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A common complaint of elderly persons who wear hearing aids is that they have a great deal of difficulty understanding speech in noisy environments. They often report that while they can hear and understand speech quite well in quiet situations, it is extremely difficult for them to understand speech when other conversations are going on simultaneously; that is, when there is a background babble of speech in addition to the conversation they wish to hear. It should be pointed out that such complaints are not limited to persons with hearing loss due to presbycusis but are also voiced by many younger persons with sensorineural hearing loss.

This complaint of special problems in understanding speech in a noisy environment is not unique to modern day hearing aid users. Hallpike, in 1934, pointed out that persons with presbycusis hearing loss experience a great deal of difficulty in understanding speech of interest to them when noise and/or other conversations are going on simultaneously in the background. He went on to comment that these individuals were best helped by the use of a speaking tube which the listener could hold close to the talker and thereby hear him but exclude most of the background noise or competition.

Mueller, in 1953, also pointed out that persons having sensorineural hearing loss are very sensitive to background noise. Further, Ewersteen, in 1966, commented that the communication of a hearing aid user may be wholly disrupted if he is forced to listen to somewhat distant speech in a noisy environment. The commonality in all of the above comments is that persons with sensorineural hearing loss, including persons with hearing loss due to presbycusis, experience communicative problems in noise. More specifically, the problem appears related to the signal-to-noise ratio, i.e. the speech-to-noise ratio in the environment. It is an improvement of the speech-to-noise ratio that Hallpike advocated in his recommendation of a speaking tube held close to

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the talker's mouth, and it is also a poorer signal-to-noise ratio that Ewersteen alludes to as the problem when the hearing aid user must listen to speech originating at some distance in a noisy background.

A critical facet of the problem which is implied in the above comments is that persons using hearing aids experience considerably greater difficulty in understanding speech in noise than do normal hearers in the same listening situations.

In light of this it seems only natural that if the speech discrimination of a hearing impaired individual is to be tested as part of a hearing aid selection procedure, at least a part of that testing should be conducted against a noise or speech competition background. Interestingly, this recommendation has been made often, as early as 1939 by Berry and by Holmgren, and by others over the intervening years. (Fest, 1944; Carhart, 1946; Davis, 1946; Carhart and Thompson, 1947; Jerger, et. al., 1966; ASHA, 1967; Carhart, 1967; Olsen and Carhart, 1967; Olsen and Tillman, 1968.) It would seem that through such testing better insight into the communication problems of the hearing impaired could be gained. However, data for aided speech discrimination tests in noise are rather limited. The data which are available suggest that the speech discrimination ability of sensorineural loss cases is markedly reduced when noise or competing speech is added to the test conditions. (Hudgins, et. al., 1948; Jerger, et. al., 1966; Miller and Niemoller, 1967; Olson and Carhart, 1967; Olsen and Tillman, 1968.)

It is my goal here to illustrate this point for persons with presbycusis hearing loss. In a series of experiments dealing with hearing aids and their use by hearing impaired persons, presbycusis cases have served as subjects and have been treated as a separate hearing loss group. It should be pointed out that the performance of the presbycusis group has been very similar to the performance of a group of younger persons with sensorineural hearing loss, but it is the data from a group of 18 presbycusis hearing loss cases that are of primary interest here.

For this work tape recordings were made of speech test items in a quiet environment and in a background of competing speech. These test materials were recorded as they were reproduced in a sound field by a system having good fidelity and as they were amplified by hearing aids.

The test items consisted of spondees and monosyllables in quiet and of monosyllables against a competing message. Bell Telephone Intelligibility Sentences from a second speaker served as a simultaneous secondary or competing signal. This competing speech situation was recorded at two primary-to-secondary ratios--one in which the monosyllables were 18 dB more intense than the competition and a second in which they were 6 dB stronger, i.e. +18 and +6 dB S/N ratios.

These tape recordings were presented monaurally via TDH 39 earphones to 12 normal hearing listeners and to 18 individuals with presbycusis hearing loss. The speech discrimination scores attained by the normal hearers with high fidelity reproduction of the various listening conditions provided a reference against which performance of the hearing loss group could be compared. The subjects with presbycusis hearing loss listened to the materials as reproduced by the hi-fidelity system and also to these speech materials as reproduced by hearing aids. Utilization of materials recorded in this way simplified the experimental procedure and also allowed for consistent hearing aid reproduction for all our hearing impaired listeners.

Speech reception thresholds were established with the tape recorded spondees and the monosyllables were always presented at a level 30 dB above the speech reception threshold obtained for each tape recording.

In Figure 1 the mean discrimination scores for monosyllabic words achieved by the normal hearing group and by the presbycusis hearing loss group, are plotted as a function of primary-to-secondary ratio. Notice here that the normal hearing group attained scores on the order of 90 percent even in the most difficult listening condition when the monosyllables were only 6 dB more intense than the secondary or competing message. In the less difficult listening condition when the primary message was 18 dB more intense than the competing speech or when there was no competition (labelled quiet) the scores obtained by the normal hearers were close to 100 percent. Thus, none of these listening conditions posed any particular difficulty for the normal listeners. All these results were, of course, obtained for high fidelity reproduction and serve as a reference against which the performance of the presbycusis loss group may be compared.

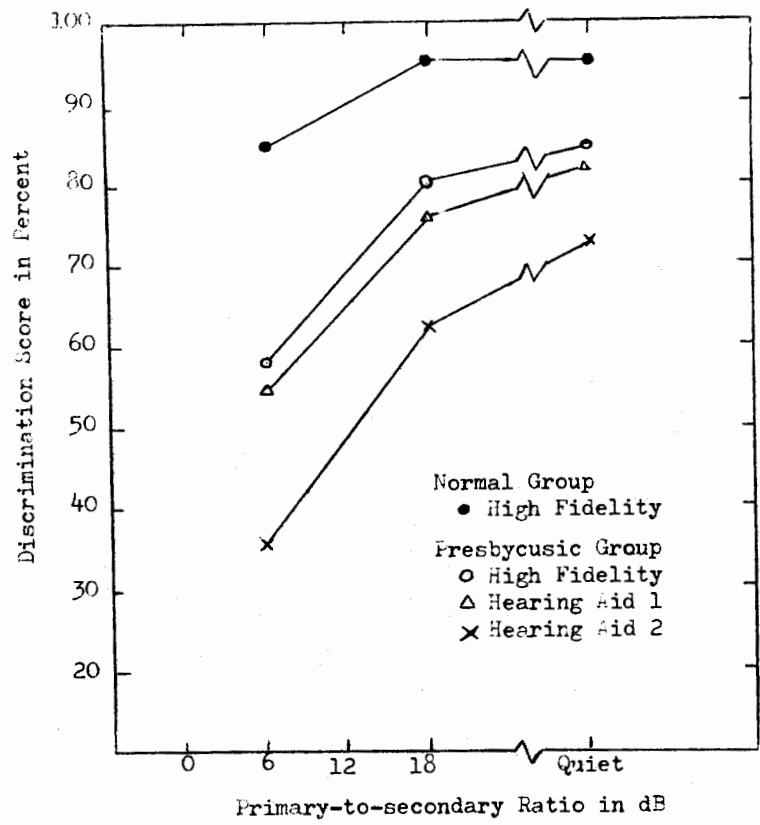


Figure 1. Mean Discrimination Scores of Normal Hearing and Presbycusis Subjects

Note that the mean scores for the presbycusis group were relatively good with high fidelity reproduction in quiet, on the order of 85 percent. With a competing message added to the test situation at 18 dB below the primary signal, the average speech discrimination score was reduced to about 80 percent. However, note that at the +6 dB primary-to-secondary ratio, a listening condition which was not at all difficult for the normal hearing group, the presbycusis group attained a speech discrimination score of only 59 percent.

In other words, this latter listening condition did not seriously affect the normal hearers understanding of monosyllables, but this same listening condition, even with high fidelity reproduction, was quite difficult for the group with presbycusis hearing loss. These test results appear to support very nicely the frequently heard complaint of persons with presbycusis hearing loss which was mentioned earlier. That is, they commonly report that they can hear and understand speech reasonably well in quiet environments, but they encounter a great deal of difficulty in understanding the speech of interest to them in noisy environments, even though their normal hearing friends and colleagues do not experience problems in hearing and understanding speech in the same situation.

The scores attained by the presbycusis group with hearing aid 1 under the same listening conditions are very similar to those achieved for high fidelity reproduction. Note that the score with hearing aid 1 at a primary-to-secondary ratio of +6 dB is only about 5 percent lower than the score they obtained with high fidelity reproduction. However, all scores obtained with hearing aid 2 are substantially poorer. The difference in speech discrimination performance with hearing aids 1 and 2 is 10 percent in quiet but is 18 percent in the competing message situations. The reduction in speech understanding from 54 percent to only 36 percent at +6 dB primary-to-secondary ratio represents a rather severe decrement in performance. In fact, this drop may represent an even greater deterioration in actual performance in everyday life than the difference score of 18 percent would indicate. It is rather discouraging to think that some elderly persons are attempting to understand speech in everyday life with an aid comparable to hearing aid 2, when they could just as well be using an instrument similar to hearing aid 1.

While group trends such as those described above are of interest, it is the individual that is of concern to the clinician. I have selected two cases for discussion which represent essentially the extremes in performance with hearing aids. Both of these cases were seen on the same day in one of Northwestern University's Hearing Clinics.

Case 1 is a 64 year old male who had experienced sufficient difficulty two years earlier to prompt his purchase of an ear level hearing aid. His audiogram and test findings are shown in Figure 2. Note that his speech discrimination at 40 dB sensation level was excellent, 94 percent for the

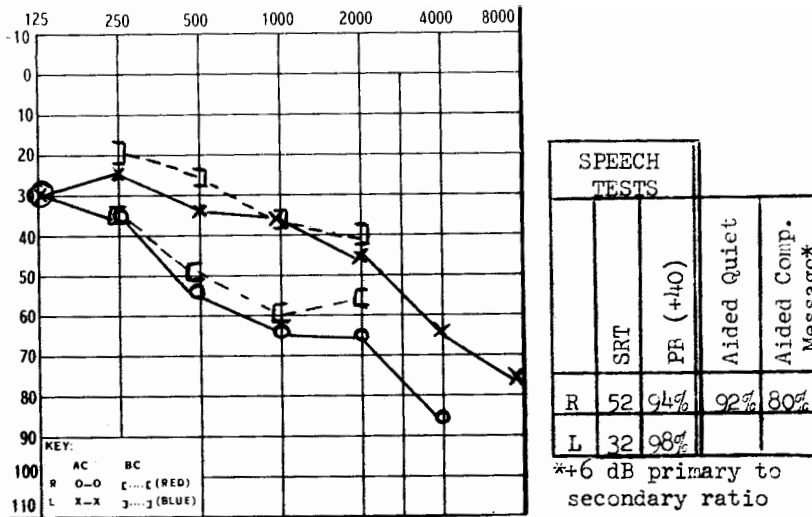


Figure 2. Case 1, 64 year old male

right ear, 98 percent for the left ear. This discrimination ability was maintained at 92 percent in quiet with his own hearing aid in the right ear. In the competing message test situation at a +6 dB primary-to-secondary ratio, his performance was still relatively good, 80 percent. It is encouraging to note that this individual reported wearing his hearing aid all the time.

In sharp contrast is Case 2, a 78 year old male who reported marked difficulty in hearing aid use. This individual reported the onset of his hearing difficulties as being at about age 63. He had purchased several hearing aids over the past seven years without satisfaction. Findings with this patient are shown in Figure 3. The speech discrimination score in quiet for this case was 86 percent in the left ear and 78 percent in the right ear. Further, his speech discrimination score was still relatively good with his own hearing aid in quiet. It was with competing message testing that the full extent of this individual's difficulty with hearing aid use became apparent.

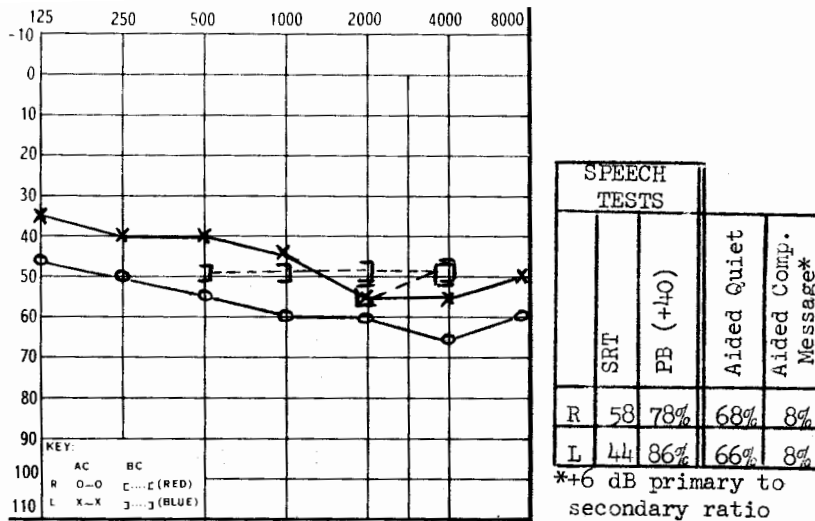


Figure 3. Case 2, 78 year old male

His score of only 8 percent demonstrates essentially a complete breakdown in aided auditory reception. The extent of his problem would not have been predicted on the basis of speech discrimination testing in quiet. In this case and in case 1, it was from information regarding performance with a hearing aid in competition that meaningful counseling could be undertaken.

From the data discussed earlier and on the basis of these two case reports, it seems to me that it is essential that the clinician have information regarding patient's aided performance in quiet and noise if realistic levels of expectation regarding hearing aid use are to be set for him. This point is apparent for both cases 1 and 2. In case 1, relatively high levels of expectation could be discussed during the counseling session. In contrast, it became imperative that case 2 realize his limitation in hearing aid use in difficult noisy listening situations.

One wonders if a hearing aid with a detachable microphone which could be held close to the talker's mouth as described recently by Miller (1967) might be beneficial for

persons experiencing difficulties like those of Case 2. This arrangement with the detachable microphone is similar to the speaking tube idea advocated by Hallpike years ago. The obvious advantage of such an arrangement is an improvement in the signal-to-noise ratio for the hearing impaired listener.

In summary, problems encountered by senior citizens in hearing aid use apparently have not changed with the advent of contemporary hearing aids. A chief complaint voiced by these individuals continues to be the difficulty experienced in noisy listening situations. In my view, the limitations of hearing aid use cannot be predicted from aided speech discrimination testing in quiet. The addition of a competing message or other noise in the test situation can highlight problems which otherwise might not be detected and therefore, probably would not be discussed during patient counseling. It is, of course, insightful counseling which is of vital importance in any aural rehabilitation program.

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