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PHYSIOLOGICAL CHANGES PRODUCED DURING EXPOSITION TO DIFFERENT FREQUENCIES AND LEVELS OF INFRASOUND

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INTRODUCTION

The present paper is a description of two series of laboratory experiments carried out in order to study physiological changes produced during exposition to infrasound. The immediate aim was to analyse the importance of infrasonic frequency and pressure level. Measurements were made on EEG, blood pressure and heart activity. The investigation was particularly directed on changes in wakefulness.

METHOD

Exposition to infrasound was carried out in a chamber previously described by Landström et al. (1, 2). The first serie of experiments included expositions to different frequencies, 6, 12, 16 Hz and adjacent pauses without infrasonic exposition (pause 20 minutes, exposition 20 minutes, pause 20 minutes etc.) During all expositions the pressure level was adjusted to 125 dB(lin). The second experiments were carried out in a corresponding way but with alternating pressure levels, 95, 110 and 125 dB(lin). During these expositions the frequency was adjusted to 16 Hz. In both types of experiments measurements were made on EEG, blood pressure and heart activity. Recordings on EEG were made in periods of 10 minutes, 5 minutes at the end of every pause and 5 minutes at the beginning of every exposition. The EEG diagnosis were based on bipolar recordings from the occipital region. During the EEG recordings the subject was sitting with his eyes closed. The number of seconds with theta activity, indicating reduced wakefulness, was estimated manually on the basis of Mingograph recordings. Measurements on blood pressure and heart activity were made at intervals of two minutes throughout the experiments. The measurements were based on automatic re-

cordings (2).

RESULTS

When the subject was sitting in a relaxed position with his eyes closed the most prominant part of the EEG was a regular pattern of waves at the frequency of 8 - 12 Hz. This pattern, named alpha rhythm, is a pertinent electroencephalographic picture of the waking state. During onset of weariness the alpha rhythm is replaced by characteristic waves of lower frequency, 4 - 7 Hz. During onset of reductions in wakefulness these alpha waves are appearing irregularly in periods of 1 - 10 seconds. In the present experiments the appearance of theta waves has been used as an indication of reduced wakefulness.
The breakup of alpha pattern and appearance of theta waves was found to be more pronounced during exposition to 6 Hz than during exposition to 12 and 16 Hz (Table 1). The effect was also more pronounced during exposition to 95 and 110 dB(lin) than during exposition to 125 dB(lin) (Table 2). The significance (p) of the results obtained is given in the tables.

Table 1. Occurance of the theta waves (seconds/5 minutes) during periods of infrasonic exposition (125 dB(lin)) at different frequencies compared to adjacent pauses. Values in the table calculated as follows: Seconds of theta waves during exposition (seconds/5 minutes) minus theta waves during the pauses before and after exposition (mean value in seconds/5 minutes). Number of subjects 20.

	6 Hz (sec/5 min)	12 Hz (sec/5 min)	16 Hz (sec/5 min)
*	+ 23.2	+ 5.6	+ 2.8
**	0.012	> 0.05	> 0.05

* = Mean value
** = Level of significance of the difference between exposition and pause (p-values). Paired t-test.

Table 2. Occurance of the theta waves (seconds/5 minutes) during periods of infrasonic exposition (16 Hz) at different pressure levels compared to adjacent pauses. Calculations of the values, see Table 1.

	95 dB(lin) (sec/5 min)	110 dB(lin) (sec/5 min)	125 dB(lin) (sec/5 min)
*	+ 29.0	+ 21.0	+ 2.8
**	< 0.01	0.059	> 0.1

* = Mean value
** = Level of significance of the difference between exposition and pause (p-values). Paired t-test.

Changes in the mean values of blood pressure and heart activity during exposition can be summerized as follows:

1. Significant reductions in heart activity during all type of infrasonic exposition at the level of 125 dB(lin) irrespective of the frequency ($p < 0.02$).
2. Reduction in diastolic pressure during exposition (125 dB(lin)) at 6 Hz ($p < 0.05$). The effect at 12 Hz and 16 Hz was not significant.
3. Reduction in systolic blood pressure during exposition (125 dB(lin)) at 16 Hz. The effect of 6 Hz and 12 Hz was close to the significant level $p = 0.05$.
4. Changes in heart activity and blood pressure not significant during exposition at 95 dB(lin) and 110 dB(lin) (16 Hz).

The reductions in blood pressure and heart activity are thought to be correlated to reductions in wakefulness.

DISCUSSION

According to the present results exposition to infrasound is effective in production of reduced wakefulness. The effect is verified by changes in EEG and in some cases also through changes in heart frequency and blood pressure. Refering to the results obtained in the present study moderate pressure levels seem to be more effective in production of weariness. As expected, if pressure level is too high, the reduction in wakefulness does not occur. It thus seems as though pressure levels in the region of colear perception threshold are the most effective, i.e. at 90 - 130 dB(lin) depending on the frequency.

Perception to infrasound is based on hearing and vibrations in different parts of the body. The range of hearing threshold is described as being about 100 - 110 dB(lin) at 6 Hz and about 85 - 95 dB(lin) at 16 Hz (3). Sensations through vibrations will occur at levels 20 - 30 dB above the hearing threshold. 125 dB(lin) at 6 Hz and 95 - 110 dB(lin) at 16 Hz thus will be auditory sensed as a moderate stimuli. 125 dB(lin) at 16 Hz will be auditory sensed as a high level producing waking effect.
As far as weariness through infrasound is concerned the effect is thought to be based on the moderate monotonous coclear stimulation with the following supressing influence on the reticular formation, cerebral cortex and other parts of the nervous system. These hypothesis (2, 4) are supported by a newly finished investigation, according to which reduction in wakefulness by infrasound, does not occur in subjects with neurosensory deafness. 10 deaf and 10 hearing subjects were exposed 20 minutes at 6 Hz, 115 dB(lin). Reduced wakefulness was noticed among the hearing subjects but not among the deaf subjects (to be published during 1983).
According to these different investigations changes in wakefulness during infrasonic exposition is based on hearing; weariness occuring above and close to the hearing perception threshold. At present, these hypothesis are tested by expositions at pressure levels below the auditory threshold values. A study has also been introduced to investigate the effect on wakefulness by masking the sensations of infrasound through harmonics.

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