LETTER TO THE EDITOR

THE EFFECT OF HAIR, GLASSES, OR CAP ON THE PERFORMANCE OF ONE PAIR OF BILSOM VIKING CIRCUMAURAL HEARING PROTECTORS.

by

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ABSTRACT

A pair of modified dosimeters were used to measure the equivalent noise exposure level inside and outside an earmuff simultaneously. The difference of the two measurements was the index of attenuation. In the present study the effect of hair, glasses, or cap on the performance earmuffs was examined with this method of comparative measurement. It was found that although the effect of hair, glasses, or a thin cap was significant in the reduction of attenuation, the amount was usually no more than 5 dB. However, a thick cap caused more than a 10 dB reduction in most cases. The results of this study support the notion of a fitting procedure for this type of earmuff.

SOMMAIRE

Pour mesurer simultanement l'intensite du niveau sonore ambiant et de celui qui est transmis a travers un casque antibruit, on a utilise deux dosimetres modifies. La difference entre les deux mesures representait l'indice d'attenuation. On a applique cette methode dans la presente etude sur l'effet des cheveux, des lunettes ou d'un chapeau sur l'efficacite des casques antibruit. On a constate que meme si les cheveux, les lunettes ou un chapeau mince reduisaient effectivement l'attenuation du niveau sonore, cette baisse ne depassait generalement pas 5 dB. Cependant, le port d'un chapeau epais entrainait, dans la plupart des cas, une reduction de plus de 10 dB. Les conclusions de l'etude favorisent l'idee de proceder a l'ajustement des casques antibruit.

INTRODUCTION

Personal hearing protection plays an important role in any hearing conservation program. There are, however, concerns whether hearing protectors are actually yielding adequate protection in real-world situations. In previous studies[1,2] we measured the field performance of earmuffs with a pair of modified Quest M-8 dosimeters. Results from these two studies indicated that not only the mean attenuation obtained in real-world situations was lower than in the laboratory, but the range and the standard deviation were higher in the former situations.

In the previous field study[2] while we were able to identify some of the obvious causes for low attenuation in the industrial working situations, the effect of hair, glasses, or thin caps on the performance of earmuffs was not clear. The present study was designed to examine these effects in the laboratory.

MEASUREMENT METHOD

Measurements of the noise exposure inside and outside the earmuff were made with a pair of modified Quest M-8 dosimeters, each of which was connected to a ¼-inch ceramic microphone. The 15-cm long portion of the regular cable, that was connected to the microphone, was replaced with a 0.5 mm thick cable. This thin portion of cable, when passed underneath the earmuff cushion, would cause negligible sound leakage[3]. The dosimeter that was to be used to measure the noise level inside the earmuff was modified to have a response range of 60 to 100 dBA instead of the normal range of 80 to 120 dBA.

The two dosimeters had an exchange rate of 3 dB, i.e. 3 dB increase for each doubling of the exposure time. Calibration was done in a B & K (Type 4212) hearing aid test box. The response curves of the two dosimeters were almost identical to each other and flat up to 6 kHz.

Five male subjects were used for all the testing conditions: (1) short hair I, (2) long hair, (3) short hair and glasses, (4) long hair and glasses, (5) long hair and a thin cap, (6) long hair and a thick cap, and (7) short hair II. Five female subjects were tested only for the effect of long hair. Both the short-hair I and II conditions for a male subject were when he had just had a hair cut and with his hair pushed backwards and upwards as much as possible so that the earmuffs were sitting on as little hair as possible. The short hair II condition was just a repeat of the short hair I condition at the end of all testing to confirm the reliability of the test and the condition of the earmuffs after they had been used during the period of the test. In no cases was the hair of the male subjects long enough to cover the whole ear. All female subjects, however, had shoulder-length hair. The short-hair condition for a female subject was when her hair was pushed backwards and upwards as much as possible and the long-hair condition was when the earmuffs were sitting on the subjects' hair both above and below the ear. In both cap conditions, the earmuffs were tested with the seals over the edge of the caps.

The noise source used in these experiments was a pink noise. The octave noise spectrum measured at the ear level of the subject position is shown in Figure 1. The overall noise level was 103 dBA. Only one pair of earmuffs was used in this study, a new pair of Bilsom Viking earmuffs with standard foam seals. They weighed 235 gms.

Each subject was seated inside a double-walled IAC sound insulated room three feet from the two speakers, each of which was located at 45° to either side of the front of the subject.

The inside microphone was taped onto the foam at the center of the cup, facing upwards. The outside microphone was taped onto the center of the cup facing forwards. The earmuff-dosimeter assembly was fitted onto the subject by one of the experimenters. The noise was then turned on for a period of five minutes, after which the readings of both dosimeters were taken. This procedure was repeated ten times. Every time the microphones were taken out and re-attached on the muffs again.

The difference in noise exposure level between the inside and outside dosimeters was the index of attenuation used in this study.

RESULTS AND DISCUSSION

Table I shows the results of the five male subjects. These are comparative data on 1 set of earmuffs under carefully controlled conditions. The numbers shown under the condition short hair I are the mean attenuation data of the ten repetitions. The numbers in parentheses represent the standard deviations. These numbers constitute the baseline data for the subjects. The numbers shown under the remaining conditions represent the difference between the baseline data and the mean attenuation data in each condition for each subject. A paired t-test was performed to test if there was any significant difference between the short hair I condition and each of the other conditions for each subject. The level of significance for each test is shown in parentheses.

It can be seen in Table I that the effect of hair varied with the individual subject. The average effect was small. It did not seem to be related to the thickness of the hair. The subject (DH) with the most hair was the one with the smallest difference.

The effect of glasses also varied with the subject. It was quite apparent that the effect was dependent on how well the glasses fitted against the skin around the ear and how thick the temples of the glasses were.

A combination of long hair and glasses seemed to affect the performance of the earmuffs more than either one of them alone. This was most obvious for subject (DH).

A thin cap and long hair together, seemed to decrease the attenuation of the earmuffs more than with long hair alone. The amount, however, was minimal.

The effect of thick cap on the attenuation achieved by the earmuffs was marked. The mean reduction in attenuation was 13.1 dB. This effect was highly significant in all subjects.

Only four subjects were re-tested again in the short hair condition (short hair II). The difference in results between the first test and the re-test was very small, confirming the reliability of the test.

Table II shows the effect of the shoulder-length hair on female subjects. Despite the fact that the muffs were sitting on the subjects' hair both above and below the ear, the average reduction of attenuation was less than 4 dB. Again, the thickness of the hair did not seem to be related to the amount of reduction.

A word of caution is appropriate here. The amount of sound leakage usually varies with the noise source. For example, if a significant amount of low-frequency noise is present, the effect of long hair, glasses, and thin cap may become serious.

Also, since only a single pair of earmuffs was used in this study and since the effect of hair, glasses, and caps could vary with earmuffs due to, for example, the difference in hardness of seals, the results of this study can only be used as a comparative guide. The absolute amount of reduction in attenuation should not be generalized for different types of noise or earmuffs.

The results of this study support the notion of a fitting procedure for earmuffs. While headgear such as a thick cap or turban is definitely detrimental to the effectiveness of earmuffs, the effect of glasses, long hair, or a thin cap varies with the subject and the noise spectral distribution. The only way to be sure of maximum attenuation, is to test the fit of the earmuffs as suggested in a previous study[2]. It is a relatively simple procedure. All workers exposed to noise levels above a certain intensity, e.g. 100 dBA, should have their hearing protectors fitted by this procedure. Only those hearing protectors that reduce the exposure level to below 85 dBA should be given to the worker. This procedure of fitting earmuffs only takes about 10 minutes, during which time the worker would be able to work. One dosimeter with similar modifications made for this study would be adequate, since in that case all one needs to know is the noise exposure inside the earmuff. Perhaps a small device, which can be placed conveniently inside the earmuff to detect a noise exposure level over 85 dBA, could be developed in the near future at reasonable cost. Such a device would certainly increase the effectiveness of a hearing conservation program.

1. Chung, D.Y., Menyhart, J. and Gannon, R.P. (1982). Single-Number Noise-Reduction Factors of Circumaural Hearing Protectors by Dosimetry. In Personal Hearing Protection in Industry, Alberti,P.W. (ed). New York: Raven Press, 15, 237-247.

2. Chung,D.Y., Hardie, R. and Gannon, R.P. (1982). A Field Study of the Performance of Circumaural Hearing Protectors by Dosimetry. American Industrial Hygiene Association, Journal. (In press).

3. Rood, C.M. and Baines, D.C. (1976). A meter for the measurement of noise dose under circumaural hearing protectors. Royal Aircraft Establishment. Technical Memorandum FS96.

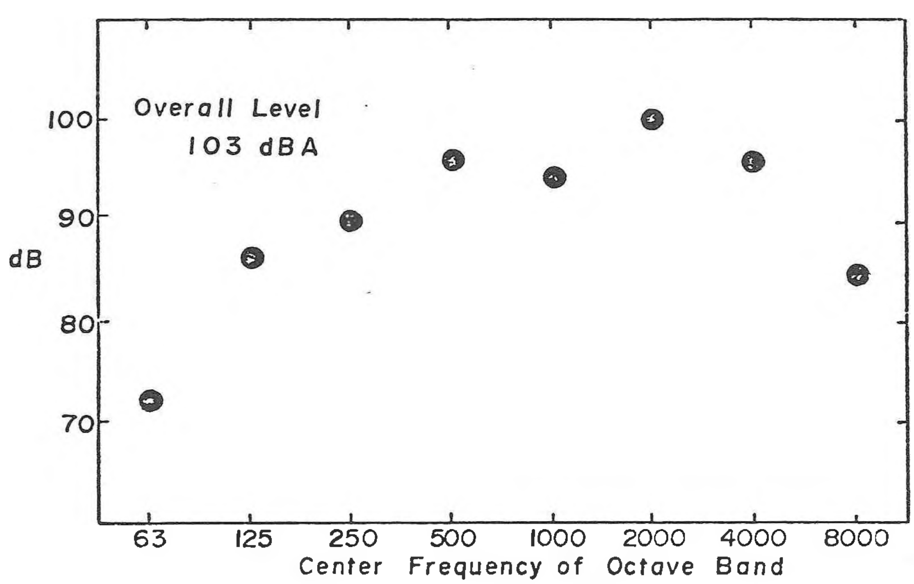

FIG. I Octave spectrum of the experimental noise as measured at the ear level of the subject.

TABLE I The effects of hair, glasses, and cap on the performance of a pair of Bilsom Viking earmuffs in male subjects. Numbers shown under 'Short Hair I' are mean attenuation data in dB and Standard deviations (in parentheses). They constitute the baseline data. The numbers shown under the remaining conditions represent the difference between the baseline data and the mean attenuation data in each condition for each subject. The t-test significance levels are shown in parentheses. NS = Not Significant.

Subject	Short Hair I (attenuation)	Glasses	Long Hair	Long Hair & Glasses	Long Hair & Thin Cap	Long Hair & Thick Cap	Short Hair II
SM	36.45 (2.01)	1.50 (NS)	2.90 (0.05)	4.75 (0.001)	1.85 (0.05)	14.90 (0.001)	-0.45 (NS)
DC	35.60 (1.60)	5.10 (0.001)	2.00 (0.05)	5.95 (0.001)	4.45 (0.001)	9.40 (0.001)	-0.30 (NS)
DH	38.4 (2.18)	-0.40 (NS)	-0.45 (NS)	6.55 (0.001)	3.9 (0.001)	15.75 (0.001)	0.05 (NS)
AM	39.4 (0.88)	1.35 (NS)	0.55 (NS)	3.90 (0.001)	1.20 (0.01)	13.45 (0.001)	1.35 (NS)
HW	38.2 (0.92)	5.40 (0.001)	3.20 (0.05)	6.30 (0.001)	2.1 (0.001)	12.1 (0.001)	—
Mean	37.61	2.59	1.64	5.49	2.70	13.12	0.16

TABLE II The effect of shoulder-length hair in female subjects. See Caption of Table I for details.

Subject	Short Hair I	Shoulder-Length Hair
SA	40.25 (1.01)	8.15 (0.001)
KE	35.05 (1.23)	5.02 (0.001)
MP	41.00 (1.13)	3.55 (0.001)
AC	36.35 (1.99)	0.85 (NS)
LB	37.70 (1.97)	1.50 (NS)
Mean	38.07	3.81

Copies of the Proceedings can be obtained from Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, N.Y. 12603, U.S.A. The two-volume set is $55.00 which includes surface mail postage and handling. Overseas orders should add an extra $25.00 if shipment of the set of books is to be by air.

INTER-NOISE 84

The location for INTER-NOISE 84, to be held December 3-5, will be the Hotel Ilikai, at one end of Waikiki Beach. The conference will be jointly organized by INCE/USA and INCE/Japan.

FASE 84

The 4th Federation of Acoustical Societies of Europe (FASE) Congress will be held in Sandefjord, Norway, 21-24 August 1984. Topics are: (1) Planning with respect to community noise, and (2) Acoustical methods in condition monitoring and analysis. For further information contact FASE 84, ELAB, N-7034 Trondheim-NTH, Norway, Telephone: +47 75 92 645.

Le 4ème Congrès de la FASE (Fédération Européenne des Sociétés d'Acoustique) aura lieu à Sandefjord, Norge, 21-24 août, 1984. Les sujets sont: (1) Les méthodes d'estimation du bruit urbain, et (2) Survellance et diagnostics par méthodes acoustiques. Pour autres informations écrire à FASE 84, ELAD, N-7034 Trodheim NTH, Norge.

CONGRESS ON BIOLOGICAL EFFECTS OF NOISE
- Italy - June 1983

The International Commission on Biological Effects of Noise has announced details of the Fourth International Congress on Noise as a Public Health Problem: Biological and Behavioral Effects. The congress is to be held 20-25 June 1983 in the BIT-ILO Center of Turin, Italy. The official language of the congress is English; simultaneous Italian translations will be available. In addition to the invited and contributed papers on research and applications, major discussions are planned on governmental and industrial needs and problems. Other discussions will be held on ways to develop procedures that will permit practical solutions both for governments and for industry. Inquiries should be addressed to Professor Giovanni Rossi, Department of Audiology, Via Genova 3, 10126 Torino, Italy.

SYMPOSIUM ON MECHANICS OF HEARING
- Delft - July 1983

A "Symposium on Mechanics of Hearing", jointly sponsored by the International Union of Theoretical and Applied Mechanics (IUTAM) and the International Commission on Acoustics (ICA), will be held in Delft, 13-15 July 1983. Approximately 30 invited papers will be presented on recent theoretical and experimental work concerning (i) the mechanical movement of cochlear structures, (ii) related physiological questions, and (iii) the mechanics of the middle ear and external ear. While all aspects (models, measurements, and mechanisms) of these subjects will be covered, the emphasis will be on mathematical modeling. The members of the scientific committee are Prof. E. de Boer (Chairman), Sir James Lighthill, Dr. E.A.G. Shaw, Prof. C.R. Steele, and Dr. M.A. Viergever (Secretary). The Symposium is associated with the 11th International Congress on Acoustics which opens in Paris on 19 July 1983. Further information can be obtained from Dr. M.A. Viergever, Department of Mathematics and Informatics, Delft University of Technology, P.O. Box 356, 2600 AJ Delft, The Netherlands.