THE EFFECTS OF SAFETY GEAR WORN IN COMBINATION AND HEARING LOSS ON EARMUFF ATTENUATION AND SPEECH UNDERSTANDING

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1.0 INTRODUCTION

This study was designed to determine whether the wearing of other safety gear in combination would decrease the sound attenuation of hearing protective ear muffs. Preliminary results showed that, in young normal-hearing listeners, the wearing of safety glasses and a half mask respirator significantly decreased the attenuation provided by a Class A earmuff[1], particularly in the low frequencies.[2] This was due to leakage of sound under the ear cup.[3] A question of interest was the interactive effect of the hearing status of the listener. In previous studies we had demonstrated that, while the amount of sound attenuation achieved was not affected by hearing loss, speech understanding was compromised by the wearing of conventional muffs and plugs.[4,5] We hypothesized that a decrease in attenuation due to the wearing of devices in combination might improve speech understanding in the hearing-impaired listener.

2.0 METHODS AND MATERIALS

2.1 Experimental Design

The design of the experiment has been previously described.[2] To assess the effects of hearing loss, the results were compared for two groups of 24 subjects, aged 40-68 years, with normal hearing and moderate bilateral high-tone hearing loss, respectively. Half of each group were males and half females. Subjects were each tested with the ears unoccluded (UN), and subsequently with Class A earmuffs attached to a hard hat (M), the muffs in combination with safety glasses (MG), the muffs in combination with an air-purifying half-mask respirator (MR), and with the muffs in combination with both the glasses and respirator (MGR). The muff on hard hat was always fit by one of the experimenters (SMA) with the goal of optimizing the attenuation of the muff. In each listening condition diffuse field hearing thresholds were measured in quiet for eight one-third octave noise bands with centre frequencies ranging from 0.25 to 8 kHz. Consonant discrimination was assessed in quiet (75 dB SPL) and in a background of 80 dB SPL speech spectrum noise.

2.1 Subjects

All subjects were fluent in English and had been screened for a history of medical disorders which might signify a central auditory processing deficit or compromise sustained attention and the ability to understand instructions. In the normal-hearing group, headphone hearing thresholds at 0.5 and 4 kHz were less than 15 dB HL on average.[6] In the hearing-impaired group, thresholds ranged from -0.5 to 26.5 dB HL at 0.5 kHz, and 21.5 to 55.5 dB HL at 4 kHz (better ear).

2.2 Apparatus

The apparatus has previously described in detail.[7] The testing was carried out in a semi-reverberant sound proof booth that met the requirements for hearing protector testing.[8]

2.4 Procedure

Hearing thresholds were measured once in each ear for each of the eight one-third octave band frequencies, using a variation of Bekesy tracking.[6] Consonant discrimination was tested by means of the Four Alternative Auditory Feature Test (FAAF).[9] For a detailed description of both protocols, see Abel et al., 2000[2].

3.0 RESULTS AND DISCUSSION

Fig. 1 shows the mean attenuation achieved as a function of stimulus frequency for each of the four protected listening conditions. Attenuation scores were derived by subtracting the unoccluded from the protected hearing threshold at each frequency, within subject. The results for the two groups are shown separately. Data from male and female subgroups have been averaged. An ANOVA and post hoc comparisons applied to these data indicated that there was no effect of hearing status. Overall, females achieved 3-dB less attenuation than males. Regardless of protector condition, attenuation increased significantly as frequency increased from 0.25 to 1 kHz and then remained constant. The least attenuation was achieved with the muff in combination with the glasses and respirator and the greatest attenuation was achieved with the muff alone. The muff/respirator and muff/glasses combinations fell midway between and were not different from each other. The range in attenuation across these conditions was greatest at 0.25 and 0.5 kHz (9 dB) and least at 2 and 3.15 kHz (3-4 dB). For the muff alone, values were lower than the manufacturer's specifications. However, the difference was no greater than 6 dB at any frequency.

An ANOVA and post hoc comparisons on the results of the FAAF test showed that there was no effect of gender. Scores for the impaired group were significantly lower than those for the normal group. For the normal listeners, there was no difference between unoccluded and protected scores. In contrast, for the hearing-impaired, protected scores were significantly lower than the unoccluded scores, by 22% in both quiet and noise. Protector combination was not a significant factor, likely because the wearing of other safety gear had its impact below the speech frequency range. Both groups performed more poorly in noise than in quiet. In the unoccluded condition, mean scores declined by 25% for both groups. In the protected conditions, mean scores declined by 18% and 27% in the normal and impaired groups, respectively.

Conclusions: Decrements in attenuation due to the wearing other safety gear in combination with hearing protective ear muffs were no different for normal and hearing-impaired listeners. As in previous studies, in the normal group, consonant discrimination was unaffected by the wearing of protectors. The hearing-impaired showed significant deficits. There was no additional affect of wearing other safety gear in combination.

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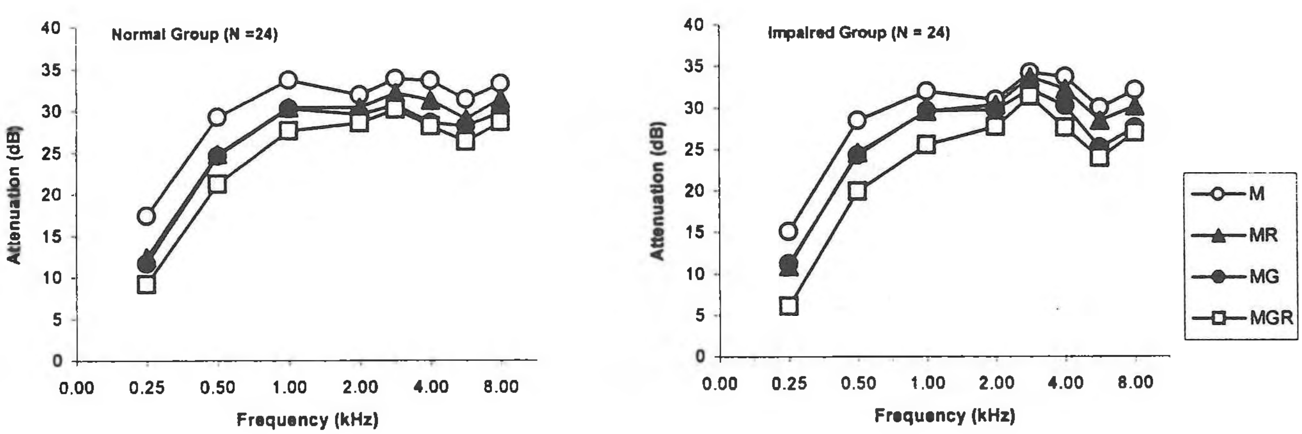

Figure 1. Attenuation as a function of frequency. Efects of ear condition and hearing status.