THE DEVELOPMENT AND STANDARDIZATION OF SPEECH TEST MATERIAL IN ENGLISH FOR INDIANS*

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Speech audiometry is an important element in the battery of audiometric tests. It has come into existence because of some inherent disadvantages in pure-tone audiometry. Though pure-tones are physically and mathematically simple and are easy to present, they are relatively uncommon and unimportant. Moreover pure-tone audiometry does not provide information about the person's ability to hear above the threshold. On the other hand speech audiometry helps in earlier detection of slight losses otherwise overlooked and provides better documentation of initial and slight going after therapy. It helps in a better assessment of differences among hearing aids. Also, in cases of high frequency loss and non-organic losses speech audiometry. Moreover, it can be used to determine the patient's ability to perform at supra-threshold levels, and to determine his social adequacy index. The need for speech audiometry arises mainly because speech is by far the most important class of sounds those are heard. Measurement of speech discrimination and speech reception threshold are " useful in reading the qualitative estimate of the outcome of surgery of potential for hearing aid use, of relative efficiency with different instruments, and of phonemic perception in everyday life " (Carhart, 1965.)

Speech tests in Indian languages (Hindi, Tamil, Telugu and Malayalam) are already available. Tests in other Indian languages are at present being made up. As an interim measure the standardized tests in English have been used with English knowing Indians. However, pilot studies (Nikam, 1968) have indicated that the available tests may not be wholly suitable to Indian populations because many words in the test are unfamiliar to us and this can affect performance Hence, here an attempt is made to modify the existing speech lists, to suit our conditions.

The purpose of the study was ; (1) to modify available English lists, (2) to standardize them to suit our conditions, (3) to help further research on these lines, (4) to compare the results of these tests with those of speech audiometry tests already available and (5) to compare them with studies in Indian languages.

Test materials (monosyllabic and disyllabic words) from speech tests that were already available in English were subjected to familiarity test on Indian population. The elected monosyllabic words were phonetically balanced. Test materials were presented at various intensities and the number of correct responses given by the subject were analysed. Articulation curves were plotted and speech reception threshold and the level at which are hundred per cent of the monosyllabic words were correctly discriminated were obtained.

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Methodology

The three tests which comprised the study were administered serially to individual subjects. They were to obtain pure-tone threshold test and speech discrimination tests were administered randomly at various levels of intensity with respect to subjects. All tests were administered in acoustically treated rooms.

There were three aspect to this study:

1. Procedure for obtaining test materials;
2. Procedure for obtaining SRT and
3. Procedure for obtaining speech discrimination scores.

Procedure for obtaining test materials

Procedure for Familiarity.

Materials :

In the development of SRT Test for adults eighty four words from Psycho-Acoustic laboratories Auditory test No. 9 and No. 14 were used. Fifty seven words of children's spondee list were used for children.

For speech discrimination tests with adults, 200 monosyllabic words of PAL and another 200 monosyllabic words of CID Auditory test W-22 were combined and used after eliminating the common words in the two tests. For developing the children's speech discrimination test one hundred and fifty monosyllabic words of kindergarten PB word lists developed by Haskine H.L. (1949) were used.

Subject : 200 graduate and post-graduate students in an age range of 16 to 25 years with mean age of 20 years and two hundred school going children in an age range of 7 to 15 years with a mean age of 12 years were selected for familiarity rating. All were of normal intelligence and knew English.

Procedure : The spondee and monosyllabic lists both for children and for adults were cyclostyled. After the purpose of the test was explained, the subjects were asked to rate the words as ' familiar ' ; ' not so familiar ' and ' not familiar.' The responses of all the subjects were evaluated by weighted scores. The words were arranged in the order of familiarity. One hundred and seventy five most familiar words were selected. This list was used as a starting point for standardization of SRT tests. The final spondee lists for adults and children had fifty and seventy five words respectively. Monosyllabic word lists for both adults and children were finalised after phonetically balancing them. The final PB lists for adults and children had fifty words each (two lists of 25 words in each list).

Phonetic balancing of the monosyllabic words :

All monosyllabic words were written in IPA. Fletcher's (1965) analysis of telephone conversation and the frequency of occurrence of English phonemes as given by him were used. This was necessary because, (*a*) no Indian data was available, (Tickoo, 1972, personal communication), (*b*) no data using conversation was available and (*c*) Hirsh et al., (1952.) had used data obtained from telephone conversations. A frequency count of all the phonemes (vowels and consonants) in the monosyllabic word list was made on the basis of Fletcher's tables. Relative frequency of occurrence of English Speech sounds in these lists were adjusted by selective elimination of a few words. These results were found to be in close correspondence with the frequeney of occurrence given by Fletcher (1965).

Finally, there were four monosyllabic word lists which were phonetically balanced, two lists of equal familiarity for adults and two lists of equal familiarity for children. Equal familiarity in the two lists was ensured by selecting the mono-syllabic words randomly from the original lists. The weighted scores of the selected words in each list were totalled and they were found to be equal in the two lists.

Recording Procedure :

The lists were recorded in a sound treated room using a UHER variocord 263 tape recorder with four tracks and stereo/mono-arrangement. Recording was done only in mono at three and three fourth inches per second speed. In the recording of test material a 21 years old female, who had four years experience in the monitore vive-voice technique of speech audiometry, spoke the test items. All the test items, both for adults and for children, were recorded preceded by a carrier phrase " say the word. " A time interval of five seconds was allowed for the subject to respond.

Equipment and Acoustic Environment.

A calibrated Madsen model OB 70 diagnostic Speech Audiometer and UHER four track, mono/stereo tape recorder were used for the purpose of administration. A talk-back system was used for subjects' responses.

The study was conducted in a sound treated environment, a two-room set up, of which one served as a control room and the other as a test room.

Test Procedure

For the purpose of standardization of speech tests with adults, 55 subjects in an age range of 16 to 25 years, with a mean age of 20 years, were selected. All the subjects had minimum

education of Pre-University. Fifty six school going children in an age range of 7 to 15 years with a mean age of 12 years, were selected for standardization of speech tests with children. All of them had normal intelligence and normal hearing acuity. The ratio of male to female subjects was 1 : 1, both for adults and children. All of them passed an otological examination and had normal air-conduction pure-tone audiograms.

Procedure for obtaining Speech Reception Threshold

For the administration of SRT tests, the instructions given by Glorig (1965) were made use of extensively both with adults and children.

Using the two lists of 25 words each for adults, each subject was tested only at one intensity once in the right ear using the list I and then in the left ear using the list II at a different intensity. The intensities at which the lists were presented varied from 0 to 35 dB at intervals of 5 dB above pure-tone average of each subject. Instructions were given to every subject and then the test items were fed from tape to him at a pre-determined intensity level. A time gap of 2 seconds was given to the subject to respond. Responses were noted down.

In the case of children, as there was only one word list, the test was administered to the right ear only. Otherwise, the procedure was same as that for adults.

Procedure for obtaining Speech Discrimination Scores

Here again, instructions given by Glorig (1965) were used extensively to instruct both adults and children while obtaining discrimination scores.

For adults two phonetically balanced monosyllabic word lists of twenty five items each were used. Each subject was tested only at one intensity, once in the right ear using the list II at a different intensity. The intensities at which the lists were administered ranged from 0 to 50 dB, in 5 dB intervals, above the subjects' PTA. Each subject was given instructions and then the test items where presented at determind intensity level. Responses were noted down. For children also there were two phonetically balanced monosyllabic lists of 25 items each. The test procedure was similar to that of the adults.

Practice effect was controlled in obtaining SRT and discrimination scores by administering each list only to each subject.

Recording of Responses

A talk back system was used for recording the subject's responses. The number of correct responses given by each subject, for each list, were noted down. These were then converted into percentage of correct responses at each intensity level for further analysis.

Plan of Analysis

The familiarity ratings of the monosyllabic and disyllabic words given by the adults and children were analyzed for selecting the most familiar words. Then the test words were divided into half word lists randomly. The selected monosyllabic words were phonetically balanced. The familiarity scores of the words in each half list were totalled to make certain whether or not the two lists are equivalent in level of difficulty.

The mean and the standard deviation values of the percentage of correct responses were calculated for each list. Articulation curves were plotted and from the graphs the SRT and the intensity levels at which one hundred per cent discrimination score were given/have/ determined.

A few subjects, adults and children from the original sample were randomly selected and they have retested to find out the test-retest reliability.

Analysis and Results

For the analysis of the familiarity of the monosyllabic and disyllabic words, scores of +3, +1 and —1 were given to each word on the basis of whether it is ' familiar,' 'not so familiar', or ' not familiar '. The ratings made by the subjects were quantified using the above scores words necessary for forming the test lists were selected from among the most familiar words. In dividing the familiar words into two 25 word lists all the words were numbered and 25 words for each list were selected randomly.

For phonetically balancing the monosyllabic word lists the words were written in IPA and a frequency count of all the phonemes were made in each 25 word list. These frequencies were compared with the frequency count made by Fletcher (1965) using telephone conversations, and with the frequeney count given by Hirsh et al., (1952) using W-22 lists. By selective inclusion and exclusion of some familiar words, the frequency count of the phonemes in the present study were found to be approximately the same as given by Fleteher (1965) and Hirsh et al., (1952). To make sure that the two lists were of equal difficulty weighted scores of all the words in each list were totalled. The total scores in the two lists have found to be approximately scores when the two equivalent lists have compared in the case of adults and children.

The percentage of correct responses, their means and standard deviations at various intensity levels were obtained both in the case of adults and children.

A comparison of the standard deviations obtained by Tillman and Carhart (1966) with N. U. Auditory Test No. 6, (Phonetically balanced CNC monosyllabic words), for subjects with normal hearing, was made with the standard deviations obtained in this study using phonetically balanced monosyllabic word list I and II for adults and children.

Figure 1 graphically shows the comparison of mean articulation scores obtained with adults at different intensity levels (re : PTA 10 dB) using two spondee word list I and II and figure 2 graphically shows the mean articulation scores obtained with adults at different intensity levels (re : PTA, 10 dB) using two phonetically balanced monosyllabic word list I and II.

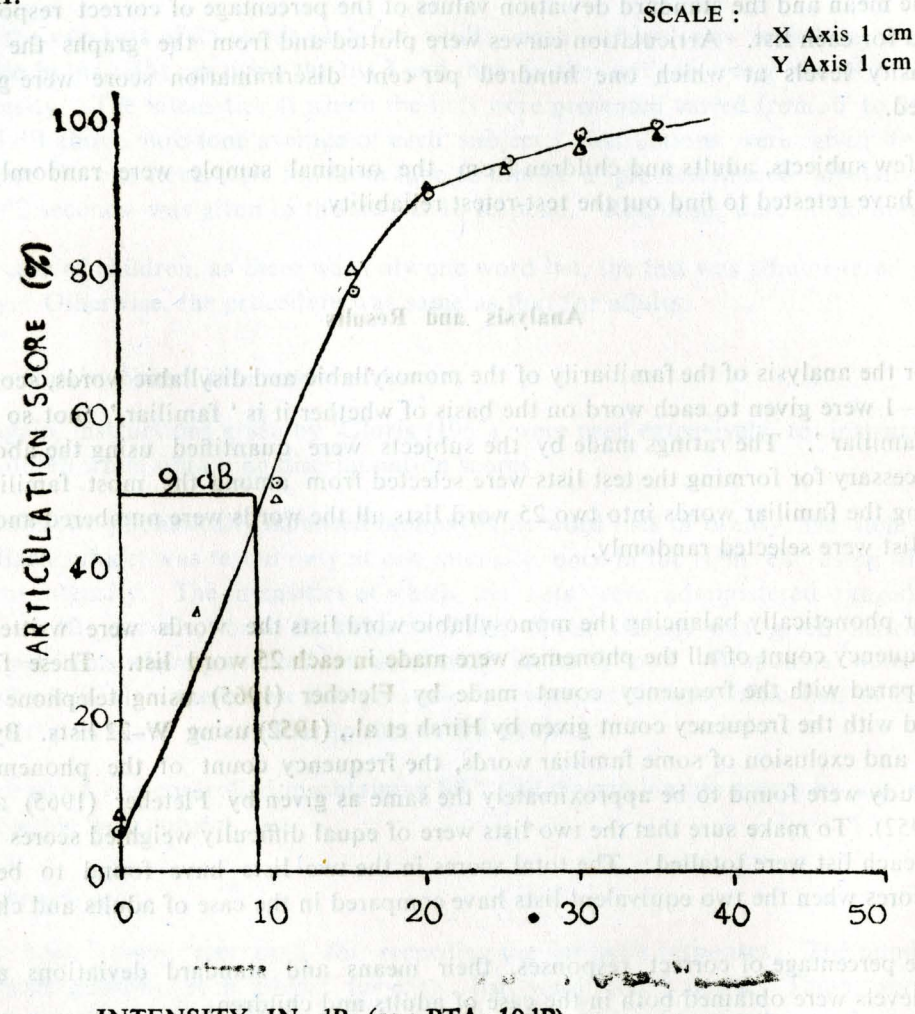

Fig. 1 Graph showing mean articulatory scores at different intensity levels (re : PTA, 10dB) obtained with adults using spondee word list I

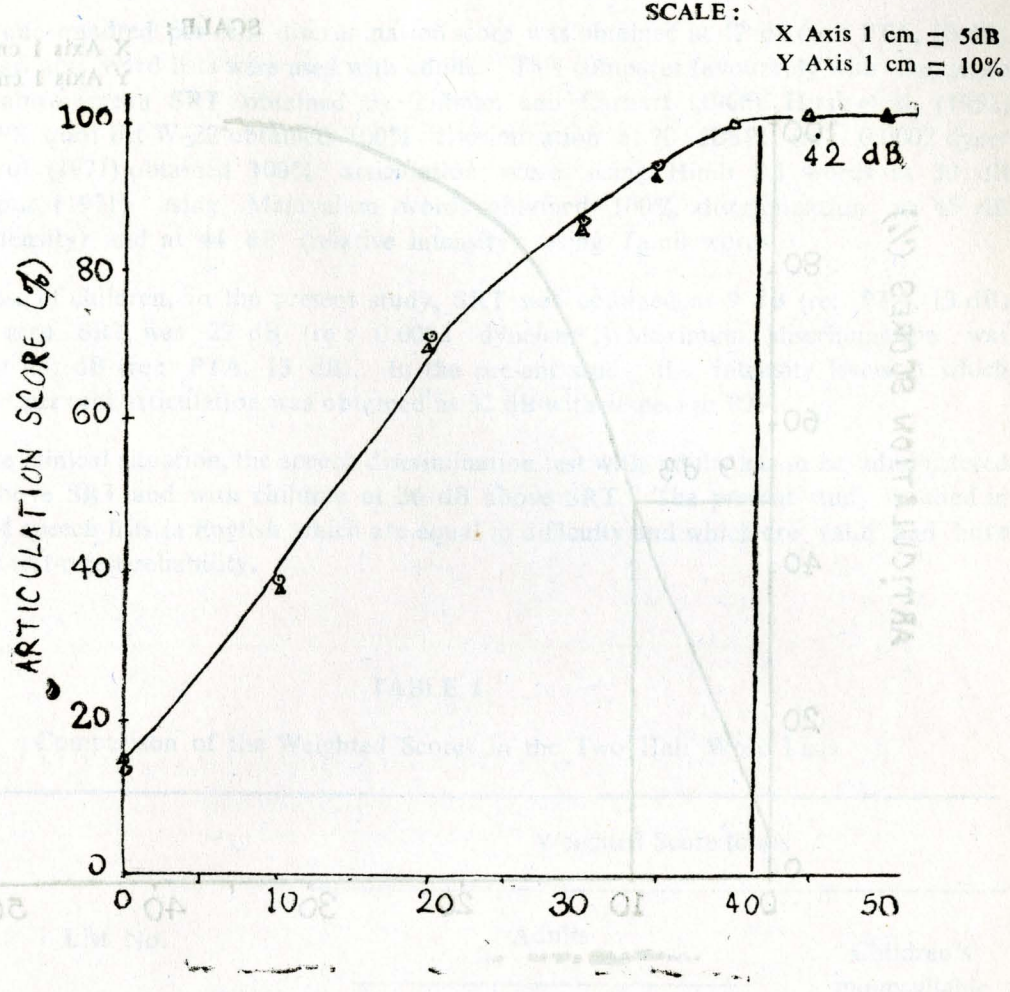

Fig. 2 : Graph showing mean articulation scores obtained with adults at different intensity levels (re : PTA, 10 dB) using phonetically balanced monosyllabic word list I.

Figure 3, graphically shows mean articulation scores obtained with children at different intensity levels (re : PTA, 13 dB) using spondee word list and figure 4, graphically shows the comparison of mean articulation scores obtained with children at different intensity levels (re : PTA, 13 dB) using phonetically balanced monosyllabic word list I and II.

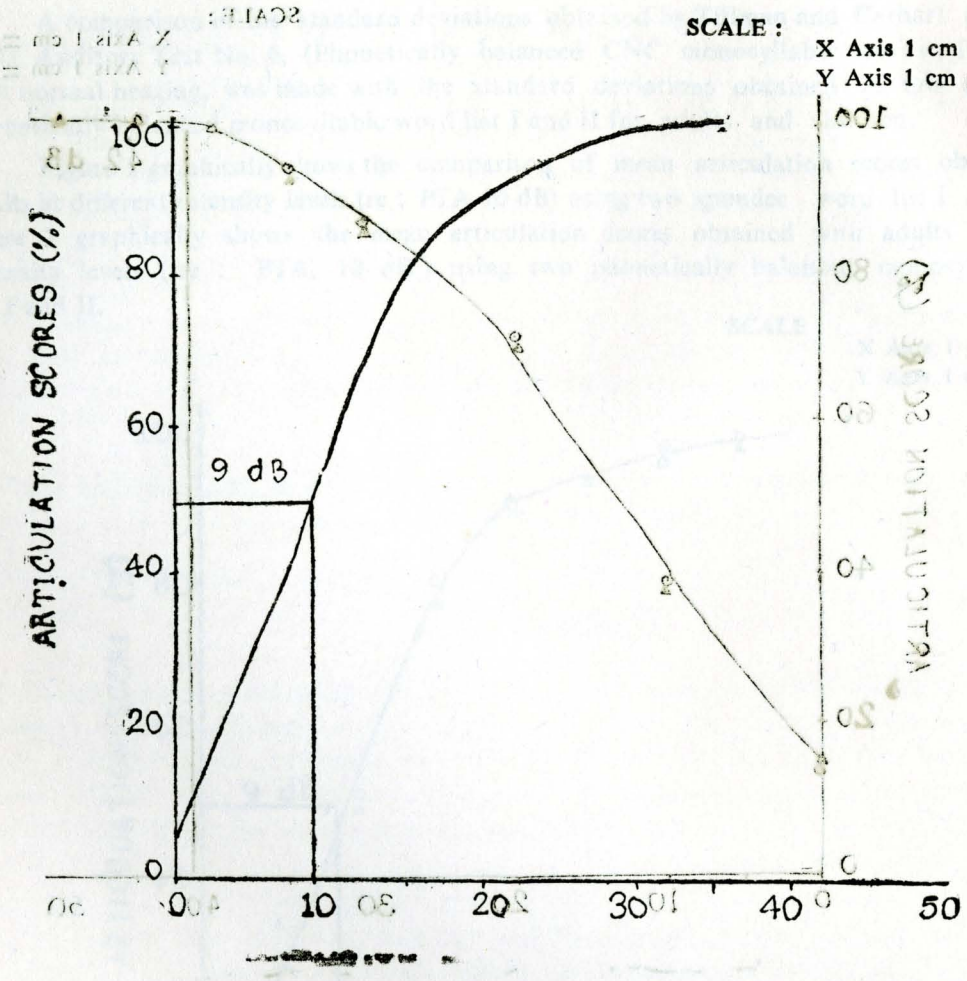

Fig. 3 : Graph showing mean articulation scores obtained with childern at different intensity levels (re : PTA, 13 dB) using spondee word list.

Results

The value of SRT obtained using adult subjects were 9 dB (re : PTA, 10 dB) i.e , the mean zero SRT for adults was 19 dB (re : 0.0002 dyne/cm^2). The SRT obtained by Hirsh et al., (1952) using W-2 list was 18 dB. American Standards Association for Speech Audiometry specified that zero hearin g level of 22 dB (re : 0.0002 dyne/cm^2) with allowable limits for calibration being $\pm$ 4 dB.

The one hundred per cent discrimination score was obtained at 42 dB (re : PTA, 10 dB) when monosyllabic word lists were used with adults. This compares favourably with the score of 32 dB above mean SRT obtained by Tillman and Carhart (1966). Hirsh et al., (1952) using CID PB word list W–22 obtained 100% discrimination at 70 dBSPL (re ; 0.0002 dyne/cm ^{2}). Abrol (1971) obtained 100% articulation score using Hindi PB words at 30 dB SRT. Kapur (1971) using Malayalam words obtained 100% discrimination at 45 dB (relative intensity) and at 44 dB (relative intensity) using Tamil words.

In case of children, in the present study, SRT was obtained at 9 dB (re: PTA, 13 dB) i.e., Mean zero SRT was 22 dB (re : 0.0002 dyne/cm^2.) Maximum discrimination was obtained at 45 dB (re : PTA, 13 dB). In the present study the intensity levels at which one hundred per cent articulation was obtained at 32 dB with respect to PTA.

In the clinical situation, the speech discrimination test with adults has to be administered at 33 dB above SRT and with children at 36 dB above SRT. The present study resulted in standardized speech lists in English which are equal in difficulty and which are valid and have a significant test-retest-reliability.

TABLE I

Comparison of the Weighted Scores in the Two Half Word Lists

Sl. No.	List No.	Weighted Score totals		
		Adults		Children's monosyllable word list
		Monosyllabic word lists	Disyllabic word lists	
1.	I	8968	7068	9249
2.	II	8974	7085	9240

P.S : In the case of children only one disyllabic word list was developed and hence no comparison could be made with a second list.

TABLE II

Percentage of correct responses, their Means and S.Ds obtained using Adult's Spondee Words List I at various Intensity Levels

Sl. No.	Intensity in dB re PTA (10dB)	Percentage of correct responses							Mean	S.D
		A	B	C	D	E	F	G		
1	0	0	12	0	16	8	0	4	6	6.0
2	5	48	44	40	36	24	28	44	38	8.2
3	10	60	48	56	48	52	48	52	52	4.3
4	15	80	88	76	80	68	84	64	77	7.9
5	20	80	84	100	88	96	88	92	90	6.4
6	25	92	84	88	100	100	96	92	93	5.6
7	30	96	92	100	100	100	100	96	98	2.9
8	35	96	100	100	100	100	96	100	99	1.8

TABLE III

Percentage of correct responses, their Means and S.Ds obtained using Adult's Spondee Words List II at various Intensity Levels

Sl. No.	Intensity in dB re : PTA (10dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	12	4	8	0	12	12	8	8	4.3
2	5	40	44	28	40	36	48	32	38	6.4
3	10	52	56	48	44	44	56	50	50	4.7
4	15	68	84	80	92	92	80	64	80	10.0
5	20	92	100	80	92	88	96	92	91	5.8
6	25	88	100	100	96	96	92	88	94	5.2
7	30	96	92	100	92	100	96	96	96	3.0
8	35	94	96	100	96	100	100	96	98	2.4

TABLE V

Percentage of correct responses, their Means and S.Ds obtained Using Adult's PB-Words List II at various Intensity Levels

Sl. No.	Intensity in dB re ; PTA (10dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	20	12	20	16	8	16	12	15	4.1
2	10	40	32	28	52	40	48	28	38	8.8
3	20	76	60	64	60	76	72	68	70	6.7
4	30	92	88	96	80	84	60	84	85	7.8
5	35	84	92	88	96	96	92	96	92	4.3
6	40	100	100	100	100	96	100	100	99	1.4
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE VI

Percentage of correct responses, their Means and S.Ds. obtained using Children's Spondee Words List at various Intensities

Sl. No.	Intensity in dB re ; PTA (13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	12	18	0	4	8	0	8	6	4.2
2	5	40	32	44	28	48	40	44	40	6.6
3	10	56	52	60	48	52	60	44	53	5.6
4	15	92	88	72	84	88	76	76	82	7.1
5	20	88	92	100	96	96	80	84	91	6.6
6	25	96	100	100	96	92	92	96	96	3.0
7	30	100	96	96	100	100	100	100	99	1.8
8	35	100	100	96	100	96	100	100	99	1.8

TABLE IV

Percentage of correct responses, their Means and S.Ds obtained using Adult's PB-Word List I at various Intensity Levels

S.l No.	Intensity in dB re ; PTA (10dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	20	16	20	16	12	16	12	14	3.6
2	10	40	32	28	52	36	48	36	39	7.5
3	20	76	76	56	60	80	76	76	71	8.7
4	30	92	84	96	76	88	88	80	86	6.4
5	35	96	92	84	92	96	96	92	93	4.0
6	40	100	96	100	100	100	96	100	99	1.8
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE VII

Percentage of correct responses, their Means and S.Ds obtained using Children's PB-Word List I at various Intensity Levels

Sl. No.	Intensity in dB re ; PTA (13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	4	4	12	8	4	4	12	6	3.6
2	10	24	32	40	32	42	28	24	24	6.6
3	20	44	44	60	48	60	48	52	51	6.3
4	30	72	68	80	72	76	88	88	78	7.4
5	35	92	80	88	84	88	80	80	85	4.5
6	40	96	100	96	88	88	92	96	94	4.2
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE VIII

Percentage of correct responses, their Means and S.Ds obtained using PB-Word List II at various Intensity Levels

Sl. No.	Intensity in dB re : PTA (13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	12	4	8	12	4	4	4	7	3.5
2	10	32	32	28	20	36	40	28	31	5.9
3	20	52	44	52	40	64	48	56	51	7.3
4	30	68	84	76	72	76	72	80	76	5.0
5	35	92	82	84	88	84	84	92	87	3.5
6	40	96	100	96	92	96	100	92	96	3.0
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE IX

Standard Deviations obtained by Tillman and Carhart (1966) using CNC words are compared with the Standard Deviations in the present study using Monosyllabic words

Sl. No.	Level of presentation of test words re : PTA *	Standard Deviations obtained in the present study				Sensation level of presentation re : 21.9 dB SPL	Standard Deviation reported by Tillman & Carhart (1966)			
		Adults		Children						
		List I	List II	List I	List II		List I	List II	List I	List II
1	0	3.6	4.1	3.6	3.5	–4	8.2	9.8	5.9	7.7
2	10	7.5	8.8	6.6	5.9	0	14.1	16.1	10.8	15.3
3	20	8.7	6.7	6.3	7.3	8	14.3	12.1	9.4	10.6
4	30	6.4	7.8	7.4	5.0	16	10.6	7.2	5.3	6.1
5	35	4.0	4.3	4.5	3.5	24	5.2	2.8	8.1	2.8
6	40	1.8	1.4	4.2	3.0	32	3.8	1.5	1.0	2.4
7	45	0.0	0.0	0 0	0.0	—	—	—	—	—
8	50	0.0	0.0	0.0	0.0	—	—	—	—	—

*Mean PTA of adults is 10 dB and of children is 13 dB.

Limitations of the present study.

1. The study was restricted to the Mysore population only.

2. Only School going children and College going adults who knew English were included in the study.

3. Even though different lists were presented at different intensities to different ears of 56 subjects, the 'total' number of subjects would tantamount to testing about 7 subjects with seven different lists. The testing procedure was selected to adequately avoid the effect of practice which it was felt that the earlier studies in India and abroad had not done. The tantamount number of seven compared favourably with the six subjects used by Hirsh et al.

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