

# DEVELOPMENT OF A SYNTHETIC SPEECH IDENTIFICATION TEST IN KANNADA LANGUAGE

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## Abstract

*An attempt has been made to develop 'A Synthetic Speech Identification Test In Kannada Language', to serve the urgent clinical needs on the basis of 'A new approach to speech audiometry'. Synthetic speech sentences of first and second order were constructed. They were recorded with a competing speech signal. It was presented to sixty normal ears and forty-three pathological ears. Their data were analyzed by using non-parametric statistics.*

Speech audiometry is a basic tool of audiological evaluation. Pure tone audiometry alone does not provide any information about a person's ability to hear above the threshold and hence should be supplemented by speech audiometry. Speech audiometry helps to measure threshold, supra-threshold intelligibility, progress in lip-reading, auditory training, success in otological surgery and to aid in the diagnosis of peripheral and central auditory disorders.

A variety of materials such as consonants, words (mono and disyllabic), nonsense syllables, sentences and continuous discourses have been used as materials for speech audiometry. In using these materials many of the limitations of each of these materials have been noticed.

Monosyllabic words are sufficiently unpredictable for clinical subjects and are perceived relatively independently as individual speech elements. So intelligent guess work on the part of subjects is minimized. Egan *et al* (1948) developed a series of tests at Psycho-Acoustic Laboratory, Harvard University and were known as PAL Tests No. 9, 14 and 12. Later Hirsh *et al* modified these tests at the Central Institute for the Deaf and were available for clinical use as W-1, W-2 and W-22 Tests of CID. Northwestern University Tests No. 4 and 6 were developed later using phonetically balanced and monosyllabic words. Later multiple choice tests, rhyme tests and modified rhyme test were developed. The Kansas University developed the K-U Speech Discrimination Test. These emphasized the auditory phonemic factors and minimized the linguistic factors. Later it was felt that, the use of single words especially single syllable words imposes severe limitation such as vocabulary, relative range of difficulty, meaningfulness which acts as variables and imposes a limitation on the parameters of

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speech and its changing pattern over time. So the National Research Council on Hearing and Bio-acoustics found the monosyllables as not a proper representative of everyday speech and suggested the use of sentences as material for speech audiometry. Sentences are considered to be more valid indicators of speech.

Bel Telephone Laboratories constructed interrogative sentences which are to be answered by the listener. These lists were found to be useless for the clinician as it involves not only hearing but also the ability to answer the questions on the part of the listener. Simple sentences were constructed by Hudgins *et al.* at Harvard University (PAL Test 12). Later set of sentences were constructed at CID to represent everyday American speech. The disadvantages in using sentences as speech material is that fairly long lists are required as the same sentences cannot be repeated as it becomes easier for a listener to recognize a sentence just by a key word. Sentences are highly redundant and cannot be used as valid materials for testing as it gives room for guess work. But these tests have high face validity 'as samples of everyday speech.

To overcome the above disadvantages James Jerger *et al.* devised 'A new approach to audiometry' in which (a) the message set is closed (b) scoring is unambiguous (c) each test word is multiword rather than single word. This technique has been extensively made use of in the present study.

In India Abrol (1971) Kapur (1971), Swarnalatha (1972), De (1973) and many more have constructed materials for speech audiometry in different languages. . So far no test in Kannada has been developed. The problem in developing a test using PB words or Spondees in Kannada is the availability of a very few monosyllabic or disyllabic with equal stress. No word in Kannada ends with a consonant. So English PBs and Spondees have been used with English knowing Kannada people and words digits and conversation have been used with those who know Kannada only. The present study was the first to be undertaken to overcome this difficulty.

*Methodology:* The 'After only' research design is made use of in the study\* It was conducted in three stages. They are (1) construction of the material; (2) the development of the test procedure and (3) collection of data.

*Construction of material:* Synthetic sentences are the sentences which are artificial as they are not real and/or synthetic as they follow a specificable rules of syntax. Synthetic sentences of first and second order were constructed.

*First order sentences:*' Words from the list of most commonly used words of the language (computed by the research project SRS Ind 38-68 AIISH using 20,000 words of the language—report 1970-71) were selected at random and put together in the same order of selection to form a seven word sentence. Twenty such sentences were constructed

*Second order sentences":* One word from the above cited list is taken at random and given to an individual 'A' to construct a sentence using the given

word in the initial position. This word served as the first word of the second order sentence. The word that immediately followed the given word was taken from the sentence constructed by the individual 'A', and given to another individual 'B' to construct a sentence using this word in the initial position. This word served as the second word of the second order sentence. The word that immediately followed the given word in the sentence constructed by the individual 'B' was taken as the third word of the second order sentence. This third word was used to elicit the fourth word of the second order sentence from yet another individual. The fourth word was used to elicit the fifth and so on till the seven words are reached in the aforementioned way. In this way 20 sentences were constructed by using different individuals for each of the word and each of the sentence. The people did not know as to why the word was used or the purpose of it. (Thus a curse word has also occurred in one of the sentences). The length of each sentence was controlled by taking seven words only in a sentence. The probability of each sentence to occur in any order is controlled by random selection.

These sentences were tested for homogeneity in reading and identification. For this purpose five subjects with normal otologic and audiologic findings and who could read and speak Kannada were selected. The time taken by them to read the sentences and to identify them after hearing through the head set and from a given list are noted down. Those sentences of first order and of second order which require equal reading time and equal identification time are grouped together to form sets of 10 sentences each in both the orders.

*Competing Speech:* A continuous speech signal was selected from a Kannada novel which was considered by most of the readers as interesting to be used along with synthetic sentences for making the task as realistic and as difficult as possible.

The sentences of the first order (Appendix: Chart I) were randomly scrambled into three lists of 10 sentences each to form the set one. In the same way 10 sentences of the second order (Appendix: Chart II) were scrambled into three random lists of 10 sentences each to form set two. Set one and set two sentences were recorded on channel one of a magnetic tape. A time gap of 10 seconds between sentences, 15 seconds between lists and 20 seconds between sets two was provided. The competing speech was recorded on the channel two of the same tape. It preceded and exceeded the synthetic speech sentences by 30 meter readings. This was tape-1. One list of first order sentences and another list of second order sentences were at randomly selected from tape-1 and recorded on tape-2 with a time gap of 10 seconds between sentences and 15 seconds between sets on the first track of the tape-2. On the track 2 of the tape-2 competing speech was recorded. It exceeded and preceded the synthetic sentences by 30 meter readings.

*Development of Test procedure:* The test was conducted in an audiometric room which met the ISO standards for audiometric rooms.

## APPENDIX : Chart—I

### Synthetic Speech Sentences of First Order

1. ಬಂದು ಅವರು ಮನಸ್ಸು ಅವನು ಇದು ಈಗ ಸ್ವಲ್ಪ
2. ಬಂದು ತಲೆ ನೋಡು ಹೋಗು ದಿನ ನನಗೆ ಒಳಗೆ
3. ಎಷ್ಟು ತಪ್ಪು ಈ ಊಟ ಅವನು ನಿನ್ನ ಮೇಲೆ
4. ಬೇಕು ಕಂಡು ತಪ್ಪು ಪಡು ಹೊರಗೆ ಈ ನಿನ್ನ
5. ಮದುವೆ ಸಿಕ್ಕು ಒಳಗೆ ಕೈ ದಿನ ವಿಷಯ ಬರುವ
6. ಸಿಕ್ಕು ಎಂಬ ಹಿಂದೆ ಎಂದ ಅವರು ತನ್ನ ಹೀಗೆ
7. ಇವರು ತಲೆ ಆ ಪಡು ಕುಳಿತು ಶ್ರೀ ಕಾಣು
8. ಬೇಕು ಮೇಲೆ ಮೊದಲು ತೆಗೆದು ನಿನ್ನ ಶ್ರೀ ಬಗ್ಗೆ
9. ಕಳಿತು ತೆಗೆದು ಅವರು ಯಾಕೆ ಅವರು ಒಳಗೆ ಇನ್ನು
10. ಕಾರ್ಯ ಕಂಡು ಈ ಹೇಗೆ ಬರುವ ಹೇಳು ಇದು.

## Chart—II

### Synthetic Speech Sentences of Second Order

1. ಸಣ್ಣ ಮಹಾದೇವ ಈ ಪುಸ್ತಕವು ಒಂದು ಬಹು ವ್ಯವಸ್ಥಿತ ಮಾತನಾಡುವುದಕ್ಕೆ
2. ಯುವಕನಲ್ಲಿ ಬಿಸಿ ಬಿಸಿ ಕಾಫಿ ಮಾಡಿ ಮಾಡುವುದಕ್ಕೆ ಕೆಲಸ
3. ವೆದ್ದ ನಾಗರಾಜ ಸತ್ತುಹೋದ ಅಯ್ಯೋ ನಮ್ಮನ್ನು ಒಳಗೆ ಚೆನ್ನಾಗಿದೆ ತುಂಬಾ
4. ಲೋಟ ಬಹಳ ಗಾಳಿ ತಂಪಾಗಿ ಇಲ್ಲ ತಲೆ ಕಲ್ಲ ತಲೆಯಿಲ್ಲದವಳಿಗೆ
5. ಸಮಾಜ ಒಹುಬೇಗ ಬನ್ನಿ ಬನ್ನಿ ಒಳಕ್ಕೆ ನಮ್ಮ ಮಕ್ಕಳು
6. ನಡೆದುಕೊಂಡು ಹೋಗು ಬೇವಾಸಿ ಬಡ್ಡೆತ್ತದೆ ಎಕೋ ಇಷ್ಟೇ ತಲೇನಾ
7. ಕೂದಲು ತುಂಬಾ ಚೆನ್ನಾಗಿ ಕೆಲಸ ಇಲ್ಲ ಇಲ್ಲವೇ ಇಲ್ಲ ನನ್ನ
8. ರಾಗ ಹಾಡುತ್ತೀಯೆ ಅಂತ ಮತ್ತೆ ಎಲ್ಲಿಗೆ ಬೇಕಾದರೂ ಕಾಸು
9. ಒಂಗಾರ ನನಗೆ ಬಂಗಾರದ ಮನುಷ್ಯ ನಾನು ಯೆಚ್ಚಿದ್ದೇ ತಡವಾಗಿ ಏಕೆ
10. ಬೀಗ ಎಲ್ಲಿಗೆ ಹೋಗಿದ್ದೆ ಅವನು ಒರುತ್ತಾನೆ ಬೇಡ ಬೆಂಗಳೂರು.

*Instruments:* Uher variocard 26- stereo tape recorder with Scennheiser type MD 722 LM microphone was used to record and reproduce the signal.

*Audiometer:* The signal was fed through an Arphi model 700 MK audier meter with TDH 39 headsets. Since there was no provision to feed the second tape signal through the audiometer it was suitably modified to inject the second signal in place of noise on the second channel of the audiometer. The two outputs from the tape recorder were fed to the audiometer such that the synthetic speech appeared on channel one and the competing speech on channel two. The audiometer was kept either in hangen right or left with a function selector switch in speech/masking position all through the testing. A pre-amplifier EA 724 Stereo developed at the electro acoustic laboratory All India Institute of Speech and Hearing was used in between tap. recorder and audiometer to boost the signal to the required extent.

To know which sentence was presented at any instance of time during testing a monitoring set comprising of an amplifier (Arphi TH 25) and headset (513/4-PP-531) was provided to the experimenter. The output of the monitor never exceeded 30 db at any moment of time during testing to avoid interference with the test signal.

To make the patient response a motor act thus avoiding ambiguity in scoring he was provided with 10 push button switches in front of him numbered from 1 to 10, correspondingly numbered 10 bulbs were arranged in front of the tester.

*Subjects:* The criteria for selection of subjects were (a) audiogram configuration (b) proficiency in speech and reading Kannada (c) above the age of 12 years (d) SRT not exceeding 65 dbs. They were tested for (1) pure-tone audiogram (2) SRT (3) special test as needed and (4) for ear-discharge and wax. In cases of wax and discharge they were tested only after the ear became clean and dry. The following table shows the distribution of the subjects studied:

Subjects	No.	(in years)		(in dbs)		
		Age range	Mean age	SRT range	Mean SRT	
Normals	M	40	16-30	21	5-15	11.2
	F	20	18-23	21.5	10-15	11.5
Conductive	M	10	19-43	31	18-98	63.0
	F	2	21	21	23-42	32.5
Mixed	M	5	20-56	38	13-40	26.5
	F	2	30	30	53-60	56.5
S.N. Group	M	15	18-72	45	17-65	41
	F	4	33-37	35	52-65	53.5
High Freq. Loss	M	4	25-31	28	13-20	16.5
	F	1	19	19	13-18	15.5

*Instructions:* There are 10 sentences written and numbered from one to ten on this chart. Please read them carefully. Now you are going to hear a continuous speech in one of your ears. Along with it and amidst it, these sentences will come one at a time. You should hear it carefully, identify the sentence which you hear from the given list and press the push switch corresponding to the number of the sentence that you have heard, for a while. If you miss any of the sentences please let me know. Now please be ready.

*Procedure:* Experiments 1 and 2 to find the presentation level of the signal and message competition ratio (ratio of the synthetic speech signal to competing

speech) for maximum performance on this test, five individuals with normal otologic and audiologic findings were presented with tape-1. The intensity level was varied in five db steps from the level of SRT each random list till maximum performance score was obtained. Then the message competition ratio was varied holding the presentation level constant from the level of zero db to forty five db above that of the synthetic sentences, noting down the responses at each of the level. The data was analyzed.

*Data collection:* First, tape-1 was presented to sixty normal ears at 40 db SL and 0 db MCR. Their responses were noted down and analyzed (Experiment No. 3). Next to rule out the effect of fatigue and to save time, tape-2 signal was presented to the above sixty normal ears and their data were recorded and analyzed (Experiment No. 4). In the same way the responses of 43 clinical ears were recorded and analysed at 40 db SL and 0 db MCR (Experiment No. 5). To find the performance intensity function of the clinical ears 10 randomly selected clinic 1 ears were subjected to testing on tape - 1. Starting from the level of SRT the intensity was varied in 5 db steps till 45 db are reached. At every intensity level different random lists were used to rule out the practice effects. The responses were recorded and analyzed (Experiment No. 6). To find the reliability of the test, 20 randomly selected normal ears were subjected to re-testing on tape-2 at 40 db SL and 0 db MCR. Their responses were recorded and reliability was computed. (Experiment No. 7). To find the validity of those subjects who know both Kannada and English were tested on English PB test in addition to the Kannada SSI test. Scores of both the tests were compared each other and validity was computed (Experiment No. 8).

*Results:* It is found from the Experiments 1 and 2 that the performance on SSI test increases as the level of presentation is increased till 45 db SPL and remains constant thereafter at the level of 0 db MCR. From the level of 15 to 25 db the performance was 0 for all the MCR levels. As the MCR was varied in 5 db steps from 0 to 45 db the performance dropped down and maximum performance was seen. The following table shows the results of the Experiment No. 3, 4, 5 and 6.

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Type of Hearing loss	Number of ears	PB range (in per cent)	SSI range (in per cent)	PB and SSI difference
Normals	60	92-100	90-100	Not significant
Conductives	14	95-100	80-100	- do -
S.N. Group	20	40- 70	30- 80	- do -
Mixed Group	7	73- 90	80-100	- do -
High freq. loss	7	75-100	90-100	- do -

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It is found from the results of the Experiment No. 3 and 4 that the normal ears obtained maximum performance scores on SSI test. Out of the 60 ears tested 11 ears got 90 per cent scores and the remaining obtained 100 per cent scores. It is also observed that the SSI score was greater than or equal to the PB scored in most of the cases. To find the statistical significance of difference between the performances on SSI and PB tests with any group and to find the statistical difference on the performance of SSI test by different groups non-parametric statistics i.e. wilcoxon-Matched-Pair Signed-ranks test and Mann-Whitney U test was applied respectively.

There was significant difference in the performance of normals on SSI test and PB tests.

From the results of Experiment 5 it is found that the sensorineural loss cases obtain lowest performance score on SSI test, mixed loss cases obtain higher scores than the sensorineural loss cases and conductive loss obtain same score as the normals. From the analysis of the data it is found that the clinical group show significant difference in performance from one another and from normals except for conductive loss cases where in the performance was same as that of normals.

From the results of Experiment 6 it is found that the performance increases as the intensity is increased. The graphic representation of the results of Experiment 6 was compared with the graphic representation of the PB scores. It is found that the area under SSI graph is greater than the area under PB graph.

The test retest reliability was found to be high as the obtained values were 0.56,0.76,1 and 1.

The test was found to be valid as there was no difference between PB and SSI scores on Wilcoxon matched pair sign rank test.

*Conclusions:* It is concluded that:

1. The performance on SSI test varies directly as the level of presentation and inversely as the level of MCR.
2. Normals obtain maximum score on SSI test at 40 db SL and 0 db MCR.
3. There exists no significant difference between normals and conductive loss cases in performance on the SSI test.
4. The clinical groups show significant difference between normals and one another in performance on the SSI test.
5. SSI test can be validly used with Kannada knowing people.

*Limitations:* Limited to Kannada population only. It cannot be used with children and those who do not know reading.

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