DEVELOPMENT OF A SYNTHETIC SPEECH IDENTIFICATION TEST IN KANNADA LANGUAGE

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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, suprathreshold intelligibility, progress in lip-reading, auditory training success in oto-logical surgery, as an aid in the diagnosis of peripheral and central auditory disorders, and in the selection and evaluation of hearing aids.

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 Psychoacoustic 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 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 limitaton such as vocabulary, relative range of difficulty, meaningfulness which acts as variables and imposes a limitation on the parameters of speech and its changing pattern over time. So the National Research Council on Hearing and Bio-acoustics found the mono-syllables 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 a set of sentences

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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 item 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), Day (1973) and many more have constructed materials for speech audiometry in different languages. Till 1973, no test in Kannada was developed. The problem in developing a list of PB or Spondee words in Kannada is the availability of a very few monosyllabic words 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

This study follows the "After only" research design. The study was conducted in three stages, i. e., (i) construction of test material, (ii) development of test procedure, and (iii) collection of data.

I Construction of Test Material

Synthetic speech sentences are constructed as speech material for the test. Synthetic sentences are synthetic or artificial as they are not real and do not convey any meaning and they are sentences as they follow a specific rule of syntax, i.e., each word in a sentence is dependent on the preceding word for its existence in that position and order.

First Order Sentences are sentences computed by selecting words in random order from the list of most commonly used words of Kannada language (Report of the Research Project 1970-71, No. S.R.S. Ind 38-68 using 20,000 words for computation) and putting them together in the same order of selection to form a seven word sentence. Twenty such sentences were constructed (Chart I).

CHART I

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

Second Order Sentences were constructed by selecting randomly a word from the above list of most commonly used words to be the first word of the second order sentences and given to an individual 'X' to construct a sentence using this word in the initial position. The word which immediately followed the given word served as the second word of the sentence and was given to another individual 'Y' to use the given word in the initial position and construct a sentence. The word that followed the given word from the sentence constructed by 'X' in the sentence constructed by 'Y' served as the third word of the sentence and was used to elicit the fourth word from another individual. Similarly seven words were elicited using seperate individuals for each of the word and all the elicited seven words were put in the same order of elicitation to form a sentence. Twenty such sentences were constructed using different individuals for word and every sentence (Chart II).

CHART II

1 ಸಣ್ಣ ಮಹಾದೇವ ಈ ಹುಡುಗರು ಬಹಳ ಎನ್ನುವುದಕ್ಕೆ ಮಾಡುವುದಕ್ಕೆ
2 ಯುವಕನಲ್ಲಿ ಬಿಸಿ ಬಿಸಿ ಕಾಫಿ ಪುಡಿ ಮಾಡುವುದಕ್ಕೆ ಕೆಲಸ
3 ಪೆದ್ದನಾಗರಾಜ ಸತ್ತುಹೋದ ಅಯ್ಯೋ ನಮ್ಮಪ್ಪ ಬಹಳ ತುಂಬಾ ಜೆನ್ನಾಗಿದೆ
4 ಲೋಟ ಬಹಳ ಗಾಳಿ ತಂಪಾಗಿ ಇಲ್ಲ ತಲೆಯಿಲ್ಲ ತಲೆ ಇಲ್ಲದವಳಿಗೆ
5 ಸಮಾಜ ಬಹುಬೇಗ ಬನ್ನೀ ಬನ್ನೀ ಒಳಕ್ಕೆ ನಮ್ಮ ಮಕ್ಕಳು
6 ಪಡೆದುಕೊಂಡು ಹೋಗು ಬೇವಾರ್ಸಿ ಬಡ್ಡೆತ್ತದೇ ಏಕೋ ಇಷ್ಟೇ ತಲೇನಾ
7 ಕೂದಲು ತುಂಬಾ ಜೆನ್ನಾಗಿ ಕೆಲಸ ಇಲ್ಲ ಇಲ್ಲವೇಇಲ್ಲ ನನ್ನ
8 ರಾಗ ಹಾಡುತ್ತೀಯ ಅಂತ ಮತ್ತೆ ಎಲ್ಲಿಗೆ ಬೇಕಾದರೂ ಕಾನು
9 ಬಂಗಾರ ನನಗೆ ಬಂಗಾರದ ಮನುಷ್ಯನಾಗಿ ಹುಟ್ಟಿದ್ದೀ ತಡವಾಗಿ ಏಕೆ
10 ಬೀಗ ಎಲ್ಲಿಗೆ ಹೋಗಿದ್ದೆ ಅವನು ಬರುತ್ತಾನೆ ಬೇಡಿ ಬೆಂಗಳೂರು

None of the individuals used for eliciting the words knew the purpose for which the words were collected or the use of it. The length of each sentence remained almost the same as only seven words were taken in each sentence. However, since the morphological variations and length of the word could not be controlled, the sentences were tested for homogeneity on reading and identification time. For this five subjects with normal otological and audiologic findings and who could read and speak Kannada were asked to (i) read the sentences and (ii) to identify the sentences when presented through headset. The time taken for reading and identifying were noted down. Those sentences of first and second order which required almost equal time for reading and for identification were put together to form a set of ten sentences each.

Competing Speech. A continuous speech signal from a Kannada novel judged to be of interest by most of the readers was selected to be presented alongwith the synthetic speech sentences to make the task as difficult and as realistic as possible. Tape I. The sentences of the first order were randomly scrambled into three lists of ten sentences each to form the set 1. In the same way second order sentences (10 in number) were scrambled into three lists of ten sentences each to form second set. Set first and second sentences were recorded on channel 1 of the magnetic tape. A

time gap of 10 seconds between sentences, 15 seconds between lists and 20 seconds between sets were provided. The competing speech was recorded on the channel 2 of the same tape. It preceded and exceeded the synthetic sentences by 30 meter readings. This was tape I.

Tape II. One list of first order sentences and another list of second order sentences were selected at random from tape I and recorded on the tract 1 of the second tape with 10 seconds of gap between sentences and 15 seconds between sets. The competing message was recorded on track 2 of the second tape which preceded and exceeded the synthetic speech sentences by 30 meter readings.

II Development of test procedure

Instruments : A Uher-Variocord 263 stereo tape recorder with Scennheiser type MD microphone was used to record and reproduce the signal.

The signal was fed through an arphi model 700 MK IV with TDH 39 headphones and Lx 41 AR supra aural cushioned clinical audiometer. Since there was no provision to tell the second tape signal through this audiometer, it was suitably modified to inject the second signal in place of noise on second channel. The two outputs of the tape recorder were fed to the audiometer such that the synthetic speech appeared on channel 1 and competing speech on channel 2.

2. The audiometric setting was Langen Lt/Rt and function selecter switch in speech/ Mask position—so that both competing signal and synthetic speech could be fed to the same ear.

A stereo preamplifier EA 72-A developed at the Electroacoustic Lab - AIISH, Mysore was used in between audiometer and tape recorder to boost the signal to required extent.

To know which sentence is appearing at a given instance of time the tester was provided with monitoring set comprising of an amplifier—Arphi TH 25 and headset—551-pp-SI. Care was taken to keep the output of the monitoring unit to be always less than that of test signal to avoid interference. To make the response of the patient a motor act and thus to reduce the ambiguity in scoring, 10 push button switches were fixed in front of the patient numbered from 1 to 10 and correspondingly numbered ten bulbs were arranged in front of the tester.

Test Environment : The test was conducted in a double room situation acoustically treated audiometric room meeting the ISO (1964) specifications for audiometric rooms.

Subjects : The table 1 shows the distribution of subjects studied. In all 60 normal ears and 43 clinical ears were studied.

TABLE 1

Subjects		*No.*	*Age range (in years)*	*Mean age*	*SRT range (in dbs)*	*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

Table 1 continued

S.N. Group	M	15	18-72	45	17-65	41
	F	4	33-37	35	52-65	53.5
High Freq. Loss	M	1	25-31	28	13-20	16.5
	F	1	19	19	13-18	15.5

The following were the criteria for selection of subjects : (i) audiometric configuration, (ii) above the age of 12 years, (iii) proficiency in speaking and reading Kannada, and (iv) SRT not more than 65 dBs.

Instructions : Here are ten sentences written and number 1 to 10 on this chart. Please read them carefully. Now you are going to hear a continuous speech in one of your ears through the earphones. Along and amidst this speech one of the sentences from list will appear. Please hear carefully, identify the sentence from the given chart and hold the switch pressed for a while corresponding to the number of the sentence you have heard. If you miss any sentence let me know. Now please be ready.

Procedure : Expt. 1 & 2. To find the presentation level and message competition ratio (S/N ratio; MCR)- Five subjects with normal otological and audiological findings were presented with tape 1. The intensity level was varied in 5 dB steps from the level of SRT till the maximum performance score was obtained with each of the random list. Then the MCR was varied holding the level of the signal constant and varying the competing speech from 0 dB to 45 dB in 5dB steps above the level of SSI sentences, noting down the responses at each step. The data were analyzed. The maximum performance occurred at 35 to 45 dB SL when the MCR was zero. Hence the further tests were conducted at 10 dB SL and zero dB MCR.

III Data Collection

Tape 1 was presented to 60 normal ears at 40 dB SL and zero dB MCR and their responses were noted down and data were analyzed (Expt. 4). Next to rule out effect of fatigue and to same time, tape 2 signals were presented to same 60 normal ears as above. Their responses were noted and analyzed. The difference in performances on tape 1 and 2 were computed (Expt. 5). In the same way responses of the each of the clinical groups for tape 2 were recorded and analyzed (Expt. 6). To find the performance intensity function of the clinical groups, 10 randomly selected clinical ears were subjected to testing on tape 1. Starting from the level of SRT intensity was varied in 5 dB step till 45 dB was reached. At every intensity level different lists were used to rule out practice effect. Responses were recorded and analyzed (Expt. 7). To find the test retest reliability, 20 randomly selected normal ears were subjected to retesting on tape 2. Their responses were recorded and anlayzed (Expt. 8), To find the validity of the test, those subjects who almost had equal proficiency in Kannada and English were given English P.B. Test (developed by K.C. Swarnalatha, 1972) in addition to the synthetic speech identification test and their data were cross validated (Expt. 9).

Result and Discussion

From experiments 1 and 2 it is found that performance on SSI test increases as the level of presentation increases till 45 dB SL and drops down thereafter at MCR zero dB. For first 25 dB SL level performance was zero for all MCR levels. As the MCR was varied from 0 to 45 dBs the performance drops down and performance was maximum at 0 dB MCR. The following table 2 indicates the results of experiment 3, 4, 5, 6 & 7.

TABLE 2

Type of Hg. loss	*No. of ears*	*PB range (in %)*	*SSI range (in %)*	*PB & 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-

The results of experiments 3 and 4 indicate that normals obtain maximum score on SSI test i.e., 90% to 100% out of 60 ears tested 11 ears got 90% and the rest 100% score. It was also observed that SSI scores in most of the cases were greater than PB scores. To find the statistical significance of difference between the scores obtained by normals, each of the clinical groups, SSI and PB tests non parametric statistics—Wilcoxon Matched Pair Sign Rank Test was employed as usually employed parametric tests were not applicable with this study as data obtained was discrete rather than continuous, groups were not matched and small in number.

There was no significant difference in PB scores and SSI scores of normal as the obtained 'T' value of 52.5 at both the levels of significance i.e., 0.05 & 0.01 was much above the given value in the standard table.

To find the difference between groups Manwhitne U test was employed.

From the results of experiment 5 it is evident that S.N. loss cases obtain low performance scores on SSI test than the other groups, the mixed loss group obtain higher score than S.N. and lesser than normals and conductive loss cases. Further it is observed that normals and conductive loss group obtained the same performance scores.

Results of experiment 6 suggests that the graphic area under SSI score is higher than the graphic area of the PB scores. The test retest reliability was found to be high as the values obtained on Rank Correlation test were 0.56, 0.76, 1 and 1.0.

From the above results it can be concluded that :

1. Performance on SSI test varies directly with the level of presentation.
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 group on SSI test.

4. The clinical groups show significant difference between one another and normals in performance on SSI test.
5. SSI test can be validly used with Kannada knowing population.

Limitation

The test is limited only to those who can read Kannada; it requires further standardization as only a few clinical groups were studied. If morphological variations are controlled it may be more valid; it is only ipsilateral study and presenting competing signal contralaterally may show some difference.

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