Acute Annoyance caused by Noise emitted from Rail and Road Traffic

Edna Leue, Martin Schütte, Barbara Griefahn
Institut für Arbeitsphysiologie an der Universität Dortmund, Ardeystraße 67, D-44139 Dortmund,
Email: leue@ifado.de, schütte@ifado.de, griefahn@ifado.de

Introduction and working basis

Previous field studies and meta analyses have found a differentiated effect of noise sources and noise levels on acute annoyance [1]. The „annoyance“ concept [2] we refer to comprises that any annoying noise is undesired noise and that annoyance is a subjective characteristic of a sound. Furthermore annoyance refers always to a certain noise event (i.e. the impact of rail noise may differ from the impact of road noise as empirically confirmed), and the level of annoyance depends on the specific situation, i.e. the accomplished activity or task. For the measurement of longterm annoyance, the ISO recommends the application of the following standardized 5-point rating scale: “Thinking about the last (...12 months or so), when you are here at home, how much does noise from (...noise source) bother, disturb, or annoy you?” [3]. When persons are asked to give global ratings about annoyance, it is unknown how persons form their judgements and which aspects determine their judgments. Therefore the present experiment focuses on the activity or task as one additional predictor for acute annoyance.

Problem and hypothesis

According to the proposed annoyance concept it is expected, that perceived annoyance depends on a person´s activity, on the levels and sources of noise. For example, at very low sound pressure levels, most persons presumably rate noises as “not at all annoying” - no matter what they are doing. At very high sound pressure levels most persons may feel extremely annoyed - no matter which activity they are engaged in. But at a medium sound pressure level persons could have opportunity for interpreting, whether they feel disturbed e.g. in reading a complex text or whether they are not at all annoyed while doing some routine work. Taking empirical outcomes into account, it is reasonable to assume, that an interaction exists between noise source, level and kind of activity.

Method

The experiment reported here was conducted in three laboratories (Eichstätt, Dortmund, Essen), each laboratory investigating 24 subjects.

Subjects

72 male and female students, aged between 20 and 30 years took part in the experiment (mean=24.6, ±3.3 years). They listened to a total of 24 sounds while sitting at a single workplace in a sound proof room. Their hearing acuity was controlled by questionnaire. Noise sensitivity was measured by the so-called “DoLe” questionnaire [4], where the maximum rating score with 105 points indicates a very high noise sensitivity. The values for the 72 persons studies here varied between 16 to 81 with a mean score of 50.3 (± 14.5).

Measuring annoyance

The noise presentations were followed by 14 questions, eight of them referring to the expected annoyance for the 8 activities described in Table 1. The selected activities should represent tasks the subjects are used to perform, as well as a broad spectrum of different demands on cognitive capacities.

(1)	talking about an important subject
(2)	talking to somebody on the telephone
(3)	listening to the radio/music or to watch TV
(4)	reading, to think or to concentrate on a certain task
(5)	talking to friends or acqaintancies
(6)	falling asleep
(7)	sleeping during the night
(8)	doing some housework

Table 1: List of activities to be imagined

The questions worded the following: “Thinking about the noise you just heard, please imagine you are *talking about an important subject*, how much would you be bothered, disturbed or annoyed by the noise?” The presented rating scale (1-50) took pattern from a 50-point scale from hearing acoustics, high scores representing high acute annoyance. The labels (“extremely, very, moderately, slightly, not at all”) correspond exactly to the ISO recommendation [3].

Design

Following an introduction and a questionnaire one half of the subjects (balanced gender) heard in the first part of the experiment 12 rail noises and in the second part of the experiment 12 road noises. The other half heard the noise sources in reversed order. Additionally, the partcipants rated the imagined annoyance for each of the 8 activities. The whole experimental process was computer controlled.

Description of noises

Each subject listened to 8 different road and 8 different rail noises. Four sounds per source were presented twice. Every noise scenario was presented for 3 minutes, the sound pressure levels (Leq) varied from 40 to 82 dBA (see Table 2). Within both noise sources all conditions were randomised.

noise source	sounds presented 1rst time (dBA)	sounds presented 2nd time (dBA)
road	40, 46, 52, 58, 64, 70, 76, 82	40, 52, 70, 82
rail	40, 46, 52, 58, 64, 70, 76, 82	40, 52, 70, 82

Table 2: Noise sources and noise pressure levels presented

Recordings of road noise comprise passenger cars travelling on a main road at a velocity of about 70 km/h. Recordings of rail noise consist of different kinds and durations of trains passing by at different velocities.

Evaluation

Variables

An analysis of covariance (BMDP) was performed with the individual noise sensitivity score as covariate. Independent variables were noise source (rail/road), noise level (40, 52, 70, 82 dBA), repetition, imagined activity (see Table 3), laboratory (Eichstätt, Essen, Dortmund) and gender.

Results

Table 3 shows the results of the analysis. Sensitivity to noise significantly co-varies with annoyance ratings (p=0.03). The postulated interaction between noise sources, levels and activities was not confirmed. Examining the main effects, firstly a significant effect of noise level on annoyance was observed (p<0.01). Furthermore there was a significant effect of noise source (p<0.01), where the annoyance due to rail noise was rated slightly higher than the annoyance due to road noise.

Variable:	*F=*	*probability p*
covariate (DoLe score)	4.76	=0.03
noise source (NS)	16.26	<0.01
noise level (NL)	788.49	<0.01
activity (A)	7.74	<0.01
gender (S)	0.96	n.s.
laboratory (Lab)	3.12	n.s.
repetition (R)	6.53	=0.01
NL x S	3.07	=0.03
NL x Lab	4.17	<0.01
NL x R	4.04	<0.01
A x NL x Lab	1.64	<0.01
A x R x NL x Lab x S	1.57	=0.01
NS x NL x A	0.84	n.s.

Table 2: Main effects and interactions - results from the analysis of covariance.

Furthermore for the activities a significant effect was found (p<0.01). There was a slight difference between activity no. 1 (mean=28.7) and no. 8 (mean=27.0). Besides this there was an interaction between gender and noise level on annoyance (p=0.03): at lower noise levels male subjects rated annoyance higher than female subjects, while at higher noise levels the male subjects rated the annoyance lower than female subjects. Additionally, the interaction between repetition and laboratory differed slightly (p=0.01), a significant interaction of repetition occuring at a level of 52 dBA.

Conclusions

The hypothesized interaction between noise source, noise level and activity was not confirmed. Thus only the main effect of noise level seems to be of practical relevance, with respect to the difference between the corresponding mean values. In contrast to this result the relative small effects of the other experimental factors is surprising and may hint to some interfering variables: At first, the subjects listened to the sounds without actually performing any real activity. They just had to imagine being at home and hearing the noises. It was not controlled, whether and how well they put themselves into the different situations. This artificial (laboratory) situation could have provocated subjects to focus only on noises. It could be expected that real execution of activities would have a distracting effect and lead to different evaluations of annoyance. Beyond this it might be possible that the annoyance ratings reflect the attraction of the activities. Considering a persons´ real or imaginated activity also requires information about motivational aspects. Differences in the three samples (laboratories) as well as differing acoustical properties of laboratories may count as explanations for the slight interaction between the laboratories and noise levels. In the follow up experiments, these effects will be reduced and controlled as far as possible. Nevertheless the results of the present experiment justify the assumption that activities should not be ignored, because they significantly influence annoyance. When measuring annoyance it seems to be useful to take activities or tasks into consideration, particularly because it could be expected that in the future people do home activities as well as business-work in their domiciles. Additionally differences between male and female persons are important. Therefore both variables - activity and gender - represent useful predictors in a dosis-response-model.

Acknowledgements

The study was made possible in the frame of a “Quiet Traffic” project, which is funded by the German Ministry of Education and Research.

References

[1] Miedema, H.M.E. & Vos, H. Exposure response functions for transportation noise. Journal of the Acoustical Society of America **104** (1998), 3432-3445

[2] Guski, R. Interference of activities and annoyance by noise from different sources. Some new lessons from old ideas. In Schick, A. & Klatte, M. (eds.) Contributions to Psychological Acoustics. Results of the Seventh Oldenburg Symposion on Psychological Acoustics. Oldenburg: BIS (1997), 221-238

[3] Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys. ISO TC 43/SC 1 (2002)

[4] Schütte, M. & Marks, A. Entwicklung des Dortmunder Lärmempfindlichkeits-Fragebogens (DoLe). In: Gesellschaft für Arbeitswissenschaft (Hrsg.), Arbeit + Gesundheit in effizienten Arbeitssystemen. Dortmund: GfA Press, 2004, 387-390