

## Noise-induced annoyance due to nocturnal road traffic: results of a field study

Sarah WEIDENFELD<sup>1</sup>; Eva-Maria ELMENHORST<sup>1</sup>; Sandra SANOK<sup>1</sup>; Uwe MÜLLER<sup>1</sup>; Daniel  
AESCHBACH<sup>1</sup>

<sup>1</sup>Institute of Aerospace Medicine, German Aerospace Center, Germany

### EXTENDED ABSTRACT

*Background:* Traffic noise is a growing and serious environmental problem due to its association with health risk, sleep disturbances and annoyance. In particular, annoyance is seen as the most important adverse effect (1) and as one of the first and widespread reactions to noise (2). Since many traffic noise studies are based on laboratory surveys or exhibit shortcomings in noise measurement, there is a lack of valid exposure-response relationships between traffic noise and annoyance. To fill this gap for road traffic, precise measurements of noise parameters (e.g. A-weighted energy equivalent sound pressure level [ $L_{Aeq}$ ]) are needed.

In addition to the acoustical characteristics of the noise event itself also non-acoustical moderators have an important effect on the development of annoyance (3). Therefore we were interested in effects of both non-acoustical and acoustical influences of road traffic noise on short-term annoyance. Furthermore we intended to explore the effect of different noise sources on annoyance by comparing data of road traffic with those of aircraft and railway traffic.

*Method:* Forty healthy participants (mean age = 29.1; SD = 11.7; 26 females) were studied at their homes in areas with moderate nighttime road traffic in the vicinity of Cologne and Bonn (Germany). On four consecutive mornings the participants completed a questionnaire that asked for their subjective sleep quality (4) as well as their annoyance (ICBEN-Scale 1 = “not at all” to 5 = “extremely annoyed”) and their perceived noise load due to road traffic noise in the previous night. Further questionnaires were applied to capture psychological variables (e.g. the perceived degree of having adapted to road traffic noise). Measurements of acoustic parameters were undertaken inside the residents’ bedroom. Based on these recordings the  $L_{Aeq}$  per night was calculated. We used a generalized estimating equation (GEE) with the stepwise forward selection process considering significance of the predictors and improvement of the QIC to find the statistical model that fitted the data best. According to the final model we derived an exposure-response curve for road traffic noise-induced annoyance.

In a further analysis the road traffic data were combined with those from two earlier field studies in which the effect of nocturnal railway noise (5) and aircraft noise (6) on residents’ annoyance in the vicinity of Cologne and Bonn were investigated. The pooled data sets were used to develop a comparative statistical model of annoyance due to road traffic, railway and aircraft noise (using a forward selection procedure as described above).

*Results:* The analysis of the road traffic data was based on a total of 29691 road traffic noise events with an average of approximately 189 passing vehicles per night. We recorded traffic noise events with the  $L_{Aeq}$  ranging from 18.4 dB(A) to 44.8 dB(A). The average annoyance rating was 1.76 ( $\pm$  0.9). The GEE revealed a statistically significant rise in the annoyance with increasing  $L_{Aeq}$  from road traffic noise ( $p = .023$ , OR = 1.159). The extent of the perceived noise load had a reinforcing effect ( $p < .001$ , OR = 44.606), whereas a high subjective sleep quality had a reducing effect ( $p = .007$ , OR = .924) on annoyance.

In the pooled data set annoyance increased again with increase in  $L_{Aeq}$  ( $p = .001$ , OR = 1.043) across all types of traffic noise. In contrast, the perceived degree of an individual’s adaptation to the

<sup>1</sup> sarah.weidenfeld@dlr.de

respective noise source reduced annoyance ( $p < .001$ , OR = .528). The probability to be annoyed turned out to be higher for road traffic noise than for aircraft noise ( $p = .001$ , OR = 3.026), whereas railway noise didn't differ from aircraft noise (reference) in its impact on annoyance ( $p = .079$ , OR = 1.812).

*Conclusion:* The current field-study on road traffic noise emphasizes the importance of subjective sleep quality for annoyance responses and delivers a prediction model for road traffic noise-induced nocturnal short-term annoyance in areas with moderate traffic. Additionally, the analysis of the pooled data set revealed an important influence of the perceived degree of an individual's adaptation and showed that the extent of annoyance tends to vary depending on the respective noise source. The  $L_{Aeq}$  proved to be a significant acoustical predictor of annoyance when taking noise from different traffic sources into consideration. Since the moderate nocturnal road traffic of the investigated areas led to rather low annoyance levels, prospective investigations should be extended to residential areas with dense road traffic.

Keywords: traffic noise, annoyance, field-study,  $L_{Aeq}$

## REFERENCES

1. Guski R, Felscher-Suhr U. The concept of noise annoyance: how international experts see it. *Journal of Sound and Vibration*. 1999;223(4):513-527.
2. Ouis D. Annoyance from road traffic noise: a review. *Journal of Environmental Psychology*. 2001;21:101-120.
3. Fields JM. Effect of personal and situational variables on noise annoyance in residential areas. *The Journal of the Acoustical Society of America*. 1993;93:2753-2763.
4. Griefahn B, Marks A, Robens S. Noise emitted from road, rail and air traffic and their effects on sleep. *Journal of Sound and Vibration*. 2006;295:129-140.
5. Pennig S, Quehl J, Müller U, Rolny V, Maass H, Basner M, Elmenhorst E-M. Annoyance and self-reported sleep disturbance due to night-time railway noise examined in the field. *Journal of the Acoustical Society of America*. 2012;132(5):3109-3117.
6. Quehl J, Basner M. Annoyance from nocturnal aircraft noise exposure: laboratory and field-specific dose-response curves. *Journal of Environmental Psychology*. 2006;26:127-140.