Is the Unaided Ear Effect Independent of Auditory Aging?

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Abstract

As a group, adults with bilateral symmetric sensorineural hearing loss (SNHL) who receive a monaural hearing aid fitting experience a progressive decline in their word recognition score (WRS) for monosyllabic word materials in the unaided ear but not in the aided ear. However, adults with binaural fittings do not demonstrate a similar deterioration in their WRS. In an effort to determine the role of senescent auditory changes on the unaided ear effect, a retrospective investigation was carried out on a group of hearing aid wearers. Using NU-6 to assess the WRS, this investigation attempted to answer the following question: is the unaided ear effect related to asymmetric senescent auditory changes? The present results indicate that the unaided ear effect is not related to such an asymmetric effect since it is shown to occur in adults with SNHL whether in the fourth or seventh decade of life.

Key Words: Auditory deprivation, binaural amplification, hearing aid effect, hearing loss, monaural amplification, speech perception, speech recognition

As a group, adults with bilateral symmetric sensorineural hearing loss (SNHL) who receive a monaural hearing aid fitting experience a progressive decline in their word recognition score (WRS) for monosyllabic word materials in the unaided ear but not in the aided ear (Hood, 1984; Silman et al, 1984; Gelfand et al, 1987; Gatehouse, 1989, 1992; Stubblefield and Nye, 1989). However, adults with binaural fittings do not demonstrate a similar deterioration in their WRSs. Similarly, adults with asymmetric SNHL demonstrate a progressive decrement in the poorer ear's WRS if that ear is unaided (Silverman and Emmer, 1993). In some cases (Silman et al, 1984, 1992; Silverman and Silman, 1990; Hurley, 1993; Silverman and Emmer, 1993), this decrement in the WRS can be significant, exceeding the 95 percent critical difference (Thornton and Raffin, 1978). In short, there is evidence that the unfitted ear WRS of some monaurally fitted individuals with bilateral SNHL decreases over time while the WRSs for the majority of binaurally fitted ears do not demonstrate a similar deterioration within the same timespan.

However, several questions are still unanswered. One such question is the role that aging of the auditory system plays in precipitating the unaided ear effect. Specifically, the majority of reports dealing with the monaural hearing aid effect, either group studies (Silman et al, 1984; Gelfand et al, 1987; Stubblefield and Nye, 1989; Burkey and Arkis, 1993) or case studies (Silman et al, 1984, 1992; Silverman and Silman, 1990; Hurley, 1993; Silverman and Emmer, 1993; Gelfand, 1995), have used subjects in the sixth to seventh decade of life—subjects by definition with aged auditory systems superimposed on SNHL. Simply stated, is the unaided ear effect nothing more than asymmetric aging of the auditory system, a unilateral "phonemic regression" (Gaeth, 1948)? Or is the unaided ear effect an unidentified, age-related phenomenon, for which we have no audiological marker, that is activated by auditory deprivation (Silman et al, 1984) or an "acclimatized" ear effect (Gatehouse, 1989, 1992)? While some studies have shown a decline in the WRS with age (Jerger and Hayes, 1977; Stach et al, 1990; Jerger, 1992), others have shown no WRS difference between young and elderly subjects (Otto and McCandless, 1982; Gordon-Salant, 1987). However, when the WRS is adjusted for hearing thresholds there does not appear to be an "age effect" decline in the WRS (Willott, 1991). There is, however, evidence of an age-related decline in left ear...
performance in speech perception that is independent of hearing threshold levels (Jerger, 1997). Since the majority of monaural hearing aid fittings are right ear and the majority of case studies show a left ear unaided effect (Silman et al., 1984, 1992; Gelfand et al., 1987; Silverman and Silman, 1990; Hurley, 1993; Silverman and Emmer, 1993; Gelfand, 1995), is the unaided ear effect a dormant phenomenon of the aging auditory system that is facilitated by the age-related decline in left ear speech perception after a right ear hearing aid fitting? If auditory system aging does not contribute to the unfitted ear effect, then the effect should be demonstrated by a reduction in the WRS in the unaided ear of younger subjects. Conversely, if the unaided ear effect is related to auditory system aging, then the WRS should be reduced only in older subjects.

This investigation attempted to answer the following: (1) does the WRS decrease over time in the unaided ear in adults with bilateral SNHL and (2) is the reduction in the WRS for a similar group of older and younger adults with SNHL comparable? To ensure that any change in the unaided ear was a result of a monaural hearing aid fitting, both the younger and older subject groups had matching cohorts that had received binaural hearing aids fittings.

**METHOD**

**Subjects**

The subjects of this investigation were 40 individuals with symmetric bilateral SNHL drawn from a large pool of hearing aid wearers. The subjects were selected from existing patient files to represent two age groups. The subjects in each group were matched for the average of the pure-tone hearing threshold levels at 500 Hz, 1000 Hz, and 2000 Hz (PTA_1) and the average of the pure-tone hearing threshold levels at 1000 Hz, 2000 Hz, and 4000 Hz (PTA_2). PTA_2 was chosen as a criterion because of its well-known influence on the WRS (Marshall and Bacon, 1981; Jerger et al., 1988; Yellin et al., 1989). Each age group was divided into monaurally fitted and binaurally fitted subgroups. All monaurally fitted subjects had their right ear fitted. The younger group ranged in age from 39 to 45 years of age (X = 43.5 years), while the older group ranged in age from 60 to 65 years of age (X = 63.5 years) at the time of the initial evaluation. Figure 1 depicts the average hearing threshold levels (HTLs) for the two age groups based on the type of hearing aid fitting, monaural or binaural. Figure 2 compares the mean PTA_1 and PTA_2 (±1 SD) values for the two age groups based on the type of hearing aid fitting.

Each subject was examined on a regular basis for re-evaluation of hearing status and hearing aid arrangement over a 5-year timespan. At the initial evaluation, each subject demonstrated the following: (1) a PTA_1 of ≥ 30 dB; (2) a normal tympanogram and contralateral acoustic reflex thresholds within the 95th percentile for the octave frequencies of 500 to 2000 Hz (Silman and Gelfand, 1981); (3) no interaural frequency difference greater than 10 dB at two adjoining frequencies for the octave frequencies of 500 to 4000 Hz; (4) no interaural difference greater than 10 percent for 50
Aided Unaided Right Left
Monaural Fitting Binaural Fitting

Figure 2 Mean (+1 SD) pure-tone averages, PTA, and PTA<sub>A</sub>, for the unaided and aided ears of the two monaurally fitted groups and the right and left ears of the two binaurally fitted groups at the initial testing.

None of the subjects demonstrated any indication of retrocochlear dysfunction.

In each group, 10 subjects were fitted binaurally and 10 subjects were fitted monaurally. The initial evaluation and the subsequent evaluations at 3 and 5 years post initial fitting consisted of the following: (1) pure-tone audiometry, (2) immittance measures, and (3) 50 words per ear of the Auditec<sup>TM</sup> NU-6 materials presented at 40 dB SL re: the SRT.

RESULTS

The mean WRS (± 1 SD) of each age group was computed for the initial testing, the third year testing, and the fifth year testing. The WRS designation used in the figures refers to the NU-6 test materials. In order to analyze the WRS changes, the percentage scores were arcsine transformed to correct for skewness before repeat measure analyses of variance (ANOVAs) were applied to the WRS data. The ANOVA significance was evaluated at an alpha level of 0.01. Post hoc analyses used the Scheffe procedure with the level of significance evaluated at an alpha level of 0.01.

Examination of Figure 3 shows the significant (F = 23.31, p < .01) decline in the mean WRS
of the unaided ear in the monaurally fitted younger group over the 5-year period from an initial mean score of 87.2 percent to a fifth year score of 78.6 percent, a decline of 8.6 percent. The post hoc Scheffe analyses indicate that the change between the initial test and the fifth year retest was significant (p < .01), as was the change between the third year retest and the fifth year retest (p < .01). In the older group, the unaided ear mean WRS significantly (F = 24.24, p < .01) declined from an initial score of 86.2 percent to a 5-year score of 76.2 percent, a decline of 10.0 percent. The post hoc Scheffe analyses indicate that the change between the initial test and the fifth year retest was significant (p < .01), as was the change between the third year retest and the fifth year retest (p < .01).

In contrast, the mean WRS of the aided ear in the younger group remained stable (F = 2.10, p > .05) over the 5-year timespan, being 86.4 percent for initial testing and 89.2 percent at year 5. Similarly, the mean WRS of the aided ear in the older group remained stable (F = 1.46, p > .05) over the 5-year timespan, where the initial mean WRS was 84.8 percent and the 5-year mean score was 85.0 percent.

The mean WRS for the binaurally fitted individuals in the younger group displayed in Figure 3 showed no significant decline (F = 1.89, p > .05 for the right ear; F = 3.07, p > .05 for the left ear), being initially 86.8 percent and 85.8 percent for the right and left ears, respectively, and 88.0 percent and 84.2 percent, respectively, after 5 years. The mean WRS of the binaurally fitted older group remained stable (F = 1.16, p > .05 for the right ear; F = 1.31, p > .05 for the left ear) over time. Initial scores were 84.0 percent bilaterally. At the fifth year, they were 83.2 percent and 81.4 percent for the right and left ears, respectively.

**CONCLUSIONS**

The present results show that the unaided ear effect occurs in adults with SNHL whether in the fourth or seventh decade of life. The 8.4 percent change in the unaided ear WRS for the younger adults was similar to the 10.0 percent change demonstrated by the older group. Thus, the magnitude of the unaided ear effect does not appear to be age related. Further, the binaurally fitted subjects in either age group demonstrated no group change in the WRSs across the time period, a finding consistent with previous investigations (Silman et al, 1984; Gelfand et al, 1987). These results indicate that the unaided ear effect is not related to asymmetric senescent auditory changes.

**Acknowledgments.** Laurel Christensen, Ph.D., Shlomo Silman, Ph.D., and two anonymous reviewers are thanked for their comments on a previous version of this paper. This paper is based on a presentation at the Annual Convention of the American Academy of Audiology, Richmond, VA, 1994.

**REFERENCES**


