inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 62

THE EFFECTS OF LOW FREQUENCY NOISE ON MAN - TWO EXPERIMENTS

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1.INTRODUCTION

The peculiar characteristics of the efects produced by low frequency noises on man - such as the resonances of the body, the association with natural phenomena and the fear of structural damages in buildings produced by the vibrations of doors and windows - show the importance of finding limits of risk for health.

Our early studies with the Infrasonic Detection Station, set up in the vicinity of Cordoba City [1], as well as our field recordings and laboratory analysis allowed us to confirm the presence of infrasound in our City environment [2].

A research in various stages was designed with the general purpose of finding out the minimum low frequency noise levels which produce effects on man, as well as the modulator variables influencing these effects.

In order to achieve that objective, two experiments were carried out with the following especific aims:

Experiment 1 (E1) [3]: To ascertain: a) whether exposure to different very low frequency tones, produces changes in Ss' heart rate (HR) and peripheral temperature (PT); body resonances (BR) and subjective assessment of the environment; b) whether there was a relationship between Ss' hearing thresholds (HT) and said changes.

Experiment 2 (E2): To ascertain: a) whether exposure to a pure infrasonic tone or to a real noise filtered and centered in the same tone produced changes in: HR, PT, respiratory rate (RR), GSR, anxiety state, body resonances and subjective assesment of the environments and b) whether there was a relationship among Ss' anxiety and said changes.

2.METHOD

Both experiments were carried out in a presure chamber.

Experiment 1

Subjects: 25 university students (18-25 years) were randomly assigned to four experimental and one control conditions.

Experimental Conditions (EC): each EC consisted of 30 min of exposure to one of the following steady pure tones and levels: 10Hz/110dB, 20Hz/97dB, 40Hz/89dB and 80Hz/68dB, followed by 10 min without sound stimulus. These levels were fixed at approximately 25 dB over the mean hearing thresholds with harmonics kept 10 dB lower than the fundamental.

The control condition was without sound exposure.

Instruments and Materials: HR and PT were measured automatically by means of a computer with ad-hoc preamplifiers and electrodes.

A form with a human figure was used for indicating place and type of subjective body resonances.

Another form with Semantic Differential Scales (SDS) for subjective judgements allowed subjects to assess the sound environment.

Experimental Procedure: Hearing thresholds (HT) in 10, 20 and 40 Hz were measured. The first physiological measurement was registered without the sound stimulus continuing the register every 2 min. Subjective judgements were performed during the 30 min of exposure period. The same procedure was used with the control group.

Data Analysis: 1) Mean HT of the Ss where obtained for 10, 20 and 40 Hz.
2) Physiological parameters: a) charts of trends were made with every 2 min measurements and b) two differences were obtained: the first between the first physiological value (before the exposure to the stimulus) and the last during the exposure; the second, between the last measurement during the exposure and the last after 10 min of quiet.
3) Correlations were carried out among Ss' HT and their performances in physiological and psychological variables for each EC.
5) In order to study differences in Ss' responses to the different sound stimuli, nine ANOVAS were performed: grouping factor being the five EC and the dependant variables were the physiological and psychological variables.
6) Place and kind of Ss' BR were described for each EC.

Experiment 2

Subjects: 22 university students (18-25 years) carried out in a randomly asigned order, the same tasks in three experimental conditions - with a delay of one week between each of them.

Experimental Conditions (EC): Each EC lasted 60 min, with the following designs: 1) 30 min exposure to a 10 Hz/ 110 dB tone; 2) 30 min exposure to a boiler noise filtered in 1/3 octave band centered in 10 Hz the level at which was 105± 2 dB. In both cases the stimuli were preceded and followed by 15 min without any sound stimuli and 3) 60 min without sound stimulus exposure.

Instruments and Material: Anxiety was measured with the Trait and State Spielberger's Scales. The physiological parameters, BR and SDS assessments were measured in the same way as in E1. Some scales were added.

Experimental Procedure: In a previous session Trait Anxiety Scale was completed. As in E1, HT were measured at the beginning of the experiment while the physiological parameters were registered every minute during the 60 min of each EC. The SDS, BR as well as the State Anxiety Scale, were completed during sound exposure in both EC and during the same period of time in control condition.

A simple pencil-paper task was fulfilled by the subjects while they were not performing the main tasks.

Data Analysis: 1) Charts of trends of the physiological variables performance in all the EC were performed: a) for each Ss' individual values and b) with the means of the group.

2) Correlations were carried out among state and trait anxiety and HT at 10 Hz and the SDS subjective judgements.

3) To ascertain if the sound stimuli had influenced Ss state of anxiety and the subjective judgements, ANOVAS for repeated measurements were performed with the corresponding post-hoc tests.

4) To study BR the same procedure as in E1 was fulfilled.

3.RESULTS

Experiment 1

1) The following mean HT of the 25 subjects were obtained: 10 Hz = 94.10 dB; 20 Hz = 79.63 dB; and 40 Hz 61.67 dB.

2) Charts of trends of the physiological parameters did not show differences among the groups.

3) Non-significant correlations among variables were obtained.

4) ANOVAS showed: a) non-significant differences among groups in the physiological parameters b) significant differences in SDS, among groups, in the scales agreeable-disagreeable and noisy-quiet. Ss judged more unfavorably the 10 Hz, 20 Hz and 40 Hz exposure conditions than 80 Hz and control.

5) The most frequent BR were: a) In 10 Hz EC: vibration and pressure especially in head and ears; b) In 20 Hz EC: vibration and tickling in ears, nape and head and vibration of shoulders; c) In 40 Hz EC: pressure in the ears being also localized on head and nape; d) 80 Hz EC: there were no common sensations.

Experiment 2

1) Physiological parameters:

Only in 10 Hz tone exposure condition an instability of values (without any trend) for heart rate was observed after the first 15 min, that is during sound exposure.

2) Correlations according to each of the SDS showed the following significant relationships: In 10 Hz EC: a) trait anxiety with acceptable-unacceptable ($r=.57$; $p \leq .01$); b) state of anxiety with agreeable-desagreeable and

beneficial-harmful (r=.57; p≤.01 and r=.55; p≤.01) respectively. In boiler noise EC: State anxiety with beneficial-harmful and exciting-calm (r=.57; p≤.01 and r=.65; p≤.01 respectively).
3) ANOVAS a) There were significant differences in the following SDS: agreeable-disagreeable, beneficial-harmful, charming-noncharming, acceptable-unaceptable, strong-weak, shrill-soft, arousing-drowsy, exciting-calm, soothing-startling, concentrating-distracting and harmonious-unharmonious, among the control and both exposure conditions, being more unfavourable in the last conditions.
4) The most frequent BR were: a) in 10 Hz EC vibration and pressure and annoyance, especially in head, ears, nape and back; b) in boiler noise EC vibration in ears, foot, head and nape; pressure in head and annoyance in ears, head and in general.

4.CONCLUSIONS

If we analize Ss' judgements about the sound exposure, we can say that in both experiments they clearly differenciate the experimental conditions. In E1 Ss evaluate as significantly more unfavorably 10, 20 and 40 Hz EC and in E2 both exposure conditions. There were a relationship between anxiety and some of the scales: as more unfavorable the judgements more anxiety showed the Ss. BR localizations in 10 Hz EC didn't coincide exactly with those reported by other autors indicating abdomen and breast [4,5], lumbar region, buttocks and nape [6]. In boiler noise EC Ss reported similar sensations than in 10 Hz EC but added in other zones of the body, as said in the results.

We can conclude that the sound levels in both experiments did not produce any physiological effects on Ss, while psychological and corporal effects could be observed.

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