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ON THE RELATIONSHIP OF HIGHWAY NOISE ANNOYANCE AND DISTANCE TO HIGHWAYS

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INTRODUCTION

In the planning of highways and in the control of noise at existing highways, the spatial spreading of noise must be taken into account because of the annoyance effect. In doing so, one mostly draws upon, on the one hand, theoretically-deduced relationships between sound and spatial spreading; and, on the other hand, empirical relationships between sound-dose and subject-oriented reactions.

In this study, the question is treated concerning the form of relationship of distance to the highway and the annoyance situation (reaction) of residents near the highway. Apart from the representation of the distance dependence of complex and single parameters of annoyance, a test will be made, on the basis of computations of partial correlations, whether distance has an influence on annoyance, independent of the dose-level.

In the analysis of the residents' reactions, a model by Kastka 1,2 is used, whereby the perceptual experience of sounds (K1) forms the basis for the attribution of undesirable effects of the sound on the affected person: K2, a somatic-emotional component; and K3, which represents the disruption of communication and other effects, eg. vibrations. K2 and K3 are the elements of environmental-hygienic and psychological relevance, which indicate a disturbance in the well-being of the affected person.

METHOD

Using a standardised questionnaire, 359 residents living in 5 sites near highways were interviewed within their homes. Each site consisted of 2-4 homogenously-exposed zones at different distances to the highway in the range 20-200 m.

The noise levels (Lp) ranged from 50-73 dB and were assessed by

24-hour measurements, complemented by short-term measurements. For each interviewee, the shortest distance from the house to the highway was derived from scale 1:2500 maps.

RESULTS

Values for the 3 components were computed for 1.) the annoyance reaction to highway noise; 2.) the annoyance reaction to traffic noise from the residents' urban road. These urban roads were selected such that the traffic volume was slight-typical for residential areas. A comparative analysis of the residents' K1-reactions to highway noise and to their urban road noise revealed that, by extrapolation, at a distance of about 300 m and above, the perceptual experience of disturbing noise from the highway is equivalent to the local urban road noise; at all lesser distances, highway noise is the dominant environmental noise.

For K2 (disturbed well-being), the highway noise was dominant over local traffic noise up to a distance of 240 m, and about the same distance was found for K3 (disturbed communication). From these results it follows that the distance effect of the highway noise in the stimulus-centered perceptual dimension of annoyance is more extended than the subject-oriented effect of "disturbed well-being". This means that the highway is the dominant disturbing noise-source on each side up to 300 m; up to 200 m the highway induces psychological processes of experiencing the noise as a negative environmental factor, impairing one's health, emotional states and daily activities. The distance at which the highway produces none of these negative effects lies outside the range of the sites investigated and may be assumed, by extrapolation, to lie 350-500m on each side (fig.1).

Single response variables:

Rating scale values of the loudness of the highway noise showed that, up to a distance of 80 m, the mean value is loud(stark); up to a distance of 170 m the noise can be heard distinctly (deutlich); for the closed-window situation, the loudness of the highway noise is evaluated as "rather quiet" in 195 m; for the open-window situation this judgement is found to lie outside the 200 m range. This means that undisturbed living (with open windows) is quite impossible within a range of 200 m.

A comparison of the regression function for loudness shows that closing the windows is equivalent to a shift in the distance of about 130 m. This means that closing the windows in an effective noise-reducer, and it is speculated this fact will tend to induce living with closed windows in the vicinity of highways

Continuuousness of perception

A characteristic of highway noise is the experience of the continuousness of exposure; up to 200 m, the ratings for the subjective

duration of the noise show that the noise is steady and unavoidable. The experience of continuousness of exposure at a distance of 200 m, with an L_D of about 50-53 dB (A), is quite contrary to the experience of low-level urban traffic noise, which is described as being of short duration. To be exposed to something continuously, therefore, may be a very negative aspect of environmental conditions.

Other evaluative reactions

The percentage of residents evaluating highway noise as intolerable is more than 50% at a distance of 90 m; at 140 m about 25%; and at 200 m about 5%. Up to 110 m, about 30-50% express an intention to complain about the noise, and at 200 m, 15% are ready to complain.

Distance and acoustic noise parameters

Distance and noise level do not correlate very highly ($r=-0,62$) on computation of individual residents' exposure level L_D and distance. L_D and annoyance correlate within the range $-0,31$ to $-0,43$. Partial correlations of L_D , distance and the component measures of annoyance revealed that the elimination of the L_D influence from the distance-annoyance relationship reduced the partial coefficient to a range from $-0,09$ to $-0,19$. This suggests that distance has only a limited noise independent contribution to the noise annoyance response.

Perhaps the selection and combination of the 5 sites to a common data pool has introduced a number of non-identified moderator factors, which weaken the relationship between L_D , distance and the human response.

CONCLUSION

The distance-related analysis of residents' responses near highways indicate that, up to 100 m, there seems to be severe disturbance, up to 200 m the noise has a dominant negative impact on daily activities.

Furthermore, highway noise seems to be a perceptible negatively-evaluated immission within the environment, cognized by human subjects far above the distance of 200 m.

- 1.) Kastka, J. u. E. Buchta: Zum Inhalt der Belästigungsreaktion auf Straßenverkehrslärm, Kampf dem Lärm 24, 1977, p 158-166
- 2.) Kastka, J.: Psychologische Indikatoren der Verkehrslärmbelästigung, in Schick, A.: Akustik zwischen Physik und Psychologie, Klett-Cotta-Verlag, Stuttgart 1981, p 68-86.

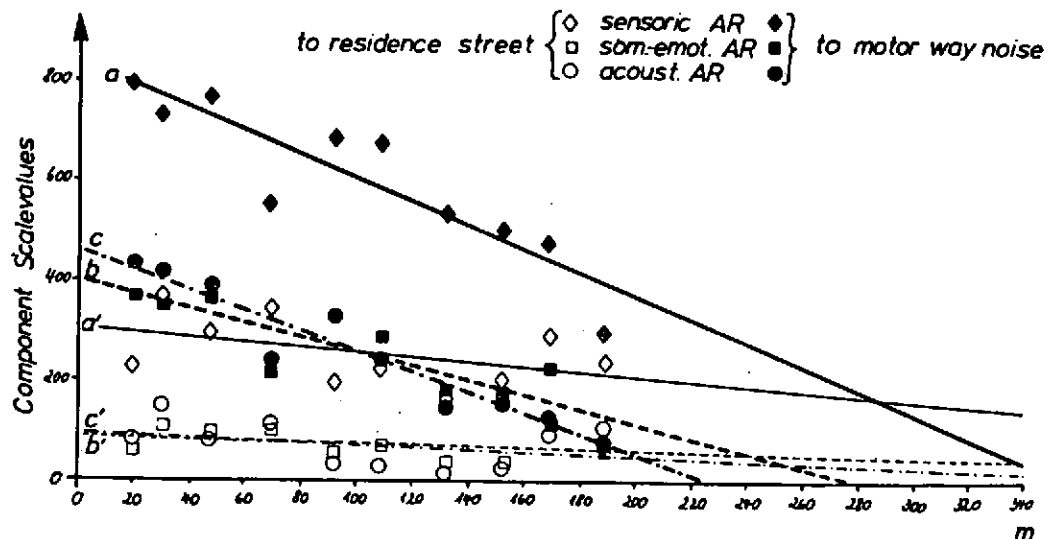


Fig.1: Distance to Highway and Residents Mean Responses to Highway Noise and Noise from their Residential Road Traffic: for Experience of Disturbing Noise K1 (sensoric Annoy. Resp. to Highway Noise: Regression Function a), for Disturbed Well-Being K2 (Somatic and Emotional Annoyance) Response to Highway Noise: Regression Function b), for Disturbed Communication K3 Regression Function c), a', b', c', are Corresponding Values of the Residents Annoyance Response to Noise of their Residential Street.