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OF
THE MEASUREMENT OF IMPROVEMENT IN SPEECH HEARING GIVEN
BY HEARING AIDS AND ITS RELATION TO HEARING AID USE

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INTRODUCTION :

This is a preliminary study of the way elderly people in particular hearing loss categories use hearing aids. The aim was to develop a procedure to measure objectively the improvement in speech hearing achieved with a hearing aid and to relate such measurements to other variables such as amount of use of the aid.

PROCEDURE :

The study takes the form of a follow-up of 45 hearing-aid fittings. Cases were selected from the files at the New South Wales Branch laboratory, in the category of patients referred by the Repatriation Department (either ex-servicemen or war widows) and subsequently fitted with Calaid hearing aids, either in-the-ear aids (Calaid E) or small body-worn aids (Calaid T). Cases were selected who were 60 years of age and older and whose last pure-tone audiogram conformed to one of four standard patterns.

Subjects were asked to come for a follow-up test of their hearing using the aid. The sample of 45 represents about half the number of such requests made.

Subjects were interviewed about the use of the hearing aid and the particular situations in which they found its use beneficial. An attempt was made in each case to assess the subject's attitude towards the hearing aid and his competence in its use and management.

In most cases recent pure-tone audiograms were available. Where necessary, pure tone thresholds were re-determined. The four categories of audiograms "spread" on retest, and are less

obviously distinct from each other than the audiograms originally available. Fig. 1 shows the most recent audiograms in each category superimposed and may be taken to define the four categories.

The material used to test hearing for speech was the set of sentence-lists developed by Fry (2). There are 10 lists, each of 25 sentences. They were read by the same trained speaker as the C.A.L. PBM lists (John West of the Australian Broadcasting Commission) and recorded on tape cartridges.

Subjects were asked to repeat the sentences they heard or as much of it as they could, guessing where necessary. Each sentence was scored right or wrong, but minor errors, in tense or number, say, were disregarded. For example, for the item "The labourer loads the lorry" the response "A labourer loaded a lorry" would be scored right but "The labourer drove the lorry" would be scored wrong.

The sentences were presented free field, through one of two speakers 4' apart and 4' behind the subject, and the level of presentations adjusted in 5dB steps after each response, increasing the level after a wrong response, decreasing it after a right response. The scoring record of this procedure looks rather like a Bekesy audiogram and a "speech threshold" can be read from it approximately by eye or more exactly by averaging the peaks. The procedure has since been standardised for telephone listening conditions (Dudley 1968)

This procedure was repeated under four conditions for each subject:

1. Without the aid, in quiet conditions.
2. Without the aid, with a competing noise from the other speaker.

3. Wearing the hearing aid on the preferred setting, in quiet conditions.
4. Wearing the hearing aid on the preferred setting, with the competing noise from the other speaker.

The subject was allowed to turn his head to take advantage of directional hearing, but not to lean towards the speaker. The unaided ear was not occluded. The noise used was derived from a tape made to simulate Navy shipboard noise. It was a multiple recording made by superimposing 8 tape loops. The noise sounds like a lot of people talking at once, but no words are distinguishable. The overall level of the noise measured at the position of the subject's head is 65 dB SPL ("A" Weighting)

From the four speech thresholds for each subject, two different scores were obtained, corresponding to the improvement in speech thresholds when wearing the hearing aid in the two conditions, quiet and constant noise.

On the basis of the interview and the test record, each subject was classified as either a successful hearing aid user or an unsuccessful user. For success, the following four criteria had to be met:-

1. The subject must wear the hearing aid in a variety of situations and report some benefit from it.
2. The speech tests must show an improvement in speech thresholds in quiet, at least.
3. The subjects must exhibit an acceptance of the hearing aid in the same way we would expect him to accept spectacles; in particular, he must be willing to wear the aid in public.
4. The subject must be reasonably competent at managing the aid, i.e. keeping it clean, changing batteries, etc.

RESULTS : -

The results are summarised in Table 1.

(1) Use of the Hearing Aid.

There were four more or less distinct patterns of hearing-aid use evident in the sample:

- (a) The constant user wears the hearing aid as a matter of course, putting it on in the morning and taking it off at night - 9 cases
- (b) The selective user wears the aid in a variety of situations where he believes it helps him, turning it off or taking it out of the ear at other times - 16 cases.
- (c) The occasional user uses the aid only for watching television or possibly held in the hand at a meeting. He cannot be said to wear the aid - 10 cases.
- (d) The non-user may experiment with the aid on rare occasions, but does not experience any worthwhile benefit - 10 cases.

(2) Speech Hearing

The median improvement in speech reception threshold when using the aid over the whole sample was 8dB for the quiet condition and 1dB for the noisy condition. Subjects with "Type D" audiograms - flat losses of about 45dB - tend to show greater improvements under both conditions.

There is no difference evident in this sample between the improvement given by the two types of hearing-aids, in-the-ear and body-worn. It should be noted however, that the tests were carried out with the gain controls on the aids at the setting customarily used by the subject, or for non-users or those who had been wearing non-functional aids at the setting preferred in the test situations; this setting was in all cases well below the maximum.

(3) Attitudes towards wearing a hearing aid.

The subject were asked what they thought about the appearance of the aid and whether they felt embarrassed about wearing the aid in public. 33 of the 45 subjects expressed no concern or embarrassment about the appearance of the aid, and if they did not wear the aid it was for some other reason. Of the 12 who expressed some dissatisfaction with the appearance of the aid, 10 had body-worn aids and 2 had in-the-ear aids. There were 25 subjects with body-worn aids in the sample and 20 with in-the-ear aids).

Only two subjects (both with body-worn aids) expressed strong feelings against the appearance of the aid, but these were "non-users" as defined above, for other reasons.

(4) Competence in Managing Aid.

33 of the 45 subjects managed the aid competently without assistance, putting the aid on, changing batteries, keeping the mould clean and so on.

The other 12 showed varying degrees of difficulty. 3 subjects, 19, 27 and 44 were wearing in-the-ear aids which were not functioning without apparently being aware of this, one, Subject 12, had always used his body-worn aid switched to "coil" instead of "mic", 8 had difficulties with the mould, but 6 of these were non-users whose difficulties could be attributed to lack of practice.

(5) Success of the Hearing-Aid Fitting.

The 10 occasional users and the 10 non-users were automatically classified as unsuccessful hearing aid fittings.

Of the 9 constant users, 2 wore aids which had not worked for some time, although they believed they got some benefit from the constant use of

the aid. The man who always used the aid switched to "coil" was also a constant user. Another constant user, Subject 8, suffered the hearing-aid only at his wife's insistence, and there was no demonstrable improvement in speech hearing when the aid was worn. These 4 were classified as unsuccessful fittings, leaving 5 successful constant hearing-aid users.

Of the 16 "selective" users, 4 were shown to hear speech as well or better without the hearing aid under the test conditions and were therefore classified as unsuccessful fittings, leaving 12 successful selective hearing aid users, a total of 17 successful users in a sample of 45.

If the requirement for an improvement in speech hearing when using the hearing aid is omitted from the criterion for success, the number of "successes" rises to 21. Comparing this group of 21 with the remaining 24 with respect to improvement scores in either the quiet or noisy test conditions shows no differences approaching significance.

There is, expectedly, a higher success rate among the subjects who had been issued with an ear-level aid (11 out of 20) compared with those with a body-worn aid (6 out of 25) although as noted above, there was no difference in the performance of these two groups on the speech hearing tests.

6. Pure tone Hearing.

The data points corresponding to the three categories of hearing aid success (successful fittings, successful apart from speech tests, unsuccessful) are shown by different symbols in Fig 2. It seems likely that success, according to our criteria should be related to hearing loss

as measured by pure-tone audiometry or by our speech-hearing tests.

Inspection of the distribution of the different symbols on the scattergram indicates this is not so in this restricted sample.

DISCUSSION.

This was a small selected group. The results obtained do not apply strictly to the larger population of hearing impaired elderly people. We consider however that the conclusions which follow apply to about half of the people in the age group 60 and over who present with a hearing problem.

The speech hearing tests used in this study proved to be fairly simple to administer and score and acceptable as valid by the subject. The situation simulated by the test is that of a mainly one-way conversation in which the speaker adjusts the level of his voice, according to the listener's responses, to the level where an acceptable proportion of what he says is understood. In this situation, the benefit given by the hearing aid is experienced by the speaker as a decrease in the effort of speaking required. This difference, measured in dB, seems a plausible measure of the benefit given by the aid. However, these differences are shown to be unexpectedly small in quiet listening conditions, and usually insignificant in a moderate noise background. Moreover, differences are not related to other criteria of "success" in using a hearing aid. There are thus two opposing problems:-

1. Given that so little measurable benefit is obtained from the aid in many circumstances; why is it nevertheless so often worn?
2. Given that so much measurable benefit is obtained from the aid in many circumstances; why is it nevertheless so often not worn?

It is evident that there are other rewards experienced by the hearing-aid user apart from the measured improvement in speech communications. The identification of these rewards is probably a psychological problem akin to market research. Similarly, it is evident that there are reasons for not wearing hearing aids apart from the more obvious reasons investigated here, and shown to have little or no bearing on the success or failure of the fitting procedure.

Thus the two problems stated are not solved by this study, nor can any clear path to a solution be seen. The implication of these negative findings is this; that among a fairly large "borderline hearing-aid fitting" group, we may make reliable and meaningful measurements of the individual differences in speech hearing tasks and objective improvement in speech hearing tasks using a hearing-aid, but this information is of no apparent value in predicting the way in which the person receiving the hearing-aid will use it.

SUMMARY :

45 people of 60 years of age and older who had been supplied with hearing aids were interviewed about their use of the aids. The improvements in speech hearing thresholds when wearing the aid were measured using a technique developed for the purpose. The improvements achieved were usually small (median 8dB in quiet, 1dB in presence of noise at 65dB SPL) and were not related to other criteria for "successful" hearing-aid use.

REFERENCES :

1. Dudley, P.F. The Development of a Speech Hearing Test using Recorded Sentences, C.A.L. Internal Report No. 5 (1968)
2. Fry, D. R. Word and Sentence Tests for use in Speech Audiometry Lancet 2, 197-199 (1961)

Audiogram Category	Subject	Sex	Age	Aid Type	TH1000			TH1000			TH1000			Use Category	Adverse Attitudes	Difficulty in Managing Aid	Success
					Aided	Unaided	Diff.	Aided	Unaided	Diff.	Aided	Unaided	Diff.				
A	1	F	79	P	25	25	61	59	2	67	71	-4	H	H	H		
	3	F	73	P	20	26	54	57	3	68	67	1	H	H	H		
	7	F	74	P	26	55	60	49	11	69	69	0	H	H	H		
	15	M	73	P	30	30	58	45	13	66	66	0	H	H	H		
	21	M	79	P	30	75	68	57	11	69	69	0	H	H	H		
	30	M	67	P	20	50	73	73	0	73	73	0	H	H	H		
	31	M	80	P	25	25	62	56	6	72	70	2	H	H	H		
	36	M	69	P	25	45	73	62	11	76	73	3	H	H	H		
	37	M	60	P	30	40	63	67	4	69	69	0	H	H	H		
	41	F	66	P	35	40	72	62	10	72	69	3	H	H	H		
44	F	81	P	25	30	67	60	7	73	74	-1	H	H	H			
B	2	M	72	P	35	40	63	60	3	72	69	3	O	X	H		
	5	M	70	P	25	30	69	59	10	74	70	4	O	X	H		
	6	M	75	P	30	30	59	59	0	64	71	-7	O	X	H		
	12	M	70	P	40	40	87	63	24	80	73	7	O	X	H		
	17	M	63	P	20	20	74	58	16	76	72	4	O	X	H		
	22	M	69	P	30	30	83	79	4	83	82	1	O	X	H		
	23	M	73	P	20	30	61	51	10	71	71	0	O	X	H		
	24	M	73	P	45	45	76	61	15	79	72	7	O	X	H		
	26	M	73	P	30	30	64	68	4	71	75	-4	O	X	H		
	27	M	81	P	40	50	72	63	9	73	72	1	O	X	H		
	29	M	68	P	25	25	60	53	7	72	68	4	O	X	H		
	32	M	70	P	30	40	63	46	17	66	62	4	O	X	H		
	33	M	72	P	30	30	64	52	12	69	71	-2	O	X	H		
	38	M	72	P	35	30	60	52	8	73	68	5	O	X	H		
39	M	64	P	30	100	74	57	17	60	71	-11	O	X	H			
40	M	76	P	30	15	64	64	0	73	72	1	O	X	H			
C	4	M	73	P	40	40	65	75	-10	75	76	-1	H	X	H		
	10	M	60	P	40	30	71	63	8	70	69	1	H	X	H		
	14	M	71	P	30	45	69	61	8	70	79	-9	H	X	H		
	19	M	78	P	30	25	59	56	3	72	71	1	H	X	H		
	20	M	77	P	35	35	69	69	0	75	73	2	H	X	H		
	25	M	72	P	40	30	59	48	11	65	66	-1	H	X	H		
	28	M	73	P	30	35	69	69	0	76	79	-3	H	X	H		
	34	M	64	P	40	25	58	64	-6	60	68	-8	H	X	H		
	35	M	69	P	35	35	69	59	10	71	74	-3	H	X	H		
	45	M	70	P	40	40	68	60	8	71	71	0	H	X	H		
D	6	F	64	P	45	40	95	81	14	95	85	10	O	X	H		
	9	F	71	P	40	40	77	68	9	79	73	6	O	X	H		
	11	M	66	P	50	35	79	76	3	81	82	-1	O	X	H		
	13	M	60	P	40	30	51	42	9	68	66	2	O	X	H		
	16	M	67	P	40	30	66	56	10	71	67	4	O	X	H		
	18	M	65	P	50	45	75	67	8	68	60	8	O	X	H		
	42	F	79	P	35	30	69	60	9	73	65	8	O	X	H		
	43	M	72	P	45	30	82	66	16	81	75	6	O	X	H		

TABLE 1. SUMMARY OF RESULTS.

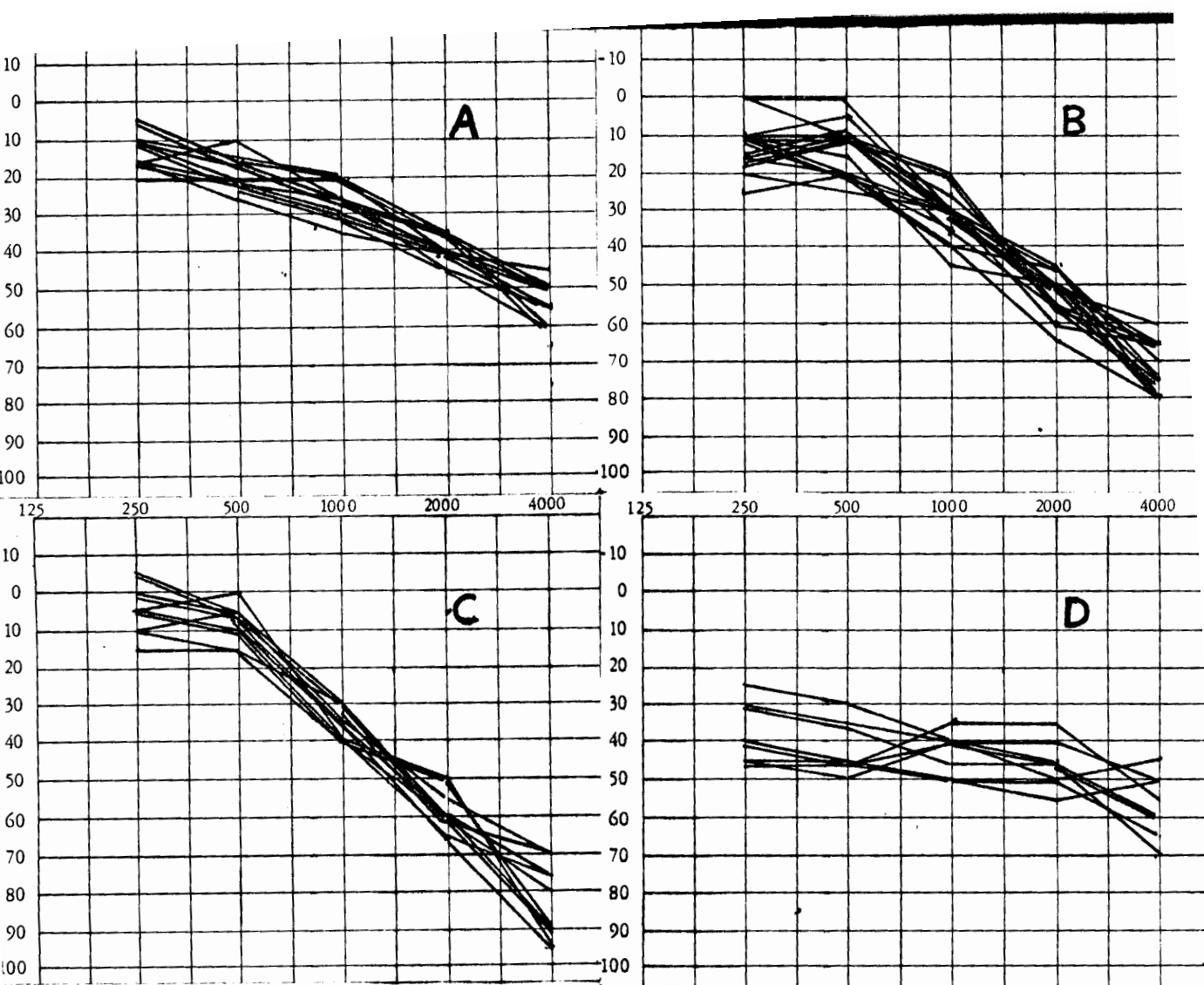


Fig. 1: The four categories of audiogram.

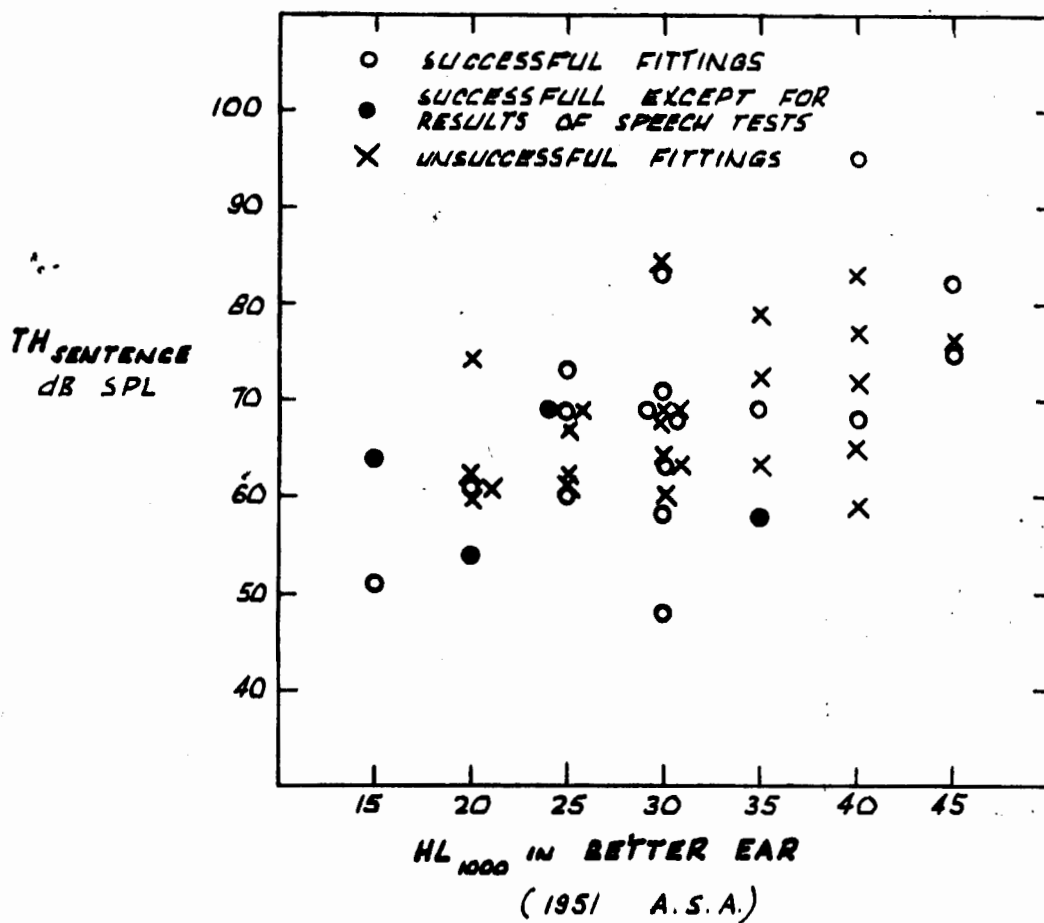


Fig. 5: Relationship between success of fitting, threshold for sentences, and hearing loss in better ear.