The Development and Standardisation of Test of a 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 problem becomes 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.

For discrimination testing, conventionally PB monosyllables were used, with reference to Indian conditions. Swarnalatha (1972) had developed a PB list meant for English speaking population. Nagaraja (1973) had developed a synthetic speech identification test meant for Kannada speaking literate population. Kapur (1971) has developed discrimination testing material using disyllabic words in Telugu, Tamil and Malayalam. Abrol (1971) and De (1973) developed test material in Hindi. The above materials were developed for clinical discrimination testing in standard speech audiometry.

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 procedure for administering the test was arrived at, after a series of five pilot experiments. The PB lists and the sentences were presented live voice by a male speaker on to a subscriber telephone No. 22502. The handset of the telephone was kept in normal talking position and the intensity of the input was monitored by an SPL meter, placed such that its condensor microphone and the telephone transmitter were equidistant from the lips. The four PB lists were presented at 80 dB SPL, 90 dB SPL, 100 dB SPL and 105 dB SPL respec-

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tively. The sentences were presented at 100 dB SPL. The noise level in the send end telephone room was around 70 dB (C scale).

The test materials were received through the headgear set (ITI manufactured) in the Mysore Telephone Exchange room through the boards and in a subscriber telephone No. 20715 at the All India Institute of Speech and Hearing.

Three groups of subjects were tested—normals, telephone operators and the clinical group. The clinical group was provided with oican extra super-hearing aids wherever deemed necessary. Most of the subjects were provided with custom made ear moulds. A few of them were provided with stock ear moulds.

All the subjects were screened for their hearing in the audiometric set-up. For clinical group, the entire audiological test battery was administered. The four PB lists were presented at 10 dB, 20 dB, 30 dB and 40 dB above their SRT's ; for normals and telephone operators, it was presented at 30 dB HL, 40 dB HL, 50 dB HL and 60 dB HL. PI functions were plotted and PB max was found.

For all the groups, PI functions were also plotted for PB lists in the trunk exchange room set-up and the subscriber telephone set-up. The scores on sentence test were also found in both of these conditions. These tests were done after sufficient lapse of time to eliminate the practice effect.

The performance of these groups was compared using non-parametric statistics, *viz.*, Mann-Whitney test for independent samples and Bilcoxon signed rank test for dependent samples (Conover, 1971).

The test–retest reliability was established by computing the reliability coefficient (Carret, 1971) between test rest scores.

The following conclusions were made from the study :

1. The mean PB max for PB lists performance for normals in the trunk exchange room set-up is 50·59%. 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 max 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 standard trunk exchange room.
4. The performance of the telephone operators for PB lists 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 normals.
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 the 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 performance 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 the 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 hearing aid (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 (normal 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 subscriber telephone set than 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 phone in 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 exchange room.

64. The unilateral high frequency hearing loss subjects without hearing aid (when normal ear is the 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 the 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 subjects without hearing aid do not significantly differ in their 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 test 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 analyzed revealed that words containing high frequency sounds and the nasals were mostly correct.

73. The responses for sentences analysed revealed that digits and their

sequencing of telephone numbers and initials of proper nouns were mostly correct.

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

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

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.

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.

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.

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.

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.

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 messages.

The clinical groups, therefore, perform better than the normals in terms of hearing efficiency, *i.e.*, they suffice the optimum criteria and in some cases, even better it. Hence, these categories of hearing loss subjects may be preferred, during selection for telephone operators jobs. The results aligment rehabilitation of the hard of hearing population, as also providing for better efficiency to the telephone subscribers.

Implications of the Study

Discrimination testing over the telephone in actual environmental conditions is important to judge the hearing efficiency of a subject who is to be appointed as a telephone operator or who is already working as a telephone operator and has developed a hearing problem.

This test could be used as a speech discrimination test in all the circles, telephone districts while recruiting telephone operators and also as a periodic check up of the telephone operators who are already recruited.

This test could be administered to the hard of hearing population to find their suitability to be employed as a telephone operator.

This test could be administered by any recruiting officer, in any of the telephone exchanges.

This test suggests that persons with certain types of hearing problems with the help of a hearing aid are ideally suited to function as telephone operators in terms of hearing efficiency.

Limitations of the Study

1. This study was limited to the equipment of Mysore City.
2. It would have been better if study was conducted on more number of hearing loss subjects.
3. Strict control on environmental noise could not be achieved because of practical problems. However, the time of listening and overall noise level were taken into account as far as possible.
4. Test–retest reliability testing could not be done in most of the subjects of the clinical population due to their non-availability.

Recommendations for Further Research

1. Standardising the test on larger clinical and normal population.
2. Standardising the test at various trunk exchanges of the country.
3. Developing synthetic sentence test materials for discrimination testing over the phone in different languages.
4. Standardising the test using standardising monosyllabic lists in various regional languages.
5. Standardising the test on long distance national and international trunk net works.
6. Standardising the test on all the available types of telephone sets and types of network in the country.
7. Developing headgear receiver sets, which could completely fit on body level or car level type of hearing aids.
8. Test may be developed using conversational speech since they are more natural in all languages.