

THE DEVELOPMENT AND STANDARDIZATION OF A TEST OF HEARING FOR TELEPHONE OPERATORS

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The Government of India had indicated to the All India Institute of Speech and Hearing, to develop standardised tests for fixing the levels of hearing which is essential for a telephone operator to perform his duty efficiently. The problems become more acute when a telephone operator, who is already appointed develops a hearing problem. Even during recruitment, no standardised hearing test has been specified by the Government to judge the hearing efficiency of the applicants in terms of telephone speech in trunk exchange environments.

This study was therefore undertaken by the investigator to develop and standardise a hearing test for telephone operators over the telephone in realistic conditions of listening environment.

Speech audiometry provides a measure of the listener's response to speech. The telephone transmits speech frequencies ranging from 300 Hz to 3.4 KHz. Speech audiometry does not reflect the performance of a listener over the telephone. Speech discrimination testing over the telephone hence provides the yardstick to judge the hearing efficiency of the telephone operators.

So, an attempt was made to develop and standardise a discrimination testing procedure over the telephone. For this purpose, PB lists standardised on Indian population and sentences made from frequently heard words, phrases and digits were used as test materials.

The final methodology used in the study may be categorised into :-

- 1 Test construction
- 2 Method of Presentation
- 3 Method of Scoring

1. Test Construction :

i. Procedure for test development :

The common speech discrimination material in English adopted from the Adult Speech Discrimination list I, standardised to the Indian Population by Swarnalatha (72). The list was phonetically balanced. From this list four lists were prepared using the same words by arranging them randomly using the Latin Square design.

The sentences were prepared by noting down the most commonly received words, phrases and digits by the telephone operators of the Mysore telephone exchange and incorporating them to form meaningful material.

The intelligibility of the PB word lists and the sentence lists were tested by presenting them to 12 normal subjects.

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2. Method of Presentation :

a) The presentation was through live voice ; the speaker was a male ; his mother-tongue was Malayalam. However, he was proficient in other languages viz., English, Tamil, Hindi, Marathi, Gujarati and was acquainted with Konkani, Kannada, Punjabi, Telugu and Urdu.

Each monosyllable was presented using the carrier phrase, " write the word ".

The sentences were presented using the carrier phrase, " sentence number " in its chronology.

The PB lists and the sentences were presented in the free field condition through live voice, into the telephone transmitter of subscriber set 22502, while holding the handset in normal talking position. The intensity of the speech input was monitored by the SPL meter with its condenser microphone to read in 'C' scale. The SPL meter was so placed, that its condenser microphone and the telephone transmitter of 22502 set were equidistant from the lips of the speaker in normal telephone conversation position. The telephone set No. 22502 was constantly used as the send end telephone for presentation of the test materials. The send end telephone was situated in the records room of the A.I.I.S.H. Same testing hours were maintained throughout the study in an attempt to keep the variable noise levels in the free field setup constant for all subjects.

b) Carrier phrase :

The purpose of the carrier phrase was two fold :

(i) To make the subject vigilant (ii) To monitor the voice while presenting.

It was not meant to give any meaning to the subjects.

c) Testing environment :

Testing of the subjects was done in three situations :

- i. Audiometric set up - experiment (A)
- ii. In the Telephone Exchange setup - Experiment (B)
- iii. Two telephones setup - Experiment (C)

In experiment A, the audiometric testing of the subjects was done in a sound treated room at the Audiology department of A.I.I.S.H. Air conduction and bone conduction testing was done in a one room situation. Speech discrimination test was done in a 2 room situation. The noise levels in the test room measured using an SPL meter (B&K type 2203 with an octave filter set : B & K type 1613) were found to be within the specifications.

In experiment B, the subjects received the test material in the telephone exchange setup.

In experiment C, the subjects received the test material in the subscriber telephone set 20715 situated far from the send end telephone 22502, within the campus of A.I.I.S.H.

d) Procedure for test standardisation

1 Testing procedure : Instructions.

Before the test began the subject was instructed as follows :

“You will now be presented with 4 lists of monosyllable words ; each list consists of 25 words ; each word will be presented with a carrier ‘write the word’ for example, ‘write the word ‘ran’ You have to write only the word ‘ran’ and not the phrase ; each list will be presented at different intensities ; so, you will have to pay attention to listen to the words, identify them and then write them down ; a gap of 5 seconds time will be given after the presentation of each word, to enable you to write down. After the word lists are over, you will be presented with 5 sentences. You need not write them down. You only have to repeat the sentences. A time gap of 10 seconds will be given to you after the presentation of each sentence to enable you to repeat the sentences. No repetition of the words or sentences would be given. Are you ready? Here, we start with list number ‘one’.

Method of testing and level of presentation :

The testing was done by the experimenter with normal hearing and studying in the final year M.Sc., Speech and Hearing. The level of presentation was kept constant for each PB list and the sentences at definite sensation levels above the individual's pure-tone average threshold.

The test procedure was first standardised by presenting the test material to male-female normals. The test material was also presented to male and female telephone operators, who were already working at the Mysore telephone exchange. Then the test material was presented to the clinical population with amplification provided with an Oticon extra super hearing aid with custom made and stock ear moulds, wherever required.

Experiment A - The audiometric set up

Normals :

32 normals with different mother tongues were screened for pure tones to test hearing at 20dBHL for frequencies at 0.25 K, 0.5 K, 1 K, 2 K, 4 K, 6 K and 8 K Hz. Their PI function was found with the 4 PB lists by presenting them at 10 dB, 20 dB, 30 dB and 40 dB above their Speech Reception Threshold (SRT).

Telephone operators :

17 Telephone Operators with different mother tongues were screened for their hearing with pure tones at 20 dBHL as in the case of the normals and their PI functions were found in the same way as in the normals.

Clinical population :

The pure tone audiograms, SRT and discrimination scores were obtained for every subject,

special tests were administered wherever necessary as per clinical findings. Their PI functions for the 4 PB lists were also found by presenting the lists at 10 dB, 20 dB, 30 dB and 40 dB above their SRT's.

Experiment B - In the Telephone Exchange setup

In order to test the performance of subjects in actual conditions, same as those of telephone operators in the trunk exchange room it was decided to test the subjects in the trunk exchange room of the Mysore Telephones. The telephone operators, who work in the trunk exchange room wear headgear sets which are monaural. They work on boards seated beside each other with hardly a distance of $1\frac{1}{2}$ feet gap between them. There are about 20 operators working at one time and each of them is either talking into the phone or listening and immediately responding by speech. Their task is such that it needs vigilance to listen and immediately respond. The room noise is therefore high and more than 60 dB. Since, the head gear set is monaural, the other ear is exposed to competing messages spoken by the other operators in the room. So, an operator has to devote a lot of attention in terms of vigilance to decide the speech signals reaching his head gear set ear, in the presence of competing messages and inherent room noises reaching the exposed ear, apart from the side tone noise, channel and trunk board noises, and the distortions produced by the send end telephone and also by the characteristics of the receiver of his head gear set.

The subjects were seated in the telephone operator's chair and the test material was received through the trunk exchange boards from the head gear set worn by the operators.

At one time, only one subject was tested. The other conditions were not altered.

Normals :

32 normal subjects were tested. The 4 PB lists were presented at 85 dB SPL, 90 dB SPL, 100 dB SPL, 105 dB SPL. The sentences were fed at 95 dB SPL.

Telephone operators :

25 subjects were tested in the same way as the normals. 5 of the subjects were allowed to read the 4 lists before the testing.

Clinical Group :

The Clinical groups were tested in the same way as the normals. The Clinical groups were provided with Oticon extra super hearing aids wherever the test ear was the ear having hearing loss. Custom made moulds were provided to most of them using hearing aids. However, in some cases, it was not feasible to make the custom ear moulds, due to some practical problems of the patient. Stock ear moulds were tried and the one that fitted best was used. The hearing aid was kept in 'T' position (Induction Coil Position); its volume control was adjusted by each subject to his comfortable listening volume, as he heard some telephone speech

before testing ; the volume control of hearing aid was not altered and left in that position. Most of the subjects had no practice using the hearing aid. Hence, they were allowed to listen to running speech through the telephone for some time. The high frequency hearing loss subjects were not provided with amplification. In unilateral hearing loss cases, when the test ear was the normal ear, hearing aid was not provided for the hearing loss ear. The head gear set receiver was placed over the microphone of the hearing aid.

Experiment C - Between two subscriber telephones set up :

The subjects received the test materials in the subscriber telephone set No. 20715. They were instructed to hold the receiver in the same ear, which was used in experiment B set up.

Normals :

20 normals were tested of which 11 of them were tested in the experiment B set up also.

Telephone operators :

15 telephone operators were tested ; they had also undergone testing in the experiment B set up.

Clinical subjects :

All the subjects were tested. Here again, the telephone receiver was placed over the microphone of the hearing aid in 'T' position. Conditions of providing amplification were same as in experiment B set up.

All the subjects in experiment B and in experiment C had undergone testing in experiment A set up.

3 Method of scoring :

For each of the four lists, the PB maximum was found out. The maximum scores thus obtained was taken for analysis. The sentences were scored using the principle of key words, defined in terms of the subjects understanding the essentials in the sentence. If the subject, missed one key word or even the digits or its correct sequence in one sentence, he got zero point. If he repeated all the key words correctly in a sentence, he was given one point.

Reliability

Reliability of the tests were done by taking 5 subjects and then testing them again in the experiment A, B and C, after a long time.

The following conclusions were made from the study ;

1. The mean PB maximum (for PB lists) performance for normals in the trunk exchange room set up is 50.50%. This may be considered as the minimal level of performance required in

terms of the hearing efficiency over the phone, for normals who apply for the job of a telephone operator (PB max. in %)

2. The mean PB maximum (for PB lists) performance for the telephone operators in the trunk exchange room set up is 75.76%. This may be considered as the optimum level of performance desired in terms of hearing efficiency over the phone for persons who apply for the job of a telephone operator.

3. The performance of the normals for PB lists in standard speech audiometry is significantly better than over the telephone received in trunk exchange room.

4. The performance of the telephone operators for PB lists in standard speech audiometry is significantly better than over the telephone received in the trunk exchange room.

5. The performance of normals for PB lists in standard speech audiometry is significantly better than over the telephone received in a subscriber telephone set.

6. The performance of the telephone operators for PB lists in standard speech audiometry is better than over the telephone received in a subscriber telephone set.

7. The performance of the bilateral moderate conductive hearing loss subjects with hearing aid for PB lists received over the phone in the trunk exchange room does not significantly differ from their performance in standard speech audiometry.

8. The performance of the bilateral moderate conductive hearing loss subjects with hearing aid for PB lists received over the phone in the subscriber telephone set does not significantly differ from their performance in standard speech audiometry.

9. The performance of bilateral moderate high frequency hearing loss subjects without hearing aid for PB lists received over the phone in the trunk exchange room does not significantly differ from the performance in standard speech audiometry.

10. The performance of the bilateral moderate mixed hearing loss subjects with hearing aid for PB lists received over the phone in the trunk exchange room does not significantly differ from their performance in standard speech audiometry.

11. The performance of the bilateral moderate high frequency hearing loss subjects without hearing aid for PB lists received over the phone in the subscriber telephone set does not significantly differ from their performance in standard speech audiometry.

12. The performance of the bilateral moderate mixed hearing loss subjects with hearing aid for PB lists received over the phone in the subscriber telephone set does not significantly differ from their performance in standard speech audiometry.

13. The performance of the telephone operators for PB lists received over the phone in the trunk exchange room is significantly better than the normals.

14. The performance of the telephone operators for PB lists received over the subscriber telephone set does not significantly differ from that of normal.

15. Males perform significantly better than females (Normal group) for PB lists received over the phone in the trunk exchange room.

16. There exists no significant difference in the performance of males and females (normal group) for PB lists, received over the phone in the subscriber telephone set up.

17. There exists no significant difference in the performance of males and females (normal group) for PB lists in standard speech audiometry.

18. There exists no significant difference in the performance of males and females (telephone operators) for PB lists received over the phone in the trunk exchange room.

19. There exists no significant difference in the performance of males and females (telephone operators group) for PB lists received over the phone in the subscriber telephone set.

20. There is no significant difference in the performance of males and females (telephone operators group) for PB lists in the standard speech audiometry.

21. The performance of the normals for PB lists received over the phone is significantly better in the subscriber telephone set than in the trunk exchange room set up.

22. The performance of the telephone operators for PB lists received over the phone is significantly better in the subscriber telephone set than in the trunk exchange room set up.

23. There exists no significant difference between the performance of telephone operators who are exposed to the PB lists before the testing and those telephone operators who are not exposed to the PB lists before testing, when received over the phone in trunk exchange room.

24. The bilateral moderate conductive hearing loss subjects with hearing aid perform significantly better than normals for PB lists received over the phone in the trunk exchange room.

25. The bilateral moderate conductive hearing loss subjects with hearing aid perform significantly better than the telephone operators for PB lists received over the phone in the trunk exchange room.

26. There exists no significant difference in the performance of the bilateral moderate conductive hearing loss subjects with hearing aid and the normals for PB lists received over the phone in the subscriber telephone set.

27. There exists no significant difference in the performances of the bilateral moderate conductive hearing loss subjects with hearing aid and the telephone operators for PB lists received over the phone in the subscriber telephone set.

28. The unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is the test ear) perform significantly better than the normals for the PB lists received over the phone in the trunk exchange room.

29. There exists no significant difference in the performance of the unilateral conductive hearing loss subjects with hearing aid (when the hearing loss ear is the test ear) and the telephone operators for PB lists received over the phone in the trunk exchange room.

30. There exists no significant difference in the performance of the unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is the test ear) and the normals for PB lists received over the phone in the subscriber telephone set.
31. There exists no significant difference in the performance of the unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is the test ear) and the telephone operators for PB lists received over the phone in the subscriber telephone set.
32. The unilateral conductive hearing loss subjects without hearing aid (when normal ear is the test ear) perform significantly better than the normals for PB lists received over the phone in the trunk exchange room.
33. There exists no significant difference in the performance of the unilateral conductive hearing loss subjects without hearing aid (when normal ear is the test ear) and the telephone operators for the PB lists received over the phone in the trunk exchange room.
34. There exists no significant difference in the performance of the unilateral conductive hearing loss subjects without hearing aid (when normal ear is the test ear) and the normals for PB lists received over the phone in the subscriber telephone set.
35. The unilateral conductive hearing loss subjects without hearing aid (when normal ear is test ear) perform significantly poorer than the telephone operators for PB lists received over the phone in the subscriber telephone set.
36. The bilateral moderate mixed hearing loss subjects with hearing aid perform significantly better than the normals for PB lists received over the phone in the trunk exchange room.
37. The bilateral moderate mixed hearing loss subjects with hearing aid do not significantly differ from the normals in their performance for PB lists received over the phone in the trunk exchange room.
38. The bilateral moderate mixed hearing loss subjects with hearing aid do not significantly differ from the normals in their performance for PB lists received over the phone in the subscriber telephone set.
39. There exists no significant difference in the performance of the bilateral moderate mixed hearing loss subjects with hearing aid and the telephone operators for PB lists received over the phone in the subscriber telephone set.
40. There exists no significant difference in the performance of the bilateral conductive hearing loss subjects with hearing aid for PB lists received over the telephone in the trunk exchange room and the subscriber telephone set.
41. There exists no significant difference in the performance of the unilateral high frequency hearing loss subjects without aid hearing (when test ear is hearing loss ear) for PB lists received over the phone in the trunk exchange room and in the subscriber telephone set.
42. The telephone operators perform significantly better than the normals for sentences received over the phone in the trunk exchange room.

43. There exists no significant difference in the performance of the normals and the telephone operators for sentences received over the phone in the subscriber telephone set.

44. There exists no significant difference in the performance of males and females (normals group) for sentences received over the phone in the trunk exchange room.

45. There exists no significant difference in the performance of males and females (normal group) for sentences received over the phone in the subscriber telephone set.

46. There exists no significant difference in the performance of males and females (Telephone operators group) for sentences received over the phone in the exchange room.

47. There exists no significant difference in the performance of the males and females (telephone operators group) for sentences received over the phone in the subscriber telephone set.

48. Normals perform significantly better for sentences received over the phone in the trunk exchange room.

49. There exists no significant difference in the performance of the telephone operators for sentences received over the phone in the trunk exchange room and the subscriber telephone set.

50. The bilateral moderate conductive hearing loss subjects with hearing aid perform significantly better than the normals for sentences received over the trunk exchange room.

51. The bilateral moderate conductive hearing loss subjects with hearing aid perform significantly better than the telephone operators for sentences received over the phone in the trunk exchange room.

52. There exists no significant difference in the performance of bilateral moderate conductive hearing loss subjects with hearing aid and normals for sentences received over the phone in the subscriber telephone set.

53. There exists no significant difference in the performance of the bilateral moderate conductive hearing loss subjects with hearing aid and the telephone operators for sentences received over the phone in the subscriber telephone set.

54. The unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is test ear) perform significantly better than the normals for sentences received over the phone in the trunk exchange room.

55. The unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is test ear) do not significantly differ in their performance from the telephone operators for sentences received over the phone in the trunk exchange room.

56. The unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is the test ear) do not significantly differ in their performance from the normals for sentences received over the phone in the subscriber telephone set.

57. The unilateral conductive hearing loss subjects with hearing aid (when hearing loss ear is the test ear) do not significantly differ in their performance from the telephone operators for sentences received over the phone in the subscriber telephone set.

58. The bilateral moderate mixed hearing loss subjects with hearing aid do not significantly differ in their performance from the normals for sentences received over the phone in the trunk exchange room.

59. The bilateral moderate mixed hearing loss subjects with hearing aid perform significantly poorer than the telephone operators for sentences received over the phone in the trunk exchange room.

60. The bilateral moderate mixed hearing loss subjects with hearing aid do not significantly differ in their performance from the normals for sentences over the phone received in the subscriber telephone set.

61. The bilateral moderate mixed hearing loss subjects with hearing aid perform significantly poorer than the telephone operators for sentences received over the phone in the subscriber telephone set.

62. The bilateral moderate conductive hearing loss subjects perform significantly better for sentences received in the subscriber telephone set than in the trunk exchange room.

63. The bilateral moderate hearing loss (high frequency) subjects without hearing aid perform significantly better than the normals for sentences received over the phone in the trunk room.

64. The unilateral high frequency hearing loss subjects without hearing aid (when normal ear is test ear) perform significantly better than the normals for sentences received over the phone in the trunk exchange room.

65. The bilateral moderate high frequency hearing loss subjects without hearing aid do not significantly differ in their performance from the telephone operators for sentences received over the phone in the trunk exchange room.

66. The unilateral high frequency hearing loss subjects with hearing aid (when normal ear is the test ear) perform significantly poorer than the telephone operators for sentences received over the phone in the trunk exchange room.

67. The bilateral moderate high frequency hearing loss subjects without hearing aid do not significantly differ in their performance from the normals for sentences received over the phone in the subscriber telephone set.

68. The unilateral high frequency hearing loss subjects without hearing aid (when normal ear is test ear) do not significantly differ in their performance from the normals for sentences received over the phone in the subscriber telephone set.

69. The bilateral moderate high frequency hearing loss subject without hearing aid, do not significantly differ in performance from the telephone operators for sentences received over the phone in the subscriber telephone set.

70. The unilateral high frequency hearing loss subjects without hearing aid (when normal ear is the left ear) do not significantly differ in their performance from telephone operators for

sentences received in the subscriber telephone set.

71. For all the subjects, performance intensity function could be done while testing discrimination. The results indicated that to get maximum score PI function should be obtained since the maximum score was obtained at different levels.

72. The responses for PB lists, revealed that words containing high frequency sounds and the nasals were mostly correct.

73. The responses for sentences revealed that digits and their sequencing of telephone numbers and initials of proper nouns were mostly correct.

74. The ambient noise reaching the non-test exposed ear affects the performance of listening to telephone speech in the test ear to varying degree in the different groups

75. Experience in listening to telephone speech under noise conditions increases the vigilance of the listeners. Hence, the telephone operators perform better than the normals.

76. The performance of normal subjects may be considered as the minimum level of performance in terms of hearing efficiency essential for normals to apply for the telephone operators job.

77. The performance of normal hearing telephone operators may be considered as the optimum level of performance for hearing efficiency essential for persons to apply for operators jobs.

78. The standard speech audiometric discrimination test does not reflect the efficiency of a listener over a telephone listening in the trunk exchange room or in the subscriber telephone set, under different environmental conditions.

79. Persons who apply for telephone operators jobs should undergo a hearing test for discrimination over the telephone and must satisfy the minimum levels of performance as seen in normals. Optimum levels of performance may be preferred.

“A person who is hard of hearing obviously cannot be efficient as a telephone operator” is not true.

80 The different categories of the hearing problems react differently, when an amplified signal is fed to their ears. The amplification provided by the hearing aid is louder than the level of the signal received in the headgear set or the telephone receiver.

81. The hearing loss in the non-test ear (exposed ear) may be considered as an advantage for telephone communication as hearing loss overcomes the interference of environmental noise and competing message.

The clinical groups, therefore perform better than the normals in terms of hearing

6. Standardising the test on all the available types of telephone sets and types of net work in the country.
7. Developing headgear receiver sets, which could completely fit on body level or ear level type of hearing aids.
8. Test may be developed using conversational speech since they are more natural in all languages.

Reference

- Swarnalatha K. 1972 *"The development and standardization of speech test material in English for Indians"* M.Sc., Dissertation, Mysore University.

वक्रा श्रोता च वाक्यं च यदात्वविकलं नृप । सममेति
विवक्षायां तदासोऽर्थः प्रकाशते । वक्रव्ये तु यदा वक्रा
श्रोतारवमन्यते । स्वार्थमाह परार्थं तत्रदा वाक्यं न रोहति ॥

That in which there is agreement between it on one hand & the speaker and the listener on the other hand is communication. A speech though clear to the speaker himself if uttered without any regard for the listener, produces no impressions in the latter.

(Maha Bharata 12-320.91 to 320.92)



यस्तु वक्रा द्वयोरर्थमविरुद्धं प्रभाषते ॥
श्रोतुष्वैवात्मनश्चेव स वक्रा नेतरो नृप ॥

He alone is a speaker who employs words which expressing his own meaning are also understood by his listener.

(Maha Bharata 12-320.94)