reflexes at normal levels.

2.2.2 Procedure

All the sentence lists were administered on 100 normal hearing subjects (this does not include participants studied in the previous sections) at -5 dB SNR (to avoid ceiling effect) at their most comfortable level. The sentences were routed through a personal computer and delivered through Sennheiser HDA 200 closed dynamic headphones via calibrated MA 53 diagnostic audiometer.

The participants were asked to repeat back the sentences they heard. Prior to the actual testing, participants were presented with ten practice sentences that were not present in the final sentence lists. Each sentence was scored based on the number of key words identified and the lists were subjected to appropriate statistical analysis to determine the presence of equivalency.

2.3 Phase III: Assessment of clinical utility

The aim of this part of the study was to assess the clinical utility of the developed sentence lists in individuals with sensorineural hearing loss of varying degrees.

2.3.1 Participants

Forty individuals with (sensorineural) hearing loss aged between 18 to 70 years (Mean = 28.9 years) and forty individuals with normal hearing aged from 22 to 55 years (Mean = 28.85 years) participated in the study. The degree of hearing loss consisted of mild, moderate, moderately severe and severe categories (based on modified Goodman classification, 1965). Each category consisted of 10 ears. The configuration of loss was restricted to flat type (< 15 dB variation per octave in threshold between 250 Hz to 8000 Hz) and the speech identification scores had to be in agreement with the degree of hearing loss suggesting cochlear hearing loss. All participants had ‘A’ type of tympanogram and reflexes appropriate to their degree of hearing loss.

2.3.2 Procedure

The participants were tested in a sound treated room with noise levels complying with the ANSI (1999) standards. The sentence lists were presented monaurally at the participants' most comfortable level in quiet condition.

Killion (1997) has evaluated individuals with hearing impairment with SIN test. He reported that even the individuals with mild hearing loss required higher SNR than the normal individuals in the presence of noise, even when the testing is done at higher intensity levels. In the current study, the normative is given at -5 dB SNR which is well below the SNR required even for an individual with 40 dB hearing loss according to the reports of Killion (1997). Further, it has also been reported that individuals with hearing impairment have poorer sentence recognition scores that normal hearing counter parts even if it is presented in quiet condition (Rahana & Yathiraj, 2007). Hence, in the third phase of the study, the sentences were presented without noise. For comparison purposes, a group of normal individuals were also tested in quiet condition. The sentences were routed through a personal computer and delivered through Sennheiser HDA 200 closed dynamic headphones via a calibrated audiometer.

Participants practiced with ten trial sentences and were provided with feedback regarding their performance before the start of the actual test runs. The subjects were instructed to repeat the sentences as accurately as possible. They were also encouraged to guess the sentence if they were unsure of it and were given ample time to respond. The words correctly identified by the subjects were marked on a printed response sheet by the examiner. Each sentence was scored based on the number of key words (25% for each key word) correctly repeated, wherein contractions, spelled out contractions, identifiable mispronounced words, and changes in plurality were counted as correct. The results were tabulated in accordance with the degree of hearing loss and the mean and standard deviations were calculated.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Phase I: Development of sentence lists in Kannada language

The first phase of the study focused on the development of the sentence material in Kannada language. This involved selection and determination of naturalness and predictability of 700 sentences, determination of sentence equivalency of 564 shortlisted sentences.

The results of assessment of sentence equivalency revealed scores of approximately 75% correct (mean raw score = 2.95, Range = 0 – 4, SD = 1.2) at -3 dB SNR, 50% correct (mean raw score = 2.19, Range = 0 – 4, SD = 1.13) at -5 dB SNR and 30% correct (mean raw score = 1.20, Range = 0 – 4, SD = 1.39) at -7 dB SNR. A sigmoid function was obtained by plotting the identification scores (averaged for all 564 sentences) against the SNRs. Figure 3.1 illustrates the percentage of correctly identified key words at three SNRs for each individual. The sentences which were too easy (145 nos.) and too difficult (103 nos.) were eliminated. Sentences were considered easy if the average number of correctly identified key words was more than the mean scores obtained at those three SNRs, and the sentences were considered difficult if the average number of correctly identified key words were less than the mean score obtained at those three SNRs. Thus based on this, 316 out of 564 sentences with moderate difficulty were considered for making the sentence lists.

The results of this are in agreement with the results obtained by Kollmiere and Wesselkemp (1997). They had obtained 20% correct scores at -8 dB SNR and 80% correct scores at -4 dB SNR for sentence lists. Hence, the sentences in the present study also had a sigmoid function as reported in the literature.

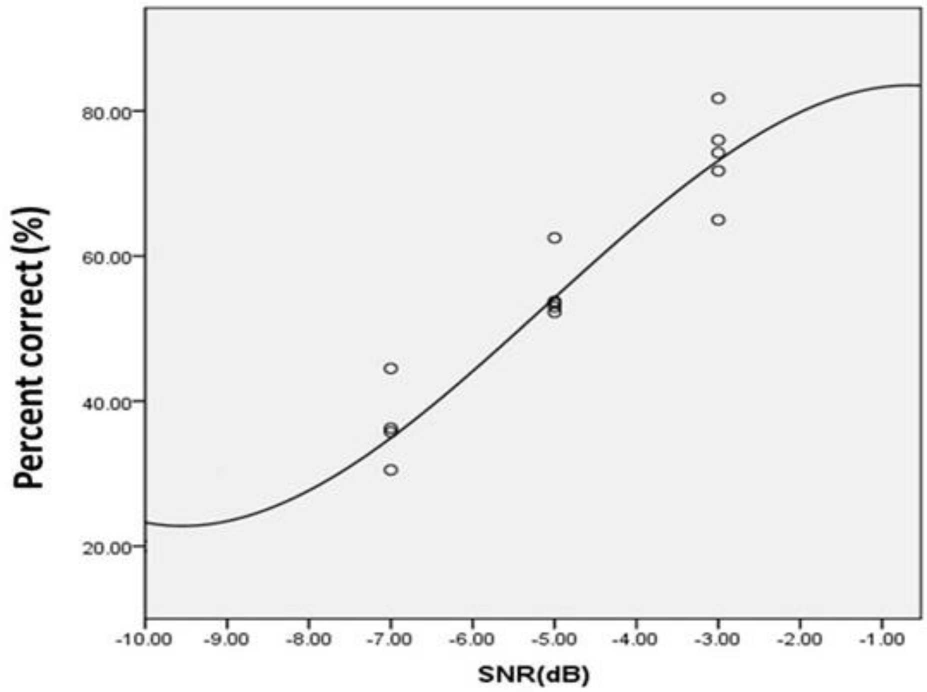

Figure 3.1. Sigmoid function representing mean percent correct keyword identification at -7 dB SNR, -5 dB SNR and -3 dB SNR respectively. Each circle represents each participant.

The aim of the study was to construct 30 lists of 10 sentences each. Hence, only 300 of the 316 sentences were utilized to construct 30 lists, with 10 sentences each. All the 30 sentence lists contained all the speech sounds of the language. Of these, 25 lists could be phonemically balanced, i.e., the frequency of occurrence of speech sounds resembled the frequency of occurrence reported by Ramakrishna et al. (1961). The remaining 16 sentences of 316 sentences, that were not included in the sentence lists, were used for familiarization.

3.2 Phase II: Standardization and Assessment of list equivalency

Normative performance was established on 100 participants with normal hearing sensitivity at -5 dB SNR. Table 3.1 gives the mean of number of correctly repeated key word scores and standard deviation (SD) for each of the 30 lists.

Table 3.1

Mean and SD of number of correctly identified key words for each list in individuals with normal hearing (N = 100)

	Mean	SD		Mean	SD		Mean	SD
List1	19.79	3.74	List11	21.47	3.47	List21	21.52	3.12
List2	20.69	3.34	List12	20.74	3.50	List22	21.87	3.73
List3	21.20	3.28	List13	20.72	3.29	List23	22.78	3.66
List4	20.72	3.69	List14	21.46	3.72	List24	21.83	3.53
List5	21.64	3.32	List15	21.57	2.30	List25	21.30	3.87
List6	22.18	3.49	List16	21.44	3.39	List26	22.20	3.33
List7	20.75	3.77	List17	21.14	3.49	List27	22.90	3.77
List8	21.61	3.25	List18	22.11	3.24	List28	22.58	3.36
List9	21.40	3.45	List19	22.47	3.04	List29	22.04	3.46
List10	20.44	3.37	List20	21.51	3.54	List30	23.70	3.73

It can be observed from Table 3.1 that the performance was quite uniform across the lists. To determine if the difficulty level across lists was equivalent or not statistically, the difference between the each individual's score for each list and that listener's mean score (scores averaged for all the lists) was calculated. Figure 3.2 presents the mean and SD of these modified scores. Repeated measures ANOVA was carried out on these data to determine if performance across lists varied significantly at the global SNR of -5 dB SNR.

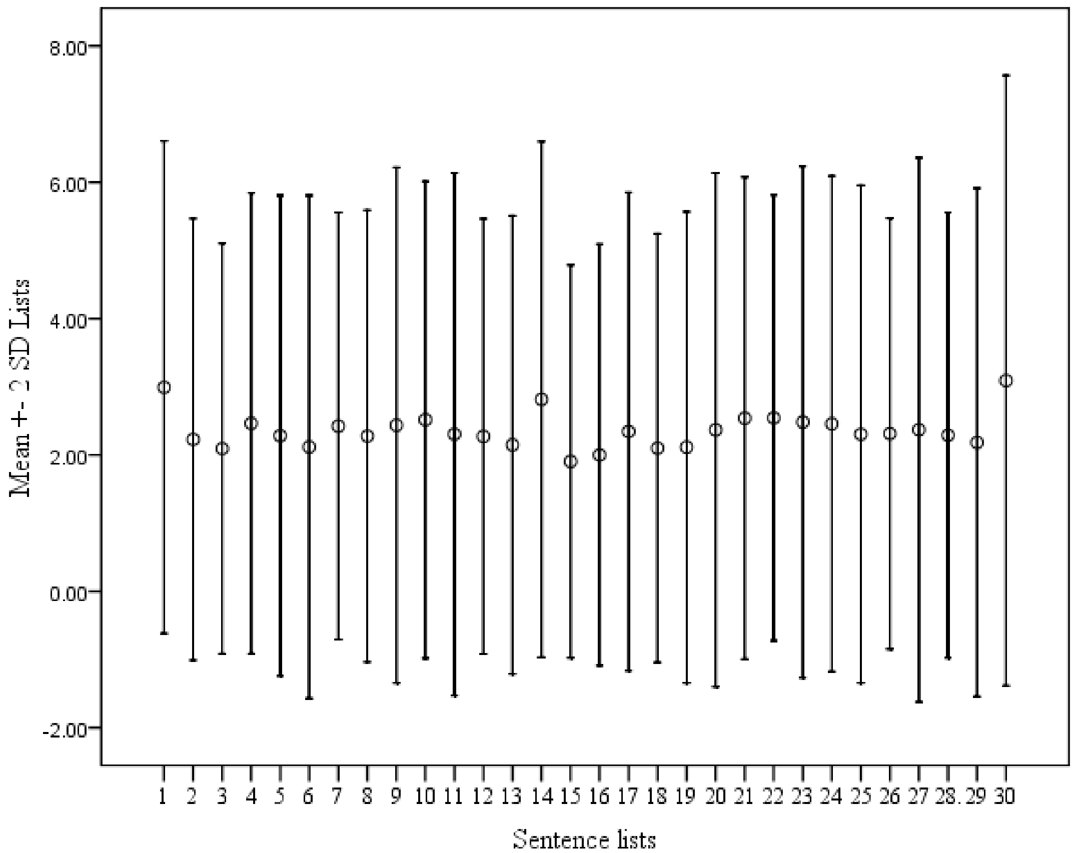

Figure 3.2

Mean difference and SD for 30 lists. Mean difference is the difference between the mean score of each listener and the score obtained by each individual for each list. For each list, n = 100. Error bars show ±2 standard deviation for the mean.

It can be observed, from Figure 3.2, that the deviation from the average mean score for all the lists showed similar values, except for the list 1, 3, 14, 15, 16 and 30. It can also be observed that the SD is higher for the list 30. The repeated measures ANOVA revealed that there was a significant difference in performance across the lists ($F(27.00, 2.87) = 2.293$, $p<0.001$) revealing a main effect of lists. Hence, Bonferroni pair-wise comparison was done to analyze which lists differed in scores. The results of this are given in the Table 3.3. The results revealed that the list 1 was significantly different from the lists 3, 15 and 16, and list 30 was significantly different from the lists 15 and 16.

Table 3.2

Results of pair-wise comparison across lists using Bonferroni post hoc analysis.

Groups (I)	Groups (J)	Mean Difference (I-J)	Standard Error	Significance
List1	List3	0.899*	.212	.022
	List15	1.087*	.251	.015
	List16	0.992**	.221	.009
List15	List 1	1.087*	.251	.015
	List30	1.185**	.261	.007
List16	List1	0.992**	.221	.009
	List30	1.090*	.258	.023

Note: *p<0.05; **p<0.01

The Figure 3.2 has the mean and SD for all the 30 lists, however, in a different order. That is, the lists 1, 3, 15, 16 and 30 are included at the end. The order of these five lists depended on their mean scores. The lists at and below the reference line are equivalent lists. The equivalent lists are given as List 1 to 25 and the key words are highlighted in the Appendix. The non-equivalent lists are given as practice lists in the appendix.

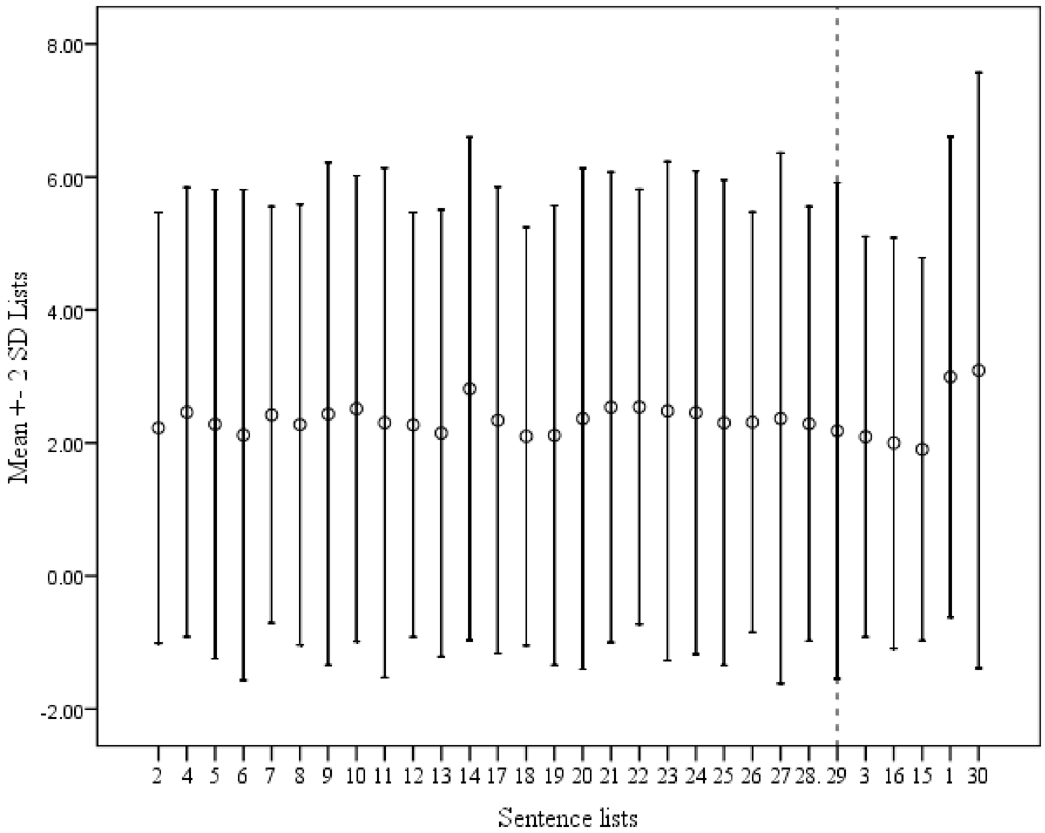

Figure 3.3. Mean difference and SD for 30 lists with revised order. The lists with significantly different scores are given after the reference line. For each list, n = 100. Error bars show ±2 standard deviation for the mean.

After removing Lists 1, 3, 15, 16 and 30, the overall normative performance for the 100 normal hearing subjects had a mean of 21.60 with a range from 20.44 to 22.90. The mean identification score at -5 dB SNR was hence 54%. In English, a score of 48% at -3 dB SNR for CID-Everyday sentences was reported by Rippy, Dancer, and Pittenger (1983). This implies that the latter list was less difficult than the list developed in this study. This difference could be attributed to factors including the number of key words in the list (50 keywords in their study vs. 40 keywords in our study), noise used to mask the speech material (white noise in their study vs. speech noise in the present study) as well as differences between the languages. However, the inter-list equivalency was not present for the CID-Everyday sentences. Kollmeier and Wesselkemp (1997) reported a SNR of -6.1 dB for the 50% scores. Although the results of this study are comparable with that reported by Kollmeier and Wesselkemp, this small difference could be because of the differences in the method. Kollmeier and Wesselkemp have applied weighting factors depending on the difficulty level of the words to bring homogeneity. They reported that if the weighing factor is removed, there could be variations in the scores up to 4%. In addition, the speech material was recorded by a male talker in their study.

Further, the standard deviation of raw scores, given in Table 1, is lower than that reported by Kollmeier and Wesselkemp. This suggests there is high homogeneity of the sentence lists in the present study even in a difficult condition of -5 dB SNR. In addition, the sigmoid function for sentences used in the lists was derived using the scores at -3, -5 and -7 dB SNRs. The test developed by Kollmeier and Wesselkemp has been found to have clinical applications in assessment, comparing hearing aid benefits and monitoring the progress after the training. Thus, it is speculated that the sentences in the present study could possibly be used in conditions with varying difficulty (in terms of SNR) for different applications such as routine hearing evaluation, hearing device fitment and monitoring progress in the rehabilitation process. The validation of the sentence lists is being carried out for hearing evaluation on clinical population. Further investigations are required to test the other applications of the developed lists.

3.3 Phase III - Assessment of clinical utility

The clinical utility of the developed sentence material was evaluated in 40 individuals with hearing loss and in 40 individuals with normal hearing (a new group). The clinical group consisted of subjects with mild, moderate, moderately-severe and severe sensorineural hearing loss (10 subjects each). Thus, including the normal group, there were a total of five groups.

3.3.1 Between group comparison

Table 3.3 gives mean and SD of correctly identified words (averaged for all the lists) for all the five groups. Though data were collected for all the 30 lists in all the groups, comparison are made only for the equivalent 25 lists.

Table 3.3

Mean and SD of number of words correctly identified by all the groups.

Groups	Number	Mean Age (years)	Range (years)	SD (years)	Mean (keywords correctly identified/percentage scores)	SD
Normal hearing	40	28.85	18 - 55	8.19	39.44 **(98.61%)**	0.15
Mild hearing loss	10	27.00	18 - 38	7.13	39.54 **(98.84%)**	0.13
Moderate hearing loss	10	42.00	20 - 60	16.16	36.93 **(92.33%)**	1.80
Moderately severe hearing loss	10	41.60	27 - 60	12.96	24.58 **(61.44%)**	3.12
Severe hearing Loss	10	45.70	25 - 69	15.74	19.30 **(48.24%)**	3.10

The Table 3.3 shows the mean scores (averaged for all the lists) and the SD. It can be observed that the mean value decreases with increasing in degree of hearing loss. However, the scores are comparable between normal and mild group.

Kruskal-Wallis statistical analysis was done to evaluate if the difference in mean is statistically significant. The results revealed that statistically significant difference between groups was present ($p<0.01$). Hence, pair-wise comparison was made using Mann-Whitney U test. Table 3.4 presents the results of this. The table shows that the difference was significant ($p<0.01$) between all the groups except between mild hearing loss and normal hearing groups ($p = 0.63$).

Table 3.4

Results of Mann-Whitney U test

Groups (I)	**Groups (J)**	**Z**	**Significance**
Mild HL	Moderate HL	3.78*	0.00
	Moderately-severe HL	3.78*	0.00
	Severe HL	3.78*	0.00
	Normal	1.87	0.63
Moderate HL	Mild HL	3.78*	0.00
	Moderately-severe HL	3.78*	0.00
	Severe HL	3.78*	0.00
	Normal	4.87*	0.00
Moderately-severe HL	Mild HL	3.78*	0.00
	Moderate HL	3.78*	0.00
	Severe HL	3.02*	0.00
	Normal	4.87*	0.00
Severe HL	Mild HL	3.78*	0.00
	Moderate HL	3.78*	0.00
	Moderately-severe HL	3.02*	0.00
	Normal	4.87*	0.00
Normal	Mild HL	1.87	0.63
	Moderate HL	4.87*	0.00
	Moderately-severe HL	4.87*	0.00
	Severe HL	4.87*	0.00

Note: *p>0.01

These results are consistent with the universal fact that as the extent of hearing loss increases, the perceptual difficulties also increase. The most quoted reference for the lower limits of speech identification scores for different degrees of cochlear pathology is Yellin, Jerger and Fifer (1989). They reported lower limits of 68%, 38.5%, 24%, and 11% for Mild, Moderate, Moderately Severe and Severe cochlear pathology respectively. The scores obtained in this study remain well below the lower limits specified in the present study. The reason for differences could be that the mentioned authors used synthetic sentences which would have considerably increased the difficulty and reduced the scores.

Further, the effects of severe hearing loss on speech identification scores have also been well reported. The drastic decrease in speech identification ability in these individuals may be attributed to the loss of cochlear nonlinearity, decreased frequency selectivity, decreased temporal resolution, increased upward spread of masking and possible presence of dead regions (Moore et al., 2000; Moore, Lynch & Stone, 1992; Plomp, 1994). This could also result in poor speech perception even in quiet (Pekkerinan, Salmivalli & Suonpa, 1990).

In addition, the results reveal that the sentence material is sensitive to differences in speech identification abilities across different degrees of hearing loss. Similar abilities have been demonstrated in well used speech tests like Hearing in Noise Test (HINT) (Nilsson, Soli, & Sullivan, 1993) and CID Everyday sentences list (Rippy, Dancer & Pittenger, 1983). This lends support to the idea of using the developed sentence lists for routine clinical examination as well as for research studies.

3.3.2 Within group comparison

In order to validate the equivalency of the lists in the hearing impaired population, within group comparison of the scores were made for the four groups of individuals with hearing impairment. Table 3.5 gives the mean and SD of number of correctly identified words for 25 lists for the mild group.

Table 3.5

Mean and SD of number of words repeated correctly for 25 lists by individuals in the mild group (N = 10).

	Mean	SD		Mean	SD		Mean	SD
List1	39.80	0.63	List11	39.40	0.70	List21	39.60	0.63
List2	39.40	0.97	List12	39.70	0.48	List22	39.60	0.97
List3	39.70	0.48	List13	39.80	0.42	List23	39.10	0.69
List4	39.50	0.71	List14	39.70	0.48	List24	39.50	0.99
List5	39.70	0.67	List15	39.60	0.84	List25	39.60	0.69
List6	39.80	0.42	List16	39.50	0.85			
List7	39.80	0.42	List17	39.40	0.84			
List8	39.50	0.70	List18	39.30	0.82			
List9	39.50	0.71	List19	39.60	0.70			
List10	39.20	1.03	List20	39.10	1.00			

Table 3.5 shows that the mean and the standard deviation do not vary across the lists. Repeated measures ANOVA was carried out to test this. The results revealed that there is no significant difference $F(24,216) = 0.802$, $p>0.05$ between the lists for the scores obtained from the individuals with mild degree of hearing loss.

Table 3.6

Mean and SD of number of words repeated correctly for 25 lists by individuals in the moderate group (N = 10).

	Mean	SD		Mean	SD		Mean	SD
List1	37.20	2.70	List11	36.30	2.16	List21	36.20	2.65
List2	36.80	3.29	List12	36.40	2.59	List22	35.80	2.34
List3	38.40	1.50	List13	36.70	3.19	List23	37.00	2.30
List4	37.20	1.93	List14	37.60	2.95	List24	36.90	3.38
List5	37.10	2.33	List15	38.50	1.64	List25	37.50	2.79
List6	35.80	4.10	List16	37.50	1.84			
List7	36.50	3.24	List17	37.10	1.91			
List8	37.10	2.72	List18	37.30	2.40			
List9	36.20	2.25	List19	37.20	2.93			
List10	36.70	2.31	List20	36.30	2.83			

Table 3.7

Mean and SD of number of words repeated correctly for 25 lists by individuals in the moderately-severe group (N = 10).

	Mean	SD		Mean	SD		Mean	SD
List1	20.90	3.75	List11	25.20	4.54	List21	22.20	7.95
List2	23.30	2.40	List12	24.70	5.71	List22	24.80	3.96
List3	25.30	4.00	List13	23.70	3.74	List23	25.40	2.59
List4	25.40	3.86	List14	24.20	4.49	List24	25.90	2.99
List5	23.00	6.81	List15	24.30	4.85	List25	25.60	4.29
List6	25.40	4.11	List16	24.70	4.29			
List7	26.70	4.16	List17	25.00	3.43			
List8	24.20	5.00	List18	25.30	4.92			
List9	24.90	4.60	List19	23.60	4.52			
List10	25.70	4.73	List20	25.00	5.12			

Table 3.8

Mean and SD of number of words repeated correctly for 25 lists by individuals in the severe group (N = 10)

	Mean	SD		Mean	SD		Mean	SD
List1	18.10	3.90	List11	20.40	4.69	List21	18.20	3.85
List2	19.10	3.81	List12	19.40	3.23	List22	19.60	4.27
List3	18.60	3.89	List13	18.70	3.30	List23	20.10	3.81
List4	16.90	3.69	List14	19.80	2.74	List24	18.30	3.02
List5	17.70	3.86	List15	19.60	4.16	List25	18.60	4.88
List6	18.70	4.83	List16	19.40	3.13			
List7	21.40	4.35	List17	21.10	4.22			
List8	19.10	3.92	List18	20.20	3.61			
List9	20.80	5.20	List19	19.80	4.56			
List10	19.30	4.90	List20	19.50	3.59			

Table 3.6, 3.7 and 3.8 give the mean and SD of number of correctly identified words for 25 lists for the moderate, moderately-severe and severe groups, respectively. It can be observed that even in these groups, the mean does not vary across the lists. Repeated measures ANOVA also revealed no significant difference for the Moderate group [$F(24,216) = 1.161$ $p>0.05$], Moderately severe group [$F(24,216) = 1.347$ $p>0.05$] and severe group [$F(24,216) = 1.496$, $p>0.05$].

These results suggest that the mean number of correctly identified words do not vary across the lists in any of the four groups, hence, suggesting equivalency across the standardized 25 lists. Any test should aid in comparing a large number of different variables of interest and the results should reflect the actual differences between the conditions. That is, the differences should not be due to the differences in the lists of the tests (Spahr et al., 2011). Hence, from the results, it can be said that the test developed in the present study can aid in comparisons across large set of test conditions for different degrees of hearing loss in quiet. However, the same needs to be assessed in noise as well.

CHAPTER 4

SUMMARY AND CONCLUSION

The aim of the undertaken project was to develop and standardize a sentence test in Kannada language. In the first stage of the study, 30 lists were developed which had equivalent sentences. In the second stage, the test was standardized by administering on 100 individuals with normal hearing sensitivity, by presenting the lists at -5 dB SNR. After the analysis of results obtained from this large group of normal hearing participants, 25 lists were found to be equivalent.

The standardized lists were administered on hearing impaired individuals of different degrees of hearing loss (mild, moderate, moderately severe and severe). The results revealed that all the 25 lists were equivalent in terms of difficulty and the lists were also sensitive enough to differentiate different degree of hearing loss, by giving lesser scores for individuals with greater degree hearing loss versus individuals with lesser degree of hearing loss.

It can be concluded from the results of the project that these list can be efficiently used as a for measurement of speech intelligibility or SNR-50 measures in various applications such as hearing evaluation in different conditions and it can also be used for evaluating the benefits and effects of hearing aids on speech perception by varying the different features and parameters of hearing device, in adults. Further, the test is also sensitive to the extent of hearing impairment.

REFERENCES

ANSI. (1999). Criteria for permissible ambient noise during audiometric testing. *American National Standards Institute* S3.1- 1999, New York.

Avinash, M. C., Raksha, R., M, & Ajith Kumar U. (2010). Development of Sentences for Quick Speech-in-Noise (QuickSin) Test in Kannada. *Journal of Indian Speech Hearing Association,* 24(1), 59–65.

Barreto, S., & Ortiz, K.Z. (2010). Intelligibility: effects of transcription analysis and speech stimulus. *Pro Fono*, 22(2), 125–132.

Carhart, R. (1965). Problems in the measurement of speech discrimination. *Archives of Otolaryngology*, 82(9), 253–260.

Delattre P. (1964). Comparing the vocalic features of English, German, Spanish And French. *Iral-Int Rev Appl Linguist*, 2, 71–98.

Dubno, J.R., Dirks, D.D., & Morgan, D.E. (1984). Effect of mild hearing loss on speech recognition in noise. *Journal of the Acoustical Society of America,* 76, 87-96.

Garcia, J., & Cannito, M. (1996). Influence of verbal and nonverbal contexts on the sentence intelligibility of a speaker with dysarthria. *Journal of Speech and Hearing Research*, 39, 750–760.

Garcia, J., & Dagenais P. (1998). Dysarthric sentence intelligibility: Contribution of iconic gestures and message predictiveness. *Journal of Speech and Hearing Research*, 41(6), 1282–1293.

Gatehouse, S. (1992). The time course and magnitude of perceptual acclimatization to frequency responses: Evidence from monaural fitting of hearing aids. *Journal of the Acoustical Society of America,* 92, 1258 –1268.

Giolas, T. G., & Duffy, J. R. (1973). Equivalency of CID and Revised CID Sentence Lists. *Journal of Speech and Hearing Research,* 16, 549–555.

Gnanateja, G.N., & Pavan, M. (2012). *Speech in noise mixing, signal to noise ratio*. http://www.mathworks.com/matlabcentral/fileexchange/37842-speech-in-noise- mixing-signal-to-noise-ratio, Matlab Central File Exchange. Retrieved on 22-08-2012.

Hinkle, R.R. (1979). An investigation of list equivalency for auditory, visual and audiovisual performance using revised CID sentences. *Unpublished doctoral dissertation.* Purdue: Purdue University.

Hirsh, I.J. (1952). *The measurement of hearing*. New York: McGraw- Hill.

Killion, M. C. (1997). SNR loss: "I can hear what people say but I cannot understand them". *Hearing Review*, 4(12), 8,10,12,14.

Killion, M. C., Niquette, P. A., Gudmundsen, G. I., Revit, L. J., & Banerjee, S. (2004). Development of a quick speech-in-noise test for measuring signal-to-noise ratio loss in normal-hearing and hearing-impaired listeners. *Journal of Acoustical Society of the America*, 116, 2395–2405.

Kollmeier, B., & Wesselkamp, M. (1997). Development and evaluation of a German sentence test for objective and subjective speech intelligibility assessment. *Journal of the Acoustical Society of America*, 102(4), 2412–2421.

McGarr, N. S. (1981).The effect of context on the intelligibility of hearing and deaf children's speech. *Language and Speech*, 24, 255–264.

Mendel, L. L., Danhauer, J. L. (1997). *Audiologic evaluation and management and speech perception assessment.* San Diego: Singular Publishing Group.

Miller, G. A., Heise, G. A., & Lichten, W. (1951). The intelligibility of speech as a function of the context of the test materials. *Journal of Experimental Psychology*, 41(5), 329–335.

Moore, B. C. J., Huss, M., Vickers, D. A., Glasberg, B. R., & Alcantara, J. I. (2000). A test for the diagnosis of dead regions in the cochlea. *British Journal of Audiology,* 34, 205–224.

Moore, B.C.J., Lynch, C., & Stone, M.A. (1992). Effects of the fitting parameters of a two-channel compression system on the intelligibility of speech in quiet and in noise. *British Journal of Audiology,*26, 369–379.

Mueller, G.H. (2001). Speech audiometry and hearing aid fittings: Going steady or casual acquaintances?. *Hearing Journal*, 54(10), 19–29.

Neilsen, J.B., & Dau, T. (2009). Development of a Danish speech intelligibility test. *International Journal of Audiology*, 48, 729 – 741.

Niemeyer, W. (1967). *SprachaudiometriemitSätzen.* HNO 15, 335-343.

Nilsson, M., Soli, S. D., & Sullivan, J. A. (1994). Development of the Hearing In Noise Test for the measurement of speech reception thresholds in quiet and in noise. *Journal of the Acoustical Society of America*, 95, 1085–1099.

Nilsson, M., Soli, S. D., & Sullivan, J. A. (1995). *Development of norms and percent intelligibility functions for the HINT.* Los Angeles: House Ear Institute.

Nilsson, M ., Sullivan, J. & Soli, S. D. (1990). Development of a speech intelligibility test for hearing aid research [Abstract]. *Journal of the Acoustical Society of the America*, 8B(Suppl. I J. S 175).

Nilsson, M., Soli, S. D., Sullivan, J. A. (1993). Development of the Hearing In Noise Test for the measurement of speech reception thresholds in quiet and in noise, *Journal of the Acoustical Society of America*, 95 (2), 1085-1999.

Pekkerinan, E., Salmivalli, A., & Suonpaa, J. (1990). Effect of noise on word discrimination by subjects with impaired hearing, compared with those with normal hearing. *Scandinavian Audiology,* 19, 31-36.

Peissig, J., & Kollmeier, B. (1997). Directivity of Binaural Noise Reduction in spatial multiple-noise-source arrangements for normal and impaired listeners. *Journal of the Acoustical Society of America,* 101, 1660–1670.

Plomp, R. (1994). Noise, amplification, and compression: Considerations of three main issues in hearing aid design. *Ear and Hearing*, 15, 2–12.

Plomp, R., & Mirapen, A. (1979). Speech-reception threshold for sentences as a function of age and noise level. *Journal of the Acoustical Society of America*, 66, 1333-1342.

Rahana, N. V. V., & Yathiraj, A. (2007). Development of high and low predictable English sentence test. *Unpublished Master's Dissertation,* University of Mysore, Mysore.

Ramakrishna, B. S., Nair, K. K., Chiplunkar, V. N., Atal, B. S., Ramachandran, V., & Subramanian, R. (1961) *Relative efficiencies of Indian languages. Nature*, 189, 614-617.

Rippy, J.V., Dancer, J. E., & Pittenger, J.B. (1983). List Equivalency of the CID Everyday Sentences (Harris Revision) under Three Signal-to-Noise Ratios. *Ear and Hearing*, 4(5), 251-254.

Silverman, S. F., & Hirsh, I. J. (1995). Problems related to the use of speech in clinical audioletry. *Annals of Otology, Rhinology and Laryngology,* 64, 1234-1955.

Spahr, A. J. et al. (2011) Development and Validation of the AzBio Sentence Lists. *Ear and Hearing,* 32(4), 1-6.

Tyler, R. (1994). The use of speech-perception tests in audiological rehabilitation: Current and future research needs. *Journal of Academy Rehabilitation Audiology*, 27, 47-56.

Villchur, E. (1982). The evaluation of amplitude-compression pro-cessing for hearing aids. In: G. Studebaker, F. Bess (ed.). *The Vanderbilt hearing aid report.* Upper Darby (PA): Monographs in Contemporary Audiology. 141–143.

Wilson, R.H., Burks, C.A., & Weakley, D.G. (2005). Word Recognition in Multitalker Babble Measured with Two Psychophysical Methods. *Journal American Academy Audiology*, 16,627–636.

Wilson, R.H., & McArdle, R.A. (2005). Speech Signals Used To Evaluate The Functional Status Of The Auditory System. *Journal Rehabilitative Research Development*, 42 (Supplement 2):79-94.

Wong, L.L., & Soli, S.D. (2005). Development of the Cantonese Hearing In Noise test (CHINT). *Ear and Hearing*, 26(3), 276-239.

Wong, L.L., Soli, S.D., Liu, S., Han, N., & Huang, M.W. (2007). Development of the Mandarin Hearing In Noise test (MHINT). *Ear and Hearing*, 28(2 Suppl), 70S-74S.

Yellin, M. W., Jerger, J., *&* Fifer, R. (1989). Norms for disproportionately poor speech intelligibility. *Ear and Hearing*, 10, 231 234.

APPENDIX

Sl No.	SENTENCE LIST 1
1	**avanu t̪anna gɛɭɛjanigɛ sahaːja** maːɖɪd̪a
2	**raːdʒanɪgɛ pradʒgaɭu manavɪ sallɪsɪd̪aru**
3	**varʂakkɛ ɔmmɛ naːvu kand̪aːja** ka□□ut̪t̪ɛːvɛ
4	naːvu **sadaː parɪʃud̪d̪ʰa ni˥rannu sɛːvisabɛːku**
5	**raɪt̪a bɪsɪlɪnallɪ kɛlasa maːɖut̪t̪ɪd̪d̪aːnɛ**
6	**makkaɭu saːlaːgɪ nɪnt̪u praːrt̪ʰanɛ** maːɖɪd̪aru
7	**raɪlɔnd̪u sɛːt̪uvɛja mɛːlɛ tʃalɪsut̪t̪ɪd̪ɛ**
8	**magu malagɪruvaːga hat̪t̪ɪra hogabɛːɖa**
9	**uːrɪna pakkad̪allɪ d̪aʈʈavaːd̪a araɳ javɪd̪ɛ**
10	**avaɭu gaːdʒɪna baɭɛjannu huɖukut̪t̪ɪd̪d̪aːɭɛ**

Sl No.	SENTENCE LIST 2
1	**nad̪ıja d̪aɖad̪a** mɛːlɛ **mɔsaɭɛ malagıt̪t̪u**
2	**avanu raılınallı kaɖalɛkaːjı maːrut̪t̪ıd̪d̪a**
3	**hɔsa adʰıkaːrıgɛ huː niɖı svaːgat̪ısıd̪ɛvu**
4	**maɭɛ baːrad̪a** kaːraɳa **bɛɭɛ naːʃavaːgut̪t̪ıd̪ɛ**
5	**akkana mad̪uvɛ uːʈa bʰardʒarıjaːgıt̪t̪u**
6	ıllı **aːɖut̪t̪ıruva magu nanna snɛːhıt̪anad̪u**
7	**paːrıvaːɭa bɛːʈɛgaːrana balɛgɛ sıkkı** bıtıt̪u
8	**maguvına dʒaːɳmɛjannu kanɖu aːʃtʃarjavaːjıt̪u**
9	**kappu d̪raːkʂı** t̪ınnalu **t̪umba huɭıjaːgıd̪ɛ**
10	**nad̪ıja ni˥ru kɔnɛgɛ saːgara** sɛːrut̪t̪ad̪ɛ

Sl No.	**SENTENCE LIST 3**
1	**appa** t̪and̪a **maːvɪna haɳɳugaɭu huɭɪjaːgɪvɛ**
2	**avanu manɛjallɪ ɔbbanɛ˥ vaːsavaːgɪd̪d̪a**
3	**moɖagaɭa hɪnd̪ɛ tʃand̪ranu marɛjaːgɪd̪d̪aːnɛ**
4	**haːlɪnɪnd̪a sɪhɪ t̪ɪnɪsugaɭannu maːɖut̪t̪aːrɛ**
5	**raɪt̪ara bad̪uku ɪnd̪u kaʂʈakaravaːgɪd̪ɛ**
6	**avaɭu dʒaɖɛgɛ mallɪgɛ huː muɖɪd̪ɪd̪d̪aːɭɛ**
7	**ʃaːlɛgɛ ɔnd̪u vaːra radʒɛ** niɖalaːgɪd̪ɛ
8	**bɛnkɪja dʒɔt̪ɛ aːɖuvud̪u apaːjakaːrɪ**
9	**avanu kaɪ gaɖɪjaːrad̪allɪ samaja** noɖɪd̪a
10	**naːnu vaːrakkɔmmɛ uguru kat̪t̪arɪsut̪t̪ɛːnɛ**

Sl No.	SENTENCE LIST 4
1	avanu **mara hat̪t̪uvaːga kɔmbɛ murɪjɪt̪u**
2	**bɛːsɪgɛjallɪ nad̪ɪgaɭu bat̪t̪ɪ ho⌉d̪avu**
3	**sabʰɛjallɪ tʃartʃɛgaɭu naɖɛjut̪t̪alɛː ɪd̪ɛ**
4	**makkaɭa sangi⌉t̪a spard̪ʰɛ** ɛllarannuː **randʒɪsɪt̪u**
5	**prat̪ɪ vaːra t̪and̪ɛgɛ kaːgad̪a** barɛjut̪t̪ɪd̪d̪ɛ
6	**habbakkɛ gɛɭɛjarannu uːʈakkɛ karɛd̪ɛ**
7	**ammana dʒɔt̪ɛ d̪uːravaːɳɪjallɪ maːt̪anaːɖɪd̪ɛ**
8	**aː gʰaʈanɛ naɖɛd̪u ʃat̪amaːna kaɭɛjɪt̪u**
9	**ʃaːlaː vɪd̪jartʰɪgaɭu pravaːsa kaɪgɔnɖaru**
10	**raɪt̪anɔbba ɛraɖu ɛt̪t̪ugaɭannu saːkid̪d̪anu**

Sl No.	SENTENCE LIST 5
1	**hulıja tʃarmakkɛ bahaɭa bɛːɖıkɛ** ıd̪ɛ
2	**aɳɳanu t̪angıgɛ samaːdʰaːna maːɖıd̪anu**
3	**avara ad̪bʰut̪a aːʈa marɛjuvant̪ılla**
4	**appa gaːɖı nıllısı t̪arakaːrı kɔnɖaru**
5	**pɔli˥saru dʒanara gumpannu tʃad̪urısıd̪aru**
6	**manɛjavarɛlla ho˥gı sınımaː vi˥kʂısıd̪aru**
7	**maguvu paʈaːkı ʃabd̪ʰa** kɛːɭı **gaːbarıgɔnɖıt̪u**
8	**jud̪d̪ʰa naɖɛjalu kaːraɳagaɭu halavu**
9	**graːmad̪a dʒanat̪ɛ ni˥rıllad̪ɛ kangaːlaːd̪aru**
10	avaɭu **kamalad̪a huːvannu puːdʒɛgɛ t̪and̪aɭu**

Sl No.	SENTENCE LIST 6
1	**hasɪd̪a bɛkkɔnd̪u ılıjannu hɪɖɪd̪u** t̪ɪnd̪ɪt̪u
2	**allı d̪ɔɖɖad̪ɔnd̪u saro˥vara kaːɳut̪t̪ɪd̪ɛ**
3	**avaɭu katʃʰɛːrɪgɛllaː sɪhɪ hantʃɪd̪aɭu**
4	**aparaːd̪ʰɪgɛ dʒivaːvad̪ʰɪ ʃıkʂɛ vɪd̪ʰɪsɪd̪aru**
5	**aramanɛja vaıbʰava atʃtʃarı muːɖɪsɪt̪u**
6	**naːvu hırıjarıgɛ gaʊrava kɔɖabɛːku**
7	**t̪ammanıgɛ gaːɭɪpaʈa haːrɪsalu ıʂʈa**
8	**uːrına dʒana kaɭɭarannu sɛrɛ** hıɖɪd̪aru
9	**ıvaru i˥kaːlɛːdʒɪna hɔsa ad̪ʰjaːpakı**
10	**maːvut̪anu aːnɛgɛ snaːna maːɖɪsut̪t̪ɪd̪d̪aːnɛ**

Sl No.	SENTENCE LIST 7
1	avanu **nanagɛ anjaːja maːɖalu jat̪nısıd̪a**
2	iː **raːtrı aːkaːʃad̪allı tʃand̪ranu kaːɳalılla**
3	**avaɭa hɔsa tʃappalıgaɭu kaɭɛd̪u** ho˥jıt̪u
4	**saːku praɳıgaɭu namagɛ snɛ˥hıt̪arant̪ɛ**
5	**naːvɛllaru radʒɛja d̪ına uːrıgɛ** ho˥d̪ɛvu
6	**nanagɛ haːsıgɛ** mɛːlɛ **malagalu ıʂʈavılla**
7	**nammuːrıgɛ lakʂaːnt̪ara pravaːsıgaru band̪aru**
8	**mad̪uvɛ manɛgɛ d̪ɛːpaːlankaːra maːɖalaːgıd̪ɛ**
9	**haːvugaɭu kappɛgaɭannu t̪ınd̪u bad̪ukut̪t̪avɛ**
10	**mundʒaːnɛjınd̪a sandʒɛjavarɛgɛ ıd̪ɛː kɛlasa**

Sl No.	SENTENCE LIST 8
1	**i˥ga pat̪rɪkɛgaɭannu oduvavaru kaɖɪmɛ**
2	**naːvu ni˥rannu mɪt̪avaːgɪ baɭasabɛːku**
3	**abʰɪmaːnɪja kaɳɳu sant̪asad̪ɪnd̪a t̪umbɪt̪u**
4	**ʃaːlɛ bɪɖuva vɛːɭɛgɛ appa band̪ɪd̪d̪aru**
5	**avanɔbba tʃɪt̪rarangad̪a prasɪd̪d̪ʰa naʈa**
6	**kud̪urɛ** ɛːrɪ **raːdʒa jud̪d̪ʰakkɛ hɔraʈanu**
7	iː **sund̪aravaːd̪a manɛ nanna magaɭad̪u**
8	aː **kaːgad̪ad̪allɪ sahɪ maːɖalu marɛt̪ɛ**
9	**appaʈa hasuvɪna haːlu** ɪllɪ **d̪ɔrɛjut̪t̪ad̪ɛ**
10	**adʒdʒɪ makkaɭɪgɛ katʰɛgaɭannu hɛːɭut̪t̪ɪd̪d̪aru**

Sl No.	SENTENCE LIST 9
1	**makkaɭu mud̪d̪a**ː**d̪a ʃaılıjallı ma**ː**t̪ana**ː**ɖıd̪aru**
2	**nanagɛ d̪vıtʃakra** vaːhana **o˥ɖısalu ışʈa**
3	**avara ıbbaru**ː **makkaɭu bud̪d̪ʰıvant̪aru**
4	**ıvanu apa**ː**ra vışajagaɭannu t̪ıɭıd̪ıd̪d̪a**
5	**bi˥d̪ı na**ː**jıgaɭa ha**ː**vaɭı dʒa**ː**st̪ıja**ː**gıd̪ɛ**
6	**d̪o˥ɳıju ga**ː**ɭı bisut̪t̪ıd̪d̪a kaɖɛgɛ** saːgıt̪u
7	**lakşa**ː**nt̪ara dʒanaru parik♣ɛgɛ ha**ː**dʒara**ː**d̪aru**
8	naːvu **manɛ ka□□ı hat̪t̪u varşagaɭa**ː**jıt̪u**
9	allı **na**ː**lku d̪ına habbad̪a va**ː**t̪a**ː**varaɳavıt̪t̪**u
10	iː **habbad̪allı rɛ**ː**şmɛ u| upannu d̪ʰarısut̪t̪a**ː**rɛ**

Sl No.	SENTENCE LIST 10
1	**bʰaːnuvaːra utʃɪt̪a rakt̪ad̪aːna ʃɪbɪravɪd̪ɛ**
2	**namma manɛ ɛd̪uru ud̪jaːnavanavɪdɛ**
3	**nanna t̪and̪ɛ-t̪aːjɪ katʃɛːrɪgɛ hogɪd̪d̪aːrɛ**
4	**paːtʰakkɛ sɛːrad̪a hat̪t̪u praʃnɛgaɭu** band̪avu
5	**namma manɛjallɪ ɛraɖu koɳɛgaɭɪvɛ**
6	**gurugaɭu t̪aragat̪ɪgɛ t̪aɖavaːgɪ band̪aru**
7	**avanu ʃaːlaː d̪ɪnagaɭɪnɪd̪a t̪unʈa** huɖuga
8	**mad̪uvɛjallɪ bʰardʒarɪjaːgɪ uːʈa maːɖɪd̪ɛ**
9	**naːnu gurugaɭu** hɛːɭɪd̪a **pust̪aka od̪ɪd̪ɛ**
10	ɔnd̪u **salaga kabbɪna t̪o˥ʈakkɛ d̪aːɭɪmaːɖɪt̪u**

Sl No.	SENTENCE LIST 11
1	**nammuːrɪna dʒaːt̪rɛ bahaɭa sɔgasaːgɪrut̪t̪ad̪ɛ**
2	**avanɪgɛ ɔnd̪u ɔɭɭɛja aːlotʃanɛ** bant̪u
3	**mant̪rɪgaɭu vɪd̪ɛːʃa pravaːsa kaɪgɔnɖaru**
4	**maguvɪgɛ aːʈad̪a** mɛːlɛ **aːsakt̪ɪ hɛtʃtʃu**
5	**kaːd̪ambarɪjannu ɛʂʈɛː od̪ɪd̪aruː mugɪjad̪u**
6	**avana bɛraɭu apagʰaːt̪ad̪allɪ murɪjɪt̪u**
7	**mɔd̪alu naːnu** kɔʈʈa **haɳavannu hɪnd̪ɪrugɪsu**
8	**naːji marɪgaɭu noɖalu mud̪d̪aːgɪd̪d̪avu**
9	**avana gaːǀ ɪ kɛsarɪnallɪ sɪkkɪkɔnɖɪt̪u**
10	**nammuːrɪnallɪ ɛraɖu tʃɪkka kɛrɛgaɭɪvɛ**

Sl No.	SENTENCE LIST 12
1	**vɪd̪jaːbʰjaːsa mugɪsɪ vɪd̪ɛːʃakkɛ ho˥d̪aɭu**
2	**namma manɛgɪnt̪a nɪmma** manɛ **and̪avaːgɪd̪ɛ**
3	**nanna t̪angɪgɛ sɪhɪ t̪ɪndɪgaɭu** t̪umba **ɪʂʈa**
4	**t̪aːt̪a tʃi˥lavannu d̪aːrad̪ɪnd̪a hɔlɛjut̪t̪ɪd̪d̪aːrɛ**
5	**bɪsɪlɪllad̪a kaːraɳa baʈʈɛgaɭu ɔɳagut̪t̪ɪlla**
6	**naːvu samaːdʒakkɛ unnat̪a kɔɖugɛ** ni˥ abɛːku
7	**avanɪgɛ sarɪjaːgɪ o˥d̪alu hɛːɭɪkɔɖu**
8	**pɔli˥saru kaɭɭarannu na| u raːt̪rɪ** hɪɖɪd̪aru
9	**t̪aːɭakkɛ sarɪjaːgɪ hɛdʒdʒɛjannu haːkabɛːku**
10	**t̪ɛngɪna maravannu kalpavrukʂa ɛnnut̪t̪aːrɛ**

Sl No.	**SENTENCE LIST 13**
1	**kaːɖɪnallɪ bʰajaːnaka praːɳɪgaɭannu noɖɪd̪ɛ**
2	**d̪ɛːvara d̪arʃanad̪a bajakɛ** ɪnd̪u **iɖɛːrɪt̪u**
3	**suːrja moɖagaɭa hɪnd̪ɛ marɛjaːgɪd̪d̪a˥nɛ**
4	**maːrukattɛjallɪ huːvɪna bɛlɛ hɛtʃtʃaːgɪd̪ɛ**
5	**namma t̪oʈakkɪnt̪a nɪmma** t̪oʈa **sund̪aravaːgɪd̪ɛ**
6	**hasɪd̪a sɪmha kaːɖɛmmɛjannu bɛːʈɛjaː| ɪt̪u**
7	avara **vrut̪t̪ɪ dʒi˥vanad̪a saːd̪ʰanɛ halavaːru**
8	**d̪ana-karugaɭu maɪd̪aːnad̪allɪ mɛːjut̪t̪ɪvɛ**
9	**sɪpaːjɪgaɭu ʃat̪rugaɭannu gunɖɪkkɪ kɔnd̪aru**
10	**sadaːkaːla ɛllarɪgu sukʰavannu bajasu**

Sl No.	SENTENCE LIST 14
1	**bɛkku baʈʈalallı haːlannu kuḷ ıjut̪t̪ıt̪t̪u**
2	**niː nu huɖukut̪t̪ıruva pust̪aka allıd̪ɛ**
3	**aː sand̪ɛːʃa nanagɛ sandʒɛja** hɔt̪t̪ıgɛ **t̪alupıt̪t̪u**
4	**bɛttad̪a mɛːlına d̪ɛːvaːlaja sund̪aravaːgıd̪ɛ**
5	**naːjıgaɭannu saːkuvud̪u ɔnd̪u havjaːsa**
6	**appa bıɭı kuːd̪alıgɛ baɳɳa hatʃtʃut̪t̪aːrɛ**
7	**gɛɭɛjarɛllaː sɛːrı pravaːsakkɛ hɔraʈaru**
8	**haɖagu nuːraːru dʒanarannu** hɔt̪t̪u **saːgut̪t̪ıd̪ɛ**
9	**magu malagıruvaːga sad̪d̪u maːɖabɛːɖa**
10	**manɛ kaʈʈuva kanasu ɛllarıgu**ː ıruttad̪ɛ

Sl No.	SENTENCE LIST 15
1	**bɛːrɛ uːrugaɭɪn̪d̪a dʒanaru dʒaːt̪rɛgɛ** ban̪d̪aru
2	**nanna manɛja** sut̪t̪a **an̪d̪avaːd̪a t̪oʈavɪd̪ɛ**
3	**t̪amma tʃappalɪgaɭannu hɔragɛ bɪʈʈu** bannɪ
4	**praːɳɪ-pakʂɪgaɭannu hɪmsɪsuvud̪u kruːrat̪ana**
5	**makkaɭu nrut̪ja spard̪ʰɛjallɪ bʰaːgavahɪsɪd̪aru**
6	**manɛja maːlika t̪ɪngaɭa baːɖɪgɛ** kɛːɭɪd̪a
7	ɪd̪u **saːvɪra ruːpaːjɪgaɭa noʈɪna kant̪ɛ**
8	bahaɭa **d̪uːra oɖuva ʃakt̪ɪ avanɪgɪd̪ɛ**
9	**kaɖalallɪ ɛt̪t̪arad̪a alɛgaɭu barut̪t̪ɪvɛ**
10	**sɪnɪmaː noɖɪ baruva hɔt̪t̪ɪgɛ kat̪t̪alaːgɪt̪t̪u**

Sl No.	SENTENCE LIST 16
1	**pakʂɪgaɭannu no˥ɖalu apaːra t̪aːɭmɛ** bɛːku
2	**maɭɛjɪnd̪a hɔragɪd̪d̪a baʈʈɛ ɔd̪d̪ɛjaːgɪd̪ɛ**
3	**araɲjad̪allɪ vɪpari˥t̪a maɭɛ surɪjut̪t̪ad̪ɛ**
4	**raːt̪rɪja hɔt̪t̪u sɔɭɭɛgaɭa** kaːʈa **hɛtʃtʃaːgut̪t̪ɪd̪ɛ**
5	avanu **maːvɪna marakkɛ kallannu ɛsɛd̪anu**
6	**maːnavana d̪uraːsɛjɪnd̪a kaːɖu naʃɪsut̪t̪ɪd̪ɛ**
7	**nanagɛ kɛlasad̪a naɖuvɛ bɪɖuvɛː ɪlla**
8	avana **t̪and̪ɛ sakkarɛ kaːrkʰaːnɛja ud̪jogɪ**
9	**nɪnna nɛːt̪rut̪vad̪allɛː kɛlasa naɖɛjalɪ**
10	**manɛja mund̪ɛ vaːhanagaɭa oɖaːʈa** dʒaːst̪ɪ

Sl No.	SENTENCE LIST 17
1	**raɪʈ̪ara bɛɭɛgɛ suːkʈ̪a** bɛlɛ **d̪ɔrakalılla**
2	**avaɭɪgɛ vɪd̪ɛːʃakkɛ hoguva aːsɛ** ɪd̪ɛ
3	**makkaɭu kɪʈakı gaːdʒannu ɔɖɛd̪u** haːkɪd̪aru
4	**nanagɛ tʃaːpɛja** mɛːlɛ **malagalu ɪʂʈa**
5	**sandʒɛ bʰaːrı maɭɛ** baruva **sambʰavavɪd̪ɛ**
6	**bʰavɪʂjakkaːgɪ haɳa uɭɪʈ̪aːja maːɖabɛːku**
7	ni˥nu **allɪnd̪a kuːɖalɛ manɛgɛ hɔraɖu**
8	**huɖuga pusʈ̪akad̪a nuːranɛː** puʈa **ʈ̪ɛrɛd̪anu**
9	ni˥nu **kɛːɭɪd̪a kaːd̪ambarı ʈ̪i˥raː haɭɛjad̪d̪u**
10	**laːrɪjallı akkı muːʈɛgaɭannu saːgɪsɪd̪aru**

Sl No.	SENTENCE LIST 18
1	**manɛja pakkad̪allı gɛɭɛjaru aːɖut̪t̪ıd̪d̪aru**
2	**naːnu kaːrına tʃaːlakanıgaːgı kaːjut̪t̪ıruvɛ**
3	**avanu vıʃvaʃrɛːʂʈʰa aːtagaːranallı ɔbba**
4	**appa haːlu t̪aruvud̪annu marɛt̪u** bıʈʈaru
5	aː **saːgarad̪allı baɳɳa baɳɳad̪a mi˥nugaɭıvɛ**
6	**nanna t̪aːjı tʃɛnnaːgı rango˥lı** bıɖısut̪t̪aːrɛ
7	**avanu angaɖıjallı kɛlasakkɛ sɛːrıd̪a**
8	**naːɭɛ manɛ kɛlasad̪avaru baruvud̪ılla**
9	**hamsagaɭu kɔɭad̪allı gumpaːgı idʒut̪t̪ıvɛ**
10	**avaɭu ud̪d̪avaːd̪a dʒaɖɛjannu hod̪ıd̪d̪aːɭɛ**

Sl No.	SENTENCE LIST 19
1	iː **ʃanıvaːra habbakkɛ nammuːrıgɛ ho⌉guvɛ**
2	**nanagɛ haɳa samajakkɛ** sarıjaːgı **bant̪u**
3	**nakalı noʈugaɭa haːvaɭı hɛtʃtʃaːgut̪t̪ıd̪ɛ**
4	**gurugaɭannu kanɖa makkaɭu ʃaːnt̪araːd̪aru**
5	naːnu **dʒaːnapad̪a gi⌉t̪ɛ spard̪ʰɛjallı gɛd̪d̪ɛ**
6	**od̪ıd̪a nant̪ara** aː **pust̪aka kɔɖut̪t̪ɛːnɛ**
7	**kaːɖınallı bʰajankara sarpagaɭu aɖagıvɛ**
8	**avaɭu baɖa manɛt̪anad̪allı huʈʈıd̪avaɭu**
9	avanu **saʊd̪ɛ t̪aralu kaːɖıgɛ hɔraʈanu**
10	**adʒdʒıja manɛja mund̪ɛ** ɔnd̪u **kaːluvɛ** ıd̪ɛ

Sl No.	SENTENCE LIST 20
1	**ɛlɛgaɭu ud̪urɪ rast̪ɛja** mɛːlɛ **haraɖɪd̪ɛ**
2	**naːvu ʃrad̪d̪ʰɛ vahɪsɪ kɛlasa** maːɖabɛːku
3	**mɛːdʒɪna mɛːlɛ kaːgad̪a-pat̪ragaɭu** ɪvɛ
4	avara **saraɭa naɖat̪ɛ ɛllarɪguː maːd̪arɪ**
5	**ɛllaruː parɪsarad̪a mahat̪va t̪ɪɭɪjabɛːku**
6	aː **samajad̪allɪ nanagɛ d̪ɪkkɛ˥ t̪o˥tʃalɪlla**
7	ɪd̪ɔnd̪u **kri˥ɖaː prɛːmɪgaɭa ad̪bʰut̪a raːʂʈra**
8	**habbad̪allɪ hɔsa baʈʈɛ d̪ʰarɪsuvud̪u** vaːɖɪkɛ
9	**huɖuga bajalɪnallɪ kurɪ mɛːjɪsut̪t̪ɪd̪d̪a**
10	**maganallɪ appana sad̪guɳagaɭu kanɖɪt̪u**

Sl No.	SENTENCE LIST 21
1	**magu bahaɭa** samaja **aɭu nɪllɪsalɪlla**
2	**maraḏa** mɛːlɛ **hakkɪjɔnḏu guːdu maːɖɪḏɛ**
3	**nanna gɛɭɛjanɔbba kannaɖaka haːkuʈʈaːnɛ**
4	**avaɭu sankaʂʈaḏallɪ ḏɛːvarannu nɛnɛḏaɭu**
5	**huɖugɪjaru aːʈuraḏɪnḏa rasʈɛ ḏaːʈiḏaru**
6	**hakkgaɭu guːɖu** kaʈʈɪ **mɔʈʈɛ ɪɖuʈʈavɛ**
7	**gɛɭɛjaru kaːrɪnallɪ pravaːsakkɛ hɔraʈaru**
8	**hasu ɔɳagɪruva hullannu ʈɪnnuʈʈɪḏɛ**
9	**avanu tʃalɪsuʈʈɪḏḏa raɪlannu ɛːrɪḏanu**
10	**bi˥ḏɪ naːʈaka no˥ɖalu dʒana** sɛːrɪḏḏaru

Sl No.	SENTENCE LIST 22
1	**dʒanaru kɛlasakkɛ raılınallı hɔraʈaru**
2	**nanagɛ ıbbaru aɳɳa-t̪ammand̪ıru ıd̪d̪aːrɛ**
3	**kaːrmıkaru t̪amma muʂkara mund̪uvarɛsıd̪aru**
4	**ınd̪u ɛllaː angaɖıgaɭa baːgılu mutʃtʃıd̪ɛ**
5	**nanna gɛɭɛja nıd̪rɛjallı maːt̪aː| ut̪t̪ıd̪d̪a**
6	**amma hɔsa paːt̪rɛjallı aɖugɛ** maːɖıd̪aru
7	ɛʂʈɛː **ni|ru kuɖıd̪aruː d̪aːha t̪i|rut̪t̪ılla**
8	**ɔnd̪u ɔɭɭɛja abʰjaːsavannu ruːɖʰısıkɔllı**
9	naːvu **t̪and̪ɛ t̪aːjı hɛːɭıd̪ant̪ɛ naɖɛjabɛːku**
10	avanu **kaːɖınınd̪a saʊd̪ɛ t̪and̪u maːrut̪ıd̪d̪a**

Sl No.	**SENTENCE LIST 23**
1	**naːlvaru put̪rarallı ɔbba vıd̪ɛːʃad̪allıd̪d̪aːnɛ**
2	**nanna snɛːhıt̪aru ıvat̪t̪u barabahud̪u**
3	**laːrı tʃaːlakaru muʂkara nıllısıd̪aru**
4	**aːgasad̪allı kappu moɖagaɭu kavıd̪ıd̪ɛ**
5	**sandʒɛ** vɛːɭɛ **hakkıgaɭu guːɖıgɛ maraɭut̪t̪ıvɛ**
6	ıvɛlla **namma manɛja kaːgada pat̪ragaɭu**
7	**kutumba rakʂaɳɛ** ıvara **mɔd̪ala aːd̪jat̪ɛ**
8	**ınd̪u** namma **hɔsa manɛja gruhapravɛːʃa**
9	**ɔnd̪u d̪ına arasanɔbba kaːɖıgɛ** ho⌉d̪anu
10	naːni⌉ga **uːʈa maːɖı mugısı baruvɛnu**

Sl No.	SENTENCE LIST 24
1	**dʒanaru** t̪amma **nɛtʃtʃɪna sɪnɪma**ː **no˥ɖɪd̪aru**
2	**kaʂʈad̪ɪnd̪a pa**ː**ra**ː**galu bɛ**ː**ga upa**ː**ja** maːɖu
3	**hasɪd̪a sɪmhavu dʒɪnkɛjannu bɛ**ː**ʈɛja**ː**ɖɪt̪u**
4	**kaɭɭanu pɔli˥sara gunɖɪnɪnd̪a t̪appɪsɪkɔnɖa**
5	**ɛmmɛgaɭu rast̪ɛgɛ aɖɖava**ː**gɪ nɪnt̪ɪvɛ**
6	**mad̪ʰjara**ː**t̪rɪ ɔbbanɛ hɔragɛ hɔ˥gabɛ**ː**da**
7	**raɪlu nɪld̪a**ː**ɳad̪allɪ nɪllalu dʒa˥gavɪlla**
8	amma **nɛnnɛ rɛ**ː**ʂmɛ si˥rɛ kʰari˥d̪ɪsɪd̪aru**
9	**nɪnagɛ sɪkka kɛlasavannu ʃrad̪d̪ʰɛjɪnd̪a** maːɖu
10	**baɖava guɖɪsɪlɪnallɪ va**ː**sa ma**ː**ɖut̪t̪ɪd̪d̪a**

Sl No.	SENTENCE LIST 25
1	**amma maguvannu t̪ɔ□□ılallı malagısıd̪aɭu**
2	**huɖuga d̪aːrıja mad̪ʰjad̪allı oɖut̪t̪ıd̪d̪aːnɛ**
3	**sasja** mat̪t̪u **praːɳıgaɭıgɛ ni⌉ru avaʃjaka**
4	**ad̪ɔnd̪u dʒagat̪t̪ına suprasıd̪d̪ʰa nagara**
5	**hasıd̪a hulıju manuʂjanannu kɔnd̪uhaːkıt̪u**
6	**ni⌉rına kɔrat̪ɛ** nammannu **ɛllɛɖɛ kaːɖut̪t̪ıd̪ɛ**
7	**huɖuga tʃanɖannu kıʈakı gaːdʒıgɛ** hɔɖɛd̪anu
8	**marud̪ınad̪ınd̪a sɛːvɛ praːrambʰa maːɖıd̪ɛ**
9	naːnu **mundʒaːnɛ aıd̪u ganʈɛgɛ od̪uvɛnu**
10	nanna **haɭɛja snɛːhıt̪a manɛgɛ band̪anu**

Sl No.	**PRACTICE LIST 1**
1	**dʒanaru raɪlɪnallɪ nɪn̪t̪ɛː prajaːɳɪsɪd̪aru**
2	**kɛlasa mugɪjuvallɪ ɔnd̪u gantɛ** kalɛjɪt̪u
3	**mara gɪdagaɭɪggɛ niru at̪janṯa** avaʃjaka
4	**avanu tʃilad̪allɪ d̪^{h}aːnjavannu t̪umbɪd̪a**
5	**naːjaka sab^{h}ɛjallɪ b^{h}aːʃaɳa maːdut̪t̪ɪd̪d̪anu**
6	**aːnɛgɪnt̪a kud̪urɛ vɛːgavaːgɪ odut̪t̪ad̪ɛ**
7	**avanu kɔlɛ maːdɪ kaːraːgruhakkɛ hod̪a**
8	**allɪruva jant̪ra bahaɭa ʃabd^{h}a** maːdut̪t̪ɪd̪ɛ
9	**haɭɭɪ dʒanaru pɛːtɛgɛ valasɛ** band̪aru
10	**maɭɛgaːlad̪allɪ suːrjana d̪arʃana aparuːpa**

Sl No.	PRACTICE LIST 2
1	avaɭu **manɛ kɛlasa mugısı od̪ıd̪aɭu**
2	ıd̪u **nagarad̪a pramukʰa rast̪ɛgaɭallı ɔnd̪u**
3	**avaru godɛgaɭıgɛ bıɭı baɳɳa** hɔdɛd̪aru
4	**saːgarad̪a nirına matta hɛtʃtʃaːgut̪t̪ıd̪ɛ**
5	**makkaɭu saːmuːhıka prartʰanɛ maːdıd̪aru**
6	**avanu ɛllarıgınt̪a balaʃaːlıjaːd̪a vjakt̪ı**
7	**i gaːd̪ɛja saːraːmʃavannu nanagɛ hɛːɭu**
8	**ɛt̪t̪ına gaːdıjallı dʒanaru dʒaːt̪t̪rɛgɛ** hod̪aru
9	**manɛ angaɭad̪allı huːvugaɭu araɭıvɛ**
10	**avaru nıvrut̪t̪araːgı hat̪t̪u varʃa** kaɭɛjıt̪u

Sl No.	PRACTICE LIST 3
1	avana maːt̪annu kɛɭɪ ɛllaru nakkaru
2	pattaɳad̪a bid̪ɪ galaːtɛjɪnd̪a kuːdɪt̪t̪u
3	avara manɛjallɪ sandʒɛ d̪arodɛjaːgɪd̪ɛ
4	ʃaːlaː makkaɭɛllaː mrugaːlajakkɛ hod̪aru
5	sɪmhagaɭu kat̪t̪alallɪ bɛːtɛgɛ hɔratavu
6	avanu karugaɭannu sant̪ɛjallɪ maːrɪd̪anu
7	huduga pust̪aka t̪aruvud̪annu marɛt̪anu
8	raːdʒakaːraɳɪja hɛːɭɪkɛ vɪvaːd̪a sruʃtɪsɪt̪u
9	kaːgɛju happaɭavannu ɛt̪t̪ɪkɔndu haːrut̪t̪ɪd̪ɛ
10	avanu tʃalɪsut̪t̪ɪd̪d̪a bassɪnɪnd̪a ɪɭɪd̪anu

Sl No.	PRACTICE LIST 4
1	avaɭa saraɭat̪ana ɛllaruː mɛtʃuvant̪ad̪d̪u
2	avanu aːduvaːga balagaːlɪgɛ pɛt̪t̪aːjɪt̪u
3	samud̪rad̪allɪ naːvu hadagannu kandɛvu
4	rast̪ɛ naduvɛ nadɛjuvud̪u apaːjakaːrɪ
5	raːdʒa jud̪d̪ʰad̪allɪ soːt̪u raːdʒjakkɛhɪnt̪ɪrugɪd̪a
6	avaɭu t̪annagɛɭat̪ɪgɛ sahaːja maːdalɪlla
7	ɪd̪u pravaːsigarɪgɛ prɪjavaːd̪a t̪aːɳa
8	suːrjoːd̪ajad̪a d̪ruʃja ramaɳijavaːgɪ kandɪt̪u
9	mangavu haɳɳnnu t̪ɪnnalu hɔntʃu haːkut̪t̪ɪd̪ɛ
10	avaru bassɪgaːgɪ ɔnd̪u gantɛ kaːd̪aru

Sl No.	PRACTICE LIST 5
1	ɔnd̪u t̪ɛngɪna ka:jɪgɛ hat̪t̪u ru:pa:jɪ kɔttɛ
2	hudugaru ma:vɪna haɳɳannu kad̪d̪u t̪ɪnd̪aru
3	na:jɪ ra:t̪rɪjalla: mantʃad̪a kɛɭagɛ malagɪt̪t̪u
4	ɛlla: snɛhɪt̪aru mad̪uvɛgɛ band̪ɪd̪d̪aru
5	nammu:rɪnallɪ sa:mskrut̪ɪka me:ɭa nadɛjut̪t̪ɪd̪ɛ
6	dʒanaru dʒora:gɪ haggavannu ɛɭɛjut̪t̪ɪd̪d̪arɛ
7	ɔnd̪u va:rad̪ɪnd̪a manɛgɛ biga ha:kɪd̪d̪a:rɛ
8	namma manɛjallɪ ɛradu na:jɪ marɪgaɭɪvɛ
9	a: manɛ kattalu ɔnd̪u varʃa bɛ:ka:jɪt̪u
10	hudugaru a:ta a:dalu tʃandannu t̪and̪aru