Letter to the Editor:

LATERAL DIFFERENCE IN HEARING SENSITIVITY

by

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ABSTRACT

A series of studies on the lateral difference in hearing sensitivity by gender, age, and hearing threshold level were done at the Workers' Compensation Board of British Columbia. Results confirm the right ear is statistically the 'better' ear. In addition this lateral difference is shown to be a function of hearing threshold level. The different factors that could contribute or affect the lateral difference are discussed.

SOMMAIRE

Une série d'études portant sur la différence latérale dans la sensibilité de l'ouie selon d'âge, le sexe et le niveau d'audition a été effectuée à la Commission des accidents du travail de la Colombie-Britannique. Les résultats confirment que, pour la moyenne des gens, l'oreille droite est plus sensible. De plus, cette différence latérale est représentée comme une fonction du niveau d'audition. Cette communication traite des différents facteurs qui pourraient influencer la différence latérale.

INTRODUCTION

Results from large-scale hearing surveys have demonstrated statistically that the right ear is more sensitive than the left ear, (Kannan & Lipscomb, 1974). This i found not only in adult male populations but also in children between the ages of 12 - 17 (Roberts & Ahuja, 1975). The lateral difference in sensitivity, however, is most prominent in the male adult population. This leads to the query that the latera difference may be a sequence of a systematic asymmetrical noise exposure such as the mode of driving and/or shooting. While these possibilities may seem reasonable they cannot account for all the lateral difference.

In a study done a few years ago at the WCB (Chung et al, 1981) we separated two factors which are related to the lateral difference. The factors are shooting and th ear effect. Both factors are related positively to the lateral difference as defined by threshold of the left ear minus the threshold of the right ear.

In shooting, if one is a right-handed shooter, the left ear is more likely to have worse hearing, (Taylor & Williams, 1966; Keim, 1969). This has been ascribed to the head shadow effect. The far ear receives less noise exposure due to the attenuation of the head, thus less hearing loss. Since most people are right-handed the average shooter has more hearing loss in the left ear, at the higher frequencies.

The ear effect is defined as the difference in hearing threshold between the two ears after asymmetrical noise exposure has been controlled for. This was done by two different approaches at the WCB.

In B.C. we have jurisdiction over hearing conservation in industry. The Industrial Health & Safety Regulations of the WCB require companies to have a hearing conservation program (HCP) consisting of engineering controls, personal hearing protection and audiometric surveillance when workers are exposed to a steady-state noise of 90 dBA (time-weighted average - TWA) for eight hours. When there is a HCP all workers exposed to a TWA of 85 dBA for eight hours must have a pure-tone, air-conduction audiogram taken annually. The WCB requires copies of all audiograms along with information or medical history, shooting history, smoking history, and use of hearing protectors. All data are stored on tape.

The first approach we took was to study all workers who had a history of shooting (Chung et al, 1981). At the time of the study there were 29,953 workers who had some kind of a shooting history but no apparent ear pathology other than possibly noise damage. Since the ear effect presumably is not affected by the handedness and the shooting effect is dependent on the handedness, it is possible to separate the two effects mathematically. By doing so it was found that the shooting effect increases with the years of shooting but the ear effect does not. However, both effects are most prominent between 3 to 6 kHz. The shooting effect is negligible at 0.5 and 1 kHz and the ear effect is slightly less than 1 dB at 0.5 and 1 kHz.

Another approach in obtaining the ear effect is to study a group of subjects, with no apparent asymmetrical noise exposure (Chung et al, 1983a). In that study we only used workers without shooting history and no apparent ear pathology other than noise exposure. Workers (shingle sawyers) with asymmetrical noise exposure in the workplace are also excluded (Chung et al, 1983b). Over 50,000 cases were analyzed. The ear effect by sex, age, and hearing loss was also studied.

When the ear effect was analyzed by gender it was found that male workers have approximately twice the ear effect that the female workers have at frequencies 2-8 kHz, but at 0.5 and 1 kHz the ear effect is about the same for the two groups. For example, at 4 kHz the female ear effect is about 1.25 dB and the male ear effect is about 2.45 dB.

Analysis of the ear effect by age also shows a difference between the male and the female groups. As age increases from 20 to 50 years the ear effect also increases significantly ($p < 0.001$) at the high frequencies for the male group but the increase is not significant in the female group. However, for the male group as age increases above 50 years the ear effect decreases again.

The most important relationship was found between the ear effect and hearing level. Overall the ear effect increases significantly ($p < 0.001$) with hearing level to about 40 dB HL and then decreases for individuals who have hearing losses of 40 dB or more. This trend is true for frequencies 2 kHz and above.

At 0.5 and 1 kHz, the ear effect as a function of age behaves quite differently from that at the higher frequencies. It decreases up to the age group 45-49, where hearing level is about 10 dB HL at both frequencies. Over 45-49 years, the ear effect at these two frequencies begins to increase slightly. When the ear effect is plotted against hearing level it can be seen that the ear effect at 0.5 and 1 kHz increases to a hearing level of 20-29 dB and then it decreases.

When hearing level is controlled, the ear effect is no longer related to age. This demonstrates that the ear effect is indirectly related to age because age is related to hearing level. This, together with the fact that the ear effect, being lower in the female workers than in the male workers, which can be explained by the better hearing threshold level of the female workers in the higher frequencies, suggests that hearing level is a major factor relating to the magnitude of the ear effect.

There are various possibilities which may cause or influence the ear effect. They are: (1) the order of testing, (2) systematic asymmetrical noise exposure, and (3) lateral difference in susceptibility to noise damage.

In our program the left ear is the ear tested first unless the worker indicates his right ear is the better ear. It is possible, therefore, that such bias could contribute to the ear effect. However, the fact that the ear effect changes with hearing level suggests that the order of ear testing is not a significant factor influencing the ear effect. Also, it has been shown that the ear effect persists despite the randomization of the order of presentation (Singer et al, 1982).

While lateral difference in hearing level could be caused by a systematic asymmetrical noise exposure, evidence from this study does not support this explanation. Since in this study shooters and shingle sawyers were eliminated, and right-handers of hand-tool users would more likely yield a right bias in noise exposure, it is unreasonable to ascribe the ear effect to a systematic left bias. The data also show that, generally, there is a decrease in the ear effect when hearing level is above 40 dB HL. This is inconsistent with the asymmetrical noise exposure explanation. Furthermore, a lateral difference has already been shown to be present in teenagers (Roberts & Ahuja, 1975).

The possibility that the ear effect is partly caused by a lateral difference in the susceptibility to noise damage should be considered. For a positive ear effect to occur as a consequence of a lateral difference in susceptibility there must be a left bias in the susceptibility. This is consistent with our clinical findings (Chung et al, 1983c) which showed that of the 69 workers who had the 2-kHz asymmetry 82.6% had worse hearing thresholds in the left ear at 2 kHz. Evidence of that study suggests the asymmetry at 2 kHz is a manifestation of a lateral difference in susceptibility to noise damage and that the left ear is the more susceptible one in most cases.

How can the theory of the lateral difference in the susceptibility to noise damage explain: (1) the finding that there is a decrease in the ear effect above 40 dB HL, (2) that there is already an ear effect existing in teenagers, and (3) that the ear effect at 0.5 and 1 kHz behaves quite differently from that at high frequencies?

At present there are no unequivocal answers to these questions. Nevertheless, speculations may be made. The decrease in the ear effect above 40 dB HL or over 55 years old can be explained by the presence of presbycusis in the older age group. Presbycusis may dilute the ear effect but if this is true then presbycusis must not be simply additive to noise-induced hearing loss.

The fact that a certain amount of the ear effect already present in teenagers and in normal-hearing people of all ages suggests that there is a basic statistical difference of about 1 dB in sensitivity between the left and the right ear, both in the male and the female adult. The difference is independent of asymmetrical noise exposure and susceptibility.

The finding that the ear effect at 0.5 and 1 kHz behaves quite differently from that at the high frequencies is consistent with the theory of the lateral difference in susceptibility because 0.5 kHz and 1 kHz are usually the least affected frequencies in noise-induced hearing loss. The ear effect remains relatively stable over the age groups at these two frequencies. It also peaks at 20-29 dB HL at these lower frequencies and not 30-39 dB HL as at the high frequencies. Presbycusis occurs at a lower hearing level and at an older age at these low frequencies.

CONCLUSION

There seem to be four factors which affect the lateral difference in hearing sensitivity: (1) a basic statistical difference of about 1 dB in sensitivity between the left and the right ear, right ear being the more sensitive one; (2) asymmetrical noise exposure, such as shooting and certain types of occupational noise; (3) asymmetrical susceptibility to noise damage, left ear being statistically the more susceptible one; (4) presbycusis which tends to dilute the effect of lateral difference in hearing sensitivity due to noise.

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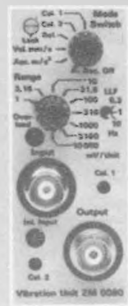

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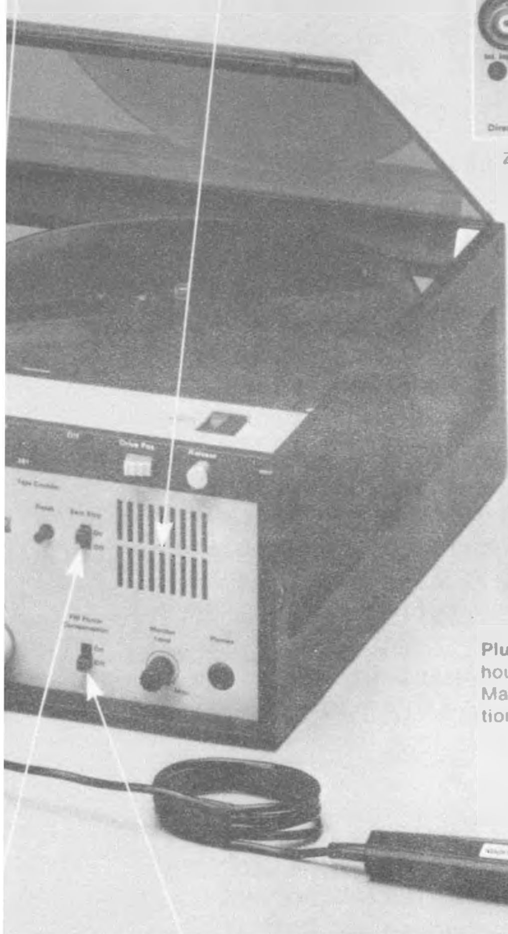

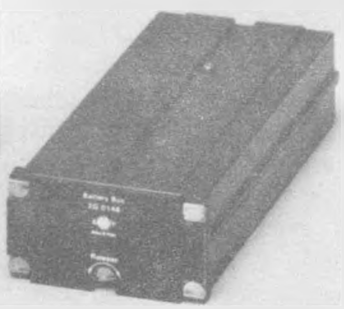

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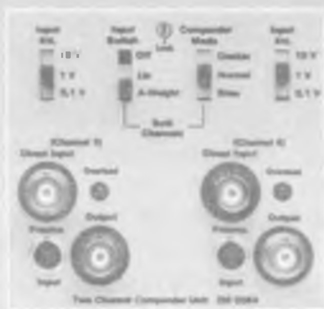

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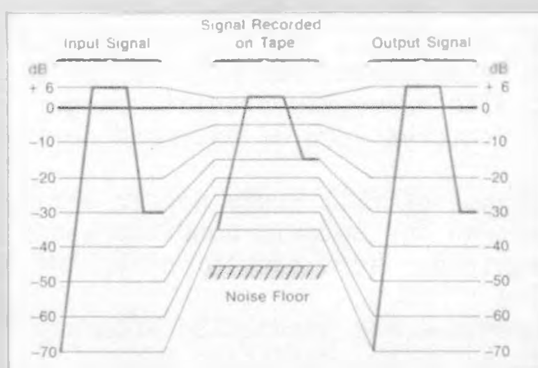

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