Late-Onset Auditory Inactivity (Deprivation) in Persons with Bilateral Essentially Symmetric and Conductive Hearing Impairment

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Abstract

The purpose of this investigation was to examine the effects of prolonged monaural amplification on the suprathreshold speech-recognition scores in the unaided ears of 46 persons with bilateral essentially symmetric and conductive hearing impairment and aided ears of 46 other persons with bilateral essentially symmetric and conductive hearing impairment. All subjects were less than 50 years of age. The suprathreshold speech-recognition loss scores for taped monosyllabic German PB words were analyzed. The frequency distribution of pure-tone averages was essentially equivalent for the aided and unaided ears. Although the magnitude of hearing impairment was essentially equivalent for the aided and unaided ears, the unaided ears tended to have large suprathreshold speech-recognition loss scores than the aided ears. The results are discussed in relation to theories of auditory deprivation and inactivity from monaural amplification. The clinical significance of these findings in relation to ear surgery is also discussed.

Key Words: Auditory deprivation, chronic otitis media, conductive hearing loss, hearing disorders, monaural amplification, otosclerosis, suprathreshold speech-recognition ability

Frequently, the rate of progression of hearing impairment is unequal in the two ears of persons with bilateral chronic otitis media or otosclerosis, leading to asymmetric audiometric configurations. In such cases, we have fitted the better ear (based on pure-tone sensitivity) with monaural amplification. Our clinical observations have indicated that after prolonged use of monaural amplification in such cases, the patients become accustomed to this condition, which is very similar to unilateral hearing, and feel "well rehabilitated." If the hearing impairment worsens substantially in only the better (aided or "used") ear, this formerly better ear becomes the poorer ear, and the formerly poorer (unaided or "unused") ear becomes the better ear, based on the pure-tone sensitivity. (The hearing impairment never deteriorated so markedly as to make the ear unusable for amplification.) In such situations, we have frequently attempted to switch monaural amplification from the formerly aided ear to the formerly unaided ear in order to maintain amplification in the ear with the better pure-tone sensitivity. Our attempts at switching, however, have been unsuccessful as these patients have rejected amplification of the unaided ear, after longstanding monaural amplification of the other ear.

We have speculated that rejection of amplification in these cases occurred because (1) prolonged pure-tone asymmetry may have strengthened the communicative efficiency of the originally better ear and weakened the communicative efficiency of the poorer ear, and (2) longstanding monaural amplification may have resulted in sufficient auditory stimulation of the aided ear and insufficient auditory stimulation of the unaided ear, resulting in "auditory inactivity" of the unaided ear. In order to investigate only the latter speculation, it is necessary to rule out pure-tone asymmetry as a factor contributing to rejection of monaural amplifica-
tion when the ear fitted with monaural amplification is alternated after long-term use of monaural amplification. The role of pure-tone asymmetry in hearing-aid rejection can be ruled out by investigating the effects of prolonged monaural amplification in persons with symmetric hearing impairment. If persons with bilateral symmetric hearing impairment reject amplification of the formerly unaided ear after extended periods of monaural amplification of the other ear, the following question must be raised: What is the mechanism of auditory inactivity in the unaided ear resulting from monaural amplification?

The results of a case study, along with the preliminary results of some other cases, which were presented at an international conference (Dieroff, 1982), suggested a possible answer to this question. The suprathreshold speech-recognition ability in a case with nonprogressive asymmetric conductive hearing impairment deteriorated essentially completely over time in the unaided (poorer) ear. This finding suggested the possibility that monaural amplification can result in deterioration of suprathreshold speech-recognition ability in the unaided ear; such deterioration could possibly lead to rejection of amplification if, after extended use of monaural amplification, an attempt is made to switch the ear fitted with monaural amplification.

The purpose of the present investigation was to evaluate the hypothesis that auditory inactivity or deprivation from monaural amplification results in deterioration in suprathreshold speech-recognition ability in the unaided ears of persons with bilateral essentially symmetric and conductive hearing impairment.

METHOD

Experimental Design

A straightforward design would be to assemble a group of persons with bilateral loss who had been aided monaurally and compare speech recognition scores of the aided and unaided ears. Such a design would be appropriate if it were known that degree of hearing loss was identical in the two ears. In reality, however, this is seldom the case. Even in persons with relatively symmetric loss there is usually some difference between the two ears. And it is common, when aiding such persons monaurally, to choose the better ear as the ear to fit with the hearing aid. In this circumstance, any difference in speech recognition between the two ears would be ambiguous in the sense that poorer scores from the unaided ear might be the result of the lack of auditory stimulation, but might also be due to the fact that the unaided ear has greater loss than the aided ear.

To circumvent this problem we formed two groups of subjects characterized by the fact that the distribution of average pure-tone loss was comparable for the aided ear of one group and the unaided ear of the other group. If we now compare speech recognition scores of these two sets of ears (the unaided ears of one group and the aided ears of the other group), then, if there is a difference between the two sets of ears, such difference cannot be attributed to greater hearing loss in one group as compared to the other.

Subjects

Subjects were 92 persons with bilateral essentially symmetric and conductive hearing impairment in which the conductive component was due to chronic otitis media or otosclerosis. Subject selection was based on the results of testing at 10 and 12 years post hearing-aid fitting. The bone-conduction thresholds ranged between 0 and 30 dB HL. All subjects were monaural hearing-aid users for 10 to 12 years and were not more than 50 years of age. Thus, there was overall matching of the groups on the basis of air-conduction thresholds averaged across the 500 to 2000-Hz range. In order to form two independent groups, the data from the unaided ears of 46 persons with bilateral essentially symmetric and conductive hearing impairment were compared with those from the aided ears of 46 other persons with bilateral essentially symmetric and conductive hearing impairment. Since the air-conduction and bone-conduction thresholds at 500, 1000, and 2000 Hz in the aided ears of one group were matched within 5 dB of those in the unaided ears of the second group at the time of assessment, it is probable that the pure-tone thresholds for the aided ears were essentially similar to those for the unaided ears at the time of hearing-aid fitting.

Procedure

The following audiologic measures were evaluated, based on retrospective analysis of the patient charts: (1) three-frequency pure-
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tone average based on the air-conduction thresholds at 500, 1000, and 2000 Hz, and (2) suprathreshold speech-recognition loss for German PB words (Hahlbrock, 1970). The Hahlbrock PB test, which resembles the CID W-22 monosyllabic word-recognition test, consists of 10 lists of 20 monosyllabic words. Taped recordings were presented at 60, 80, and 100 dB HL (whenever possible) and the maximum score was identified. Suprathreshold speech-recognition loss (SSRL) was calculated by subtracting the suprathreshold speech-recognition score from 100 percent. The non test ear was masked with pink noise.

RESULTS AND DISCUSSION

Figure 1 shows the distribution of average pure-tone loss for the group of 46 unaided ears and the group of 46 aided ears. Inspection of Figure 1 reveals that the distribution of pure-tone averages in the group of aided ears is essentially equivalent to that in the group of unaided ears.

Figure 2 shows the distribution of suprathreshold speech-recognition loss (SSRL) scores for the group of unaided ears and the group of aided ears. Inspection of Figure 2 reveals substantial differences in the distribution of suprathreshold speech-recognition loss scores between the unaided and aided ears. That is, the unaided ears had large suprathreshold speech-recognition loss scores whereas the aided ears had small suprathreshold speech-recognition loss scores. The average difference between the two groups (34.8%) was statistically significant (t = 8.00, p < .0001). These results suggest that unaided, as contrasted with the aided, ears of these subjects with bilateral, essentially conductive hearing impairment experienced auditory deprivation or "inactivity" as evidenced by the substantially larger suprathreshold speech-recognition loss scores in the unaided than aided ears. Thus, the findings of Silman et al. (1984) and other investigators on subjects with bilateral, essentially conductive hearing impairment appear to apply also to subjects with bilateral essentially symmetric sensorineural hearing impairment.

Figure 3 shows the scatter diagrams illustrating the relation between pure-tone average and suprathreshold speech-recognition loss score for the aided ears and unaided ears. Inspection of Figure 3 reveals that the individual pure-tone averages exceed approximately 50 dB HL in the aided as well as the unaided groups. On the other hand, the suprathreshold speech-recognition loss scores tend to fall below 50 percent in the aided ears versus above 50 percent in the unaided ears. These findings suggest that hearing-threshold level differences between groups is not a factor accounting for the auditory-deprivation/inactivity findings in the unaided ears.
persons with significant asymmetry in suprathreshold speech-recognition loss scores are at risk for auditory deprivation or inactivity in the poorer ear. The risk increases if the hearing in the better ear is improved by surgery, especially in the absence of amplification and auditory training for the poorer ear.

This theoretical issue of auditory inactivity or deprivation also has considerable clinical significance with respect to ear surgery. Otologists are sometimes compelled to operate on the better ear for restorative or ameliorative purposes. In such cases, a temporary postsurgical hearing impairment in the better ear associated with the surgical ear dressings occurs. This situation forces the patient to become dependent on the poorer ear and is most distressing to the patient when the poorer ear has a longstanding severe hearing impairment. Since there is always the risk that ear surgery will have an adverse effect on hearing, in rare circumstances, operation of the better ear will have a permanently adverse effect on the hearing sensitivity in that ear so that the patient will have to rely on the formerly poorer ear. Therefore, otologists must consider whether the poorer ear, which has not received amplification and auditory training, can be relied on during the recovery period following surgery in the better ear. That is, the surgeon must consider whether the poorer ear can benefit from amplification/auditory training during the necessary recovery period.


REFERENCES


