QUIET TRAFFIC
A MULTICENTER RESEARCH ON THE EFFECTS OF NOISE

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Background Transportation noise is already high if not unbearable and noise pollution will increase considerably within the forthcoming years. As compared to 1995, freight traffic and air traffic will have increased by 80 % in the year 2010 and city traffic by about 50 %. As mobility is essential for economic growth the research network *'Quiet Traffic'* aims at the reduction of transportation noise while and even though traffic density increases.
The evaluation and attenuation of transportation noise is a particular challenge. It is emitted by numerous vehicles which move at various speeds into various directions (air traffic also at various levels) and which changes permanently its temporal and local composition. Thus, effective noise reduction at any time and anywhere presupposes the limitation of noise emission. Suitable measures include technical alterations of vehicles, changes in traffic management and personal behavior of pilots and of drivers of ground vehicles.

The network 'Quiet Traffic' The global attenuation of traffic noise requires the support of politicians, industry, carriers, administration, and researchers. They founded the network 'Quiet Traffic' which is structured into 5 sections: Common procedures, Low-noise road traffic, Low-noise rail traffic, Low-noise air traffic, and Noise effects. By combining their research efforts, the partners aim to increase their output and to optimize the use of resources.

Noise effects The studies on the effects of noise, performed by 12 research teams are designed to meet the requirements of the technically oriented groups and of the administration. They aim at the provision of immediately applicable scientific findings for directed and efficient noise attenuation. The respective research concerns the most important acute effects and is therefore structured according to the following 3 effect levels.

Psychosocial effects. Annoyance is the most frequent effect that results from disturbances of communication and performance, of recreation, and of sleep. It impairs the quality of life and causes the residents in the vicinity of (projected) airports, on streets with high traffic density or along rail tracks to protest and even to form pressure groups.

Speech intelligibility and cognitive performance. Speech is the most important means of communication and essential for mental development and social behavior. The masking of the communication sound impairs performances where acoustic communication is essential or at least helpful, particularly conversations and learning processes. But noise can also disturb performances that are independent from acoustical signals if it absorbs processing capacity and/or if it interferes directly with cognitive processes (short-term memory). Moreover, noise may impair concentration via distraction and via noise-induced sleep disturbances.

Noise-induced sleep disturbances. Disturbances of sleep are assessed as most deleterious, as noise does not only affect sleep but also mood and performance the next day. The respective studies are extremely elaborate, as they require the recording of the physiological indicators of sleep as well as of subjective evaluation, of mood and performance. These studies are, however, a matter of priority, as traffic density will increase more during nighttime, then during the day.

Goals of research on noise effects The attenuation of the level and the reduction of the impulsiveness of noise are a matter of course for the technically oriented groups. This alone, however, is insufficient as the extents of the effects depend on other acoustic parameters as well, particularly on the temporal structure and on the type of traffic noise, furthermore on noise sensitivity that varies during day and night. Thus, the equivalent noise level is only of limited value for the assessment of noise effects, particularly with respect to the simultaneous influence of noises emitted from different types of traffic.
Considering the need of the technically oriented groups, 4 main goals were defined which are solved by an interdisciplinary approach.

Assessment of various frequency compositions. The technical reduction of the A-weighted noise level is usually accompanied by an alteration of the frequency spectra, as higher frequencies are much easier attenuated than lower frequencies. It is concluded from the literature that lower frequencies are particularly harmful. A central goal of the research network is the determination of the most disturbing frequencies with psychoacoustic methods. Under consideration of technical possibilities, more pleasant sounds will be generated and their interference with speech intellegibility, cognitive performance and sleep will be compared to those of the original noises.

Quantification of diurnally varying noise effects (noise processing). Sensitivity against environmental noises changes concomitantly with the diurnally varying activities. A major goal is therefore to quantify the differences in terms of noise levels that must be added or subtracted to achieve the same effect as determined at another (reference) time. Concerning *noise sensitivity during sleep, s*tudies with evenly distributed nocturnal traffic noise allow the conclusion that noise sensitivity increases toward the morning. The actual state of knowledge, however, does not allow the formulation of definite recommendations for the introduction of a temporal prohibition of road traffic or a suitable design for itineraries for rail and for air traffic.

Effect-equivalent assessment of different traffic noises. The acoustical stress is usually assessed by the calculation of the equivalent sound level. This does not correspond to equivalent effects as shown by a meta-analysis, whereupon aircraft noise annoys more than road noise and the latter more than rail noise, and the differences increase with the equivalent sound pressure level. Whether an advantage (bonus) set for rail noise in several countries or a supposed malus for aircraft noise is true for communication, cognitive performance, and sleep will be studied.

Assessment of noise from different sources (prognosis). Residents living along rail tracks and in the vicinity of airports are usually exposed to 2 or even 3 types of traffic noise. The assessment, however, concerns only the dominant or the most interesting noise source. This concept is at least debatable as noises from other sources contribute to annoyance. The solution to that problem, however, is not trivial, as the different types of traffic are differently annoying and as these differences increase with noise level. Moreover, mutual effects are possible and prevent the prediction of noise effects on the basis of the equivalent sound pressure level only.

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