

ENVIRONMENTAL NOISE AND PHYSIOLOGICAL EFFECTS

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INTRODUCTION

In the course of years, much has been published about the influence of short exposures to noise on the human body. All described laboratory experiments show that exposure to noise for some seconds up to a few minutes cause sudden changes in many physiological functions. Hardly anything has been published about the influence of noise exposure of a longer duration. Therefore the TNO Research Institute for Environmental Hygiene decided to carry out an investigation into the influence of noise exposures of longer duration on bloodcirculation and respiration. In a first investigation carried out in the institute it was found that two-hour exposure to fluctuating white noise and traffic noise caused larger effects in the physiological parameters measured than two-hour exposure to constant white noise with even higher equivalent soundlevels. Therefore a second investigation was carried out on the physiological effects of different environmental noises with a fluctuating or impulsive character. In this paper some details about this second investigation are presented.

EXPERIMENTAL METHOD

In total 88 experiments were carried out with fifteen subjects. Of the fifteen subjects eight (4 women, 4 men) were aged between 20 to 30 years and the other seven (3 women, 4 men) between 40 and 66 years. During six different experiments the subjects were exposed either to road traffic-, aircraft-, railway- or synthetic impulsive noise or quiet. The aim was to study the effects caused by a two-hour exposure on the heart rate, vasoconstriction, the systolic and diastolic bloodpressure and the respiration rate. At the end of each experiment the subject was asked for his or her subjective experience of the noise exposure concerned.

During an experiment a test subject was alone in an air-conditioned room. During the whole experiment the subject had to sit on a bench. The background noise level in the room was about 35 dB(A). By ringing a bell, the subjects could contact the experimenter. When there was no task to carry out the subjects were permitted to read a magazine or a book during the experiment. Most experiments were carried out in the morning and there was only one experiment a day.

Each experiment can be divided into three periods:

- Period 1, duration one hour. In the last 20 minutes, the physiological signals are recorded. (The test subject is sitting in a quiet environment).
- Period 2, duration two hours. The test subject is exposed to noise and has to carry out a task.
- Period 3, duration one hour. Without exposure to noise.

During the last two periods also the physiological signals are recorded.

To see whether any effects, caused by noise, occurred, the subjects also had to participate in two control experiments without exposure to noise in period two. One control experiment with a task and another without.

During period 2 of the experiments with noise exposure and one control experiment the subject had as a task to look for a small red coloured dot projected in some of the slides projected on a screen. This simple task had to be done to keep the test subjects alert. In all experiments the equivalent sound level during the exposure to one of the noises was 75 dB(A). The road traffic noise was recorded in a town near a crossing of a very busy highway with traffic lights. The railway noise was recorded near a station where a lot of through trains pass. The aircraft noise was recorded in a forest near a big airfield. The impulsive noise consisted of synthetic impulses.

The physiological signals taken from the subjects were converted into electrical signals and then processed by a computer. During the whole experiment the number of heart beats and respirations were counted each minute. For calculating the sinusarithmia, the time between every two heartbeats was measured and after this the irregularity of these interval times was derived also by computer each minute. From the relative part of the impedance plethysmogram, the maximum value of the signal, occurring as a result of a contraction of the heart, was determined, also for each minute the mean value was calculated by computer. A reduction of the amplitude of the relative impedance plethysmogram is a result of a vasoconstriction.

For all periods and all parameters the median value was calculated. From all values of the parameters of period 2 and 3 so-called normalized values, relative, to the median value of the parameter during period 1, were derived. In this way it was possible to compare results of different experiments and exposures with each other.

RESULTS

Physiological effects

For all subjects together the means of the normalized values were calculated for period 2 and 3 for each physiological parameter and for each different type of experiment. In comparing with the values of the control experiments and those of the experiments with noise exposure various statistical significant changes due to noise exposure had been established in period 2. The percentiles of these changes are given in table 1. In all cases the increase in the heart rate or respiration rate, when exposed to one of the noises was statistical significant.

Impulse noise caused the largest effects in respiration rate and almost the largest in heart rate. Also a small increase in the systolic and diastolic bloodpressure was found. Again impulse noise caused the largest and also statistically significant increases in bloodpressure. Compared with control experiments with a task noise will cause a small vasodilatation, given by an increase of about 1.5% in the amplitude of the plethysmogram. Compared with control experiments without a task vasoconstriction (4.4%) is observed. Further it was observed that within one hour after ending the noise exposure all physiological parameters were back on their baseline.

Noise from	Vasoconstriction		Heart rate		Respiration rate		Bloodpressure			
	(1)	(2)	(1)	(2)	(1)	(2)	Systolic		Diastolic	
							(1)	(2)	(1)	(2)
Trains	+4.9 s	-1.0 n	+3.7 s	+4.5 s	+8.6 s	+3.4 s	+0.8 s	+2.8 s	+0.1 n	+0.2 n
Road traffic	+3.1 s	-2.9 s	+1.6 s	+2.4 s	+6.5 s	+1.4 s	+1.1 n	+3.1 s	+1.4 n	+1.5 n
Air-crafts	+3.3 s	-2.7 n	+1.5 s	+2.3 s	+3.3 s	-1.6 s	+2.8 n	+4.8 s	-0.3 n	-0.2 n
Impulses	+6.3 n	+0.6 n	+3.5 s	+4.3 s	+10.1 s	+4.9 s	+3.0 s	+5.0 s	+3.6 s	+3.7 s
Mean	+4.4	-1.5	+2.6	+3.4	+7.1	+2.0	+1.9	+3.9	+1.2	+1.3

s : statistical significant n: not statistical significant
 (1): compared with control exp. without a task
 (2): compared with control exp. with a task

Subjective experience of noise exposure

Impulse noise seemed to be the most annoying of all noises. In table 2 the annoyance percentiles are given for all noise exposures. Also the test subjects were asked in which environment they would prefer to live if they had to choose to live in an environment with mainly railway, or road traffic, or aircraft noise. The results of this question are given in table 2. Most of the subjects don't like living in an environment with aircraft noise.

Table 2 Subjective parameters

Noise source:	% subjects that were most annoyed or annoyed	Preference to live in an environment with mainly one of the noise sources		
		First choice	Second choice	Third choice
Impulse noise	76.9%	*	*	*
Railway noise	61.5%	60%	30%	10%
Road traffic noise	50.0%	40%	40%	20%
Aircraft noise	57.1%	10%	70%	20%

CONCLUSIONS

To conclude it can be said that a two-hour exposure to environmental noise will cause a statistically significant increase in the heart rate and respiration rate, a small increase in the systolic bloodpressure and some vasoconstrictive changes. The tendency to the increase in parameters of bloodcirculation and respiration, when subjects are exposed to noise can be explained if noise is considered to be a stressor.

It is also shown that exposure to impulse noise causes larger effects than exposure to other noise sources. Although the equivalent sound levels of the two-hour noise exposures were higher than most levels in our living environment, in the latter case, the exposure time will be longer and in the course of years this may result in the same or worse effects on human beings. So one has to be careful in deciding to build houses in the neighbourhood of factories making impulsive noises or near airfields. Furthermore it is recommended that further research will be carried out on effects of exposure to impulse noise with equivalent sound levels up to 70 dB(A) for periods of more than two hours.

REFERENCES

- Rövekamp, A.J.M. Environmental noise and physiological effects. Effects of environmental noise exposure on bloodcirculation and respiration of human beings. Results of a two-hour noise exposure Report B 467, Delft, IMG-TNO, 1981.