

NOISE AND SLEEP

PRESENT STATE (2003) AND FURTHER NEEDS

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Introduction Residents living near airports, railway tracks, busy roads, or other noise-emitting facilities evaluate sleep disturbances as the most deleterious effect of noise, which might affect mood, well-being, and performance the next day. Sleep disturbances are suspected to contribute eventually to the genesis of chronic health disorders. Thus, referring to the WHO definition of health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity', noise-induced sleep disturbances are clearly classified as health effects.

Research activities during the last 5 decades Systematic research on noise-induced sleep disturbances started at the end of the sixties and was extensively performed during more than 2 decades. Economic restrictions in the nineties caused a marked reduction but research was recently resumed where a few studies were initiated, in particular 2 rather extended field studies at Schiphol Airport and at Cologne-Bonn Airport where the latter is combined with the largest laboratory study on aircraft noise ever done [Passchier-Vermeer et al. 2002, Basner et al 2001]. During that time several researchers have summarized the available literature under different aspects, to present the state of the art in carefully prepared, rather extended papers, to derive the need for further research, to develop models for the prediction of noise-induced sleep disturbances, and to evaluate the methods applied.

Reviews The reviewers agreed that the effects on sleep depend on the physical characteristics of the impinging noises as well as on individual and situational factors. The informational content, that is predominantly determined by the experience an individual has with the respective noise was identified as most important. It may change with time thus providing the mechanisms for habituation and sensitization as well. Concerning the acoustic features it is well established that the temporal distribution of noises, their maximum levels, emergences, numbers, repetitions, and durations have a considerable influence on the human response. Undisputable as well is the significance of personal features such as age and personal traits (sensitivity, neuroticism) as well as biorhythmic alterations as indicated by a greater responsiveness in the late as compared to the early night and during day sleep as compared to night sleep.

Methodological approaches The very first studies were predominantly performed in the laboratory, where the registration of the polysomnogram, i.e. the simultaneous recording of the electroencephalogram, the electrooculogram, and the electromyogram is almost indispensable. It is the only measure that reliably indicates whether a person is awake or asleep and which provides information on sleep depth. As this most sophisticated and rather costly method was applicable only for a limited number of observations, alternative though less precise methods, were applied in the field. A few researchers determined the urinary excretion of stress hormones a method that does, however, not separate between the effects of noise and of other non-specific stressors occurring during the observation period. The preferred method is the registration of body movements by means of actimeters that are worn like wrist watches. It is, however, suspected that the most striking discrepancies between the large effects observed in the

laboratory and the much smaller and even negligible effects in the field account considerably to the use of this method. The recently published Schiphol study, that relied on the same method suggests, however, that the differences might be much smaller than supposed. This seems to be supported by the still ongoing Cologne study where – thanks to tremendous technical developments within the last years – the registration of the polysomnogram was performed during almost 1 000 nights in the field.

Needs for further research Though noise emissions of the individual vehicles and airplanes were significantly reduced within the last decades, the overall noise levels increased due to considerably elevated traffic densities that are expected to increase further, more during the night than during the day. Thus, studies on the effects of noise on sleep are required to provide applicable findings for immediate and efficient noise attenuation.

- 1) *Technical measures* must – apart from the reduction of noise levels – aim at the design of less unpleasant noises. This presupposes e.g. the identification of particularly harmful frequencies and of the effects of risetimes that become gradually shorter with increasing speed of trains.
- 2) *Dimensioning of noise abatement and bonus-malus regulations based on predictive models.*
A first model [Griefahn 1992], based on 10 studies that allows the calculation of just admissible noise-and-number-combinations should be revised while including the results of now available further studies, while using complex statistical methods. A suitable model might be expected as an outcome of the still ongoing largest study on the effects of aircraft noise [Basner et al. 2001]. Additional comparative studies are needed for the *effect-equivalent assessment* of noises emitted by road-, rail-, and airtraffic. Eventually, as man reacts to the whole acoustical situation, i.e. to *noises simultaneously emitted from different sources*, it is mandatory to develop suitable predictive models. This is particularly reasonable for situations where various noises are related to each other, e.g. at airports where the increase of airtraffic is accompanied by an increase of road- and railtraffic.
- 3) *Administrative measures* presuppose suitable studies that aim e.g. at
the quantification of responsiveness during the course of the night for the design of itineraries for rail and for air traffic
the determination of noise-induced disturbances during the shoulder hours and their consequences for the consecutive sleep period
the quantification of the additional need for vulnerable groups
- 4) *Evaluation studies* are needed to quantify the effects of attenuation measures such as deviation of traffic, construction of tunnels, double glazing, etc..

Keywords: sleep, need for further research, noise abatement, methodological approaches

References

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