Protecting people against transportation noise – Overview the section 'Noise effects' within the research network 'Quiet Traffic'

Barbara Griefahn

Institute for Occupational Physiology at Dortmund University, D-44139 Dortmund, Germany,

Email: griefahn@ifado.de

Introduction

Due to conscious perception noise is the most annoying environmental pollutant leading to various extra-aural effects like disturbances of acoustic communication, of sleep and rest and of autonomous functions which are observed during noise exposure and categorized as primary effects. Annoyance and degraded performance are secondary effects (Fig. 1). Impaired performance results from noise-induced elevated arousal, from masked acoustic information, from distraction or from sleep disturbances that affect the ability to concentrate on a task. Impaired performance contributes to annoyance, which is known to result from interference with various activities. It is even assumed that noise constitutes a health risk and contributes in the long run to the genesis of chronic cardiovascular diseases. Though the latter assumption has not yet been proven, the primary and the secondary effects are, due to the WHO-definition of health as a state of complete physical, social and mental well-being, categorized as health effects. Thus, noise abatement becomes an essential element in public health care.

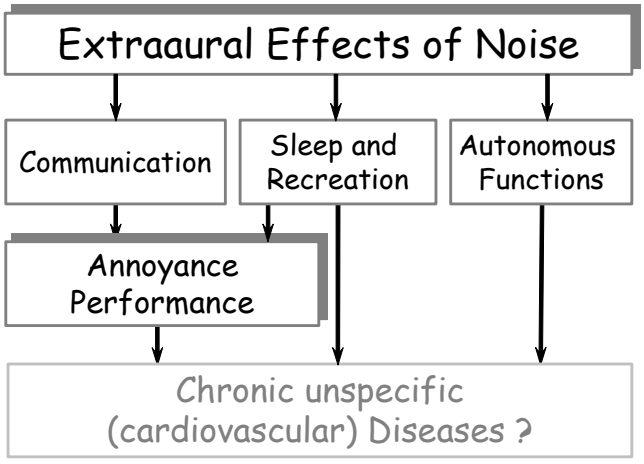

Fig. 1: Extraaural effects of noise

Research Network 'Quiet Traffic'

Transportation is the major source of environmental noise pollution. Though it was possible to attenuate the noises emitted by single vehicles considerably, the overall equivalent noise level was elevated by an unproportional increase of traffic density during the last decades. This process will continue within the forthcoming years and concerns road, rail and air traffic, where the increase will be larger during night time than during the day. Thus the most challenging overall goal of the research network 'Quiet Traffic' is the global reduction of noise despite increasing traffic density. To achieve this technical, operational, and administrative measures must be developed and applied.

Research on the Effects of Noise

The research network 'Quiet Traffic' consists of 5 working groups, where the group working on the effects of noise plays an essential role. This group aims at the provision of the technically oriented working groups with scientifically based applicable knowledge (Fig. 2).

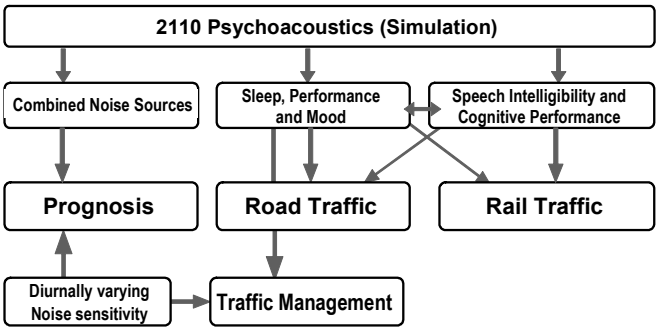

Fig. 2: Interaction between various sectors of the network

Research on the effects of noise is currently performed within seven individual projects which study annoyance caused by road and rail noise and the effects on communication, on speech intelligibility and on cognitive performance, on autonomous functions and on sleep. The research activities are focused on the solution of four major problems that are depicted in Figure 3.

Areas of research concerning noise effects	Contributing projects						
	2111	2121	2131	2211	2221	2222	2311
1 Assessment of different frequency spectra	X			X	X	X	X
2 Diurnally varying noise sensitivity			X				X
3 Assessment of different noise sources (Bonus/Malus)	X	X	X	X	X	X	X
4 Assessment of combined noise sources (prognosis)		X				X	

Fig. 3: Assignment of individual projects to the most important areas of research

1 Diurnally varying noise sensitivity.

Due to diurnally varying human activities it is conceivable that noise sensitivity varies accordingly. This is already considered in the noise indices LDN and LDEN, where 10 dBA or 5 dBA are added to the levels

measured during the night and the evening, respectively. Whether these regulations meet the actual temporal variation of noise sensitivity is still not yet proven.

The knowledge of the temporal variation of noise sensitivity during the day could for instance be used for the design of suitable itineraries for rail traffic (and probably also for air traffic).

Noise sensitivity during the day: One partner performs a field study on noise sensitivity during the day. The study is designed to investigate residents living in four areas that are defined by prevailing road noise with either a steady noise level throughout day and night or with a decrease in the late evening. Residents of two additional areas defined by prevailing rail noise with steady noise levels throughout will be studied as well. Carefully performed extensive interviews of about 200 adults of each area (overall 1 200) focus on activities and annoyance during the day. In addition, a subgroup will be asked to assess acute annoyance repeatedly during the day while using a special electronic device.

Noise sensitivity during the night: Studies on noise-induced sleep disturbances where intermittent noises such as aircraft and rail noise were evenly distributed over the night indicate that the probability and the extent of noise-induced reactions increase with the time of night due to gradually decreasing sleep depth and to decreasing tiredness. These results need to be validated with particularly designed experimental studies, where the participants are exposed to noise either in the first or in the second part of the night. Appropriately designed experiments will be performed in 2005 (with rail and road traffic noise) where 16 participants will be observed during a fortnight.

2 Assessment of frequency spectra.

The attenuation of noise leads usually to an alteration of its temporal structure and its frequency spectrum. Noises become more intermittent and the lower frequencies more prominent. As lower frequencies are more annoying and disturb more even during deep sleep the benefit of noise attenuation is often less than expected on the basis of dose-response relationships.

To quantify the significance of lower frequencies, i.e. the benefit by their directed attenuation, five partners compare the effects of actual with particularly treated transportation noises on communication, on speech intelligibility, on cognitive performance and on sleep. Very first results indicate that the impairment of cognitive performance might decrease with particularly attenuated low frequencies.

Concerning sleep disturbances suitable experiments with treated and untreated rail and road noises will be performed in Spring 2004. The results of these research activities are expected to give useful hints for the construction of vehicles.

3 Assessment of noise sources.

Extensive studies on annoyance have repeatedly shown that – presupposing the same equivalent noise level – aircraft noise annoys most and road noise annoys more than rail noise where the differences between these three traffic modes increase with the noise load (Figure 4). Based on these findings several countries have established a bonus for rail noise, meaning that the integrated noise levels are allowed to be higher along rail tracks as compared to roads. However, whether this bonus is also valid for sleep, for communication and for cognitive performance has never been verified. Thus, as rail and road traffic noise are applied in each of the single studies, it is expected that this question can be appropriately answered.

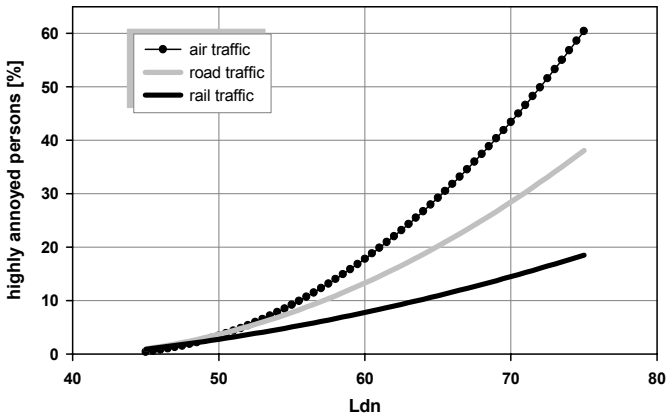

Fig. 4: Noise-induced annoyance. Amount of highly annoyed persons due to day-night level [Miedema & Vos 1998]

Concerning the effects of noise on sleep, a comparative study considers also aircraft noise. In the respective studies the three types of noise are applied with the same peak levels and with the same equivalent noise levels (where the number of events is varied).

4 Assessment of combined noise sources.

Many residents living at rail tracks or in the vicinity of airports are exposed to two or even to three sources of transportation noise. Though these various noises most likely affect the people concerned it is as yet not possible to evaluate the noise emitted from more than one source. Evaluation is instead strictly source-oriented where only the dominant or the most interesting noise is concerned. Four partners are therefore involved in a large study where acute annoyance is quantified under the influence of separately and simultaneously occurring noises emitted from rail and from road traffic of various densities. While exposed to systematic variations of noise the participants complete various performance tests and rate their annoyance soon after the cessation of noise. Thus evaluation bases on subjective assessment as well as on performance. The experimental design is based on statistical considerations and the results will be used to develop a prediction model which has to be validated thereafter in the field.

1. H.M.E. Miedema and H. Vos, 'Exposure-response relationships for transportation noise', *Journal of the Acoustical Society of America* **104**, pp 3432-3445 (1998).