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Some subjective effects of infrasound -

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Recent investigations into the occurrence of low frequency noise by Hood and Leventhall (1) have shown that there are high levels of infrasound in a variety of environments. In most of these environments the people subjected to the noise are performing exacting and potentially dangerous tasks, such as flying a helicopter or driving a car. Although Mohr et al (2) showed that short exposures to high levels of low frequency noise produced little effect it was thought that prolonged exposure to the noise might cause some loss of performance.

A chamber was constructed of dimensions 6 by 4 by 3 ft. for simulating the low frequency noise environment. The noise was produced by four 15 in. speakers mounted in the walls and driven by a 300 watt amplifier. The maximum S.P.L. obtained was 126dB for random noise and 145dB for pure tones with the aid of a tunable neck attached to the side of the chamber. The neck and chamber together formed a Helmholtz resonator which could be tuned over a range of 3 Hz to 18 Hz.

The field measurements described in reference (1) indicated that it would be useful to perform the experiments in a random noise field at levels of 110 and 120dB with a control level of 80dB. The high frequency cut-off of the spectrum used was 15Hz, low frequency fall-off being compensated by tuning the system to 3Hz. This gave a flat response from 2Hz to 15Hz. The neck also provided a method of ventilating the chamber by a small fan circulating air into and around the chamber. This gave a background low frequency noise level of 80dB which made the chamber interior independent of variation of infrasonic noise levels in the laboratory. A sound field of 70dB(A) random noise was also fed into the chamber to mask intruding audio noise.

The experiments described in this paper are only preliminary tests carried out on 7 subjects to study the general effects of infrasonic noise. As very little information is available on the effect of infrasound it was required that the subjects had a medical examination before exposure, although it was thought that this would eliminate the people most likely to be affected by the noise.

Audiometric screening of subjects was also carried out in order to exclude subjects with a hearing loss greater than 20dB. Subjects also underwent an audiometric test before and after each exposure to infrasound to determine any T.T.S. induced by the noise.

On entering the chamber the subjects were given 30 minutes to acclimatise themselves to the new environment, during which time they usually read.

The first test to be performed by the subjects was a balance task, similar to the Rail Task described by Sommer and Harris (3). The subjects were required to balance on a rail one inch wide. They were instructed to keep their eyes open and their feet positioned in a heel-to-toe fashion with their arms folded across their chests. The time was measured from the moment the subject assumed the correct position until he violated this position by unfolding arms or lifting his foot and/or stepping off the rail. The trial was terminated after 60 seconds if the subject was still balanced on the rail. A score of less than 3 seconds was not considered valid and the subject was required to repeat the trial. The subject's score was the total time in seconds that he balanced during ten trials, the maximum score being 600 seconds.

The next test was to measure any change in the subject's visual response, reaction time and co-ordination in the noise field using a pointer following method. The pointer of an adapted moving coil meter was projected on to a translucent strip which formed part of the window of the chamber and could be viewed from inside as a dark line moving along the strip. The pointer was caused to oscillate randomly by a voltage with a frequency band between 0.05 and 0.4Hz applied to the meter. The maximum excursion was ± 25 cm. The subjects were required to follow the moving line with a mechanical pointer operated through pulleys by a car steering wheel which also turned a potentiometer. The voltage across the moving coil meter was suitably scaled and subtracted from the output of the potentiometer. The difference voltage, which was a measure of the error, was full wave rectified and the result fed into an integrating voltmeter. The total on the integrator was a measure of the subject's response. The score was noted at the end of every minute, the total test lasting for 10 minutes. (Fig. 1).

A simple single button reaction-time experiment was performed 50 times. As this system was not completely automatic the operator had to endeavour to keep the stimulation as random as possible.

A further test was to treat the subject as an information channel and to determine the effect of noise when the channel was overloaded. The experiment consisted of flashing on to a screen, for 1/30th of a second, a matrix in which a dot was positioned. The subject had to indicate the position of the dot. The greater the order of the matrix the greater the amount of information to be transmitted for the subject to give the correct answer. The experiment was performed with 3 x 3, 4 x 4, 6 x 6 and 8 x 8 matrices. 125 observations took about 15 minutes to perform. The total time for these experiments was about 90 minutes.

The results for the balance, reaction time and pointer following tests were analysed using the analysis of variance technique. The matrix experiment was analysed using information theory.

Two out of the seven subjects tested in this preliminary investigation suffered a T.T.S. of 10dB. One of these complained of tinnitus. In the balance experiment only two of the subjects were significantly affected by infra-sound. The two affected in the first test were different to the ones in the second.

Pointer following and reaction time experiments showed a deterioration in performance in the noisy environment with a significance better than 0.1%. The results for these tests are shown graphically in figs. 2 and 3.

The amount of information transmitted was not affected by the noise, even when the channel capacity was completely overloaded, as with the 8 x 8 matrix. This can be explained by noting that the subjects were given a warning when the matrix was to appear and by assuming that the noise has no effect on the instantaneous overloading of the channel capacity.

These preliminary experiments show that the performance of certain tasks can be affected by levels of infrasound similar to those which we have measured in, for example, transport environments. Work is continuing to obtain further information on the subjective effects of infrasonic noise.

REFERENCES

(1) Hood, R. A. and Leventhall H. G., Acustica, Vol. 24 No. 7, 1971.

(2) Mohr, G. C. et al, Aerospace Medicine, Vol. 36 No. 9, 1965.

(3) Sommer, H. C. and Harris, C. S. AMRL-TR-70-26, 1970.

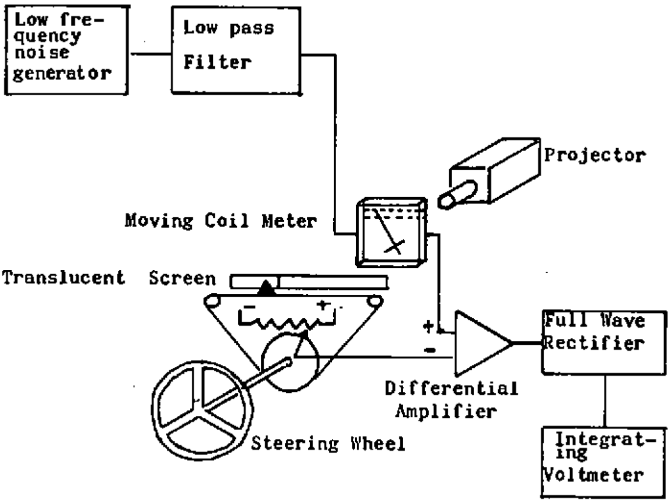

Fig. 1. The pointer following system

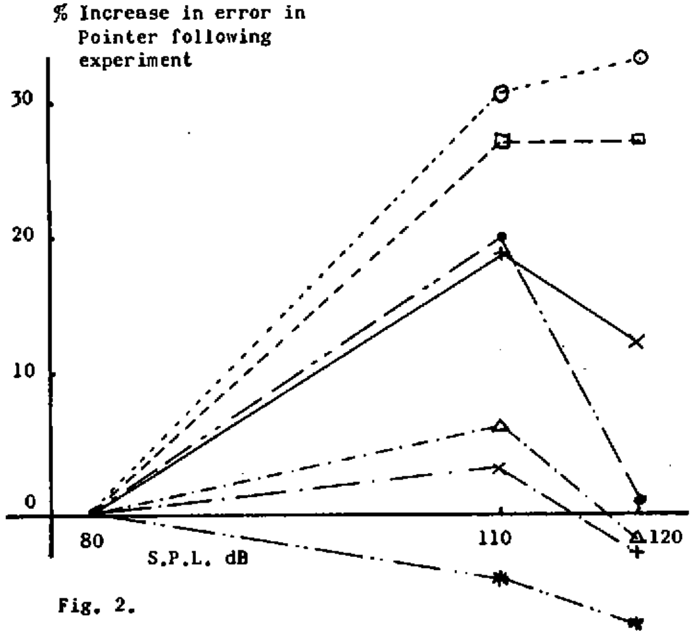
% Increase in error in Pointer following experiment
30
20
10
0
80
110
120
S.P.L. dB

Fig. 2.

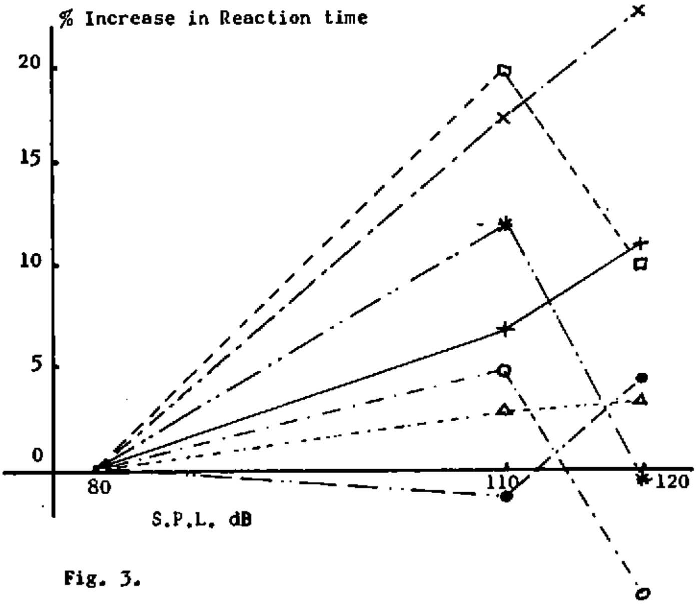
% Increase in Reaction time
20
15
10
5
0
80
110
120
S.P.L. dB

Fig. 3.