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ATTITUDES TOWARD NOISE SOURCE AS DETERMINANTS OF ANNOYANCE

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INTRODUCTION

Several field studies have shown that for equal immission levels (Lm) railway noise is less annoying and disturbing than road noise[1] (the so-called "railway bonus"; see e.g. the summarizing article by Schuemer & Schuemer-Kohrs 1991). A recent laboratory study conducted in Germany and Japan by Fastl et al (1998) yielded similar results, too.

The causes for this difference in annoyance due to the two sources are not yet clear. Among others, the following factors are discussed which may possibly be responsible for the "railway bonus":

- the existence of longer "quiet" periods without noise between the noise events (caused by single passing trains) versus the more continuous noise typically produced by road traffic
- the greater regularity and predictability of railway traffic in comparison to road traffic
- differences in the frequency characteristics (frequency spectrum) of both sounds
- differences in the evaluation of and attitude to the noise sources (railway / road traffic).

This paper will deal only with the last-named factor.

METHOD

Acoustical measurements have been taken in 8 areas with either predominant railway or road traffic noise. Both sources were present in each of the areas. Residents in these areas were interviewed with regard to their annoyance and disturbance by each of the two sources. 1600 interviews were done altogether in the 8 areas. 479 of the 1600 residents were interviewed once more some weeks later to assess their attitudes to and evaluations of road and railway traffic with regard to such criteria as: ‘environmental friendliness/ecological harmlessness’, ‘usefulness’ and ‘convenience for users’.

The data allow to test (1) whether there is a difference in annoyance between the two sources and whether the amount of this difference depends on the noise level

[1] The amount of this difference in annoyance depends on: a) the annoyance / disturbance response considererd; b) the noise level (among other factors). In spite of the dependency of the amount of the difference on the factors mentioned a *general* „bonus“ of 5 dB(A) is set by German noise regulations (the "Bundesimmissionsschutzgesetz").

(interaction between source and noise level) and (2) whether there is a difference between the evaluations of the two sources.

The analyses are based on the 'general linear model' (GLM). A two-factorial design is used: Factor 1: source (railway / road); factor 2: immission noise level for daytime (two Lm classes: '50 db(A) < Lm <= 60 dB(A)' and '60db(A) < Lm <= 70 db(A)'). Only two classes could be considered as there are not enough Subjects *(Ss)* exposed to individual noise levels exceeding 70 dB(A) in the areas with predominant road traffic noise and not enough *Ss* exposed to noise levels lower than 50 dB(A) in areas with predominant railway noise.

The dependent variables considered in the analyses referring to question (1) were three annoyance / disturbance reactions: a) BEL: general annoyance by either railway or road traffic noise; b) GES1: total disturbance - daytime; c) RT: interference with actitvities (composite score from several items). Each variable has a range from "1: not annoyed / disturbed" to "5: very annoyed / disturbed".

The design allows univariate as well as multivariate tests for the two main effects and their interaction. In the case of a non-significant interaction a one-factorial design (with the factor "source: railway / road") instead of the two-factorial design can be done using the noise level as a covariate.

The analyses referring to the attitudes to and evaluations of the noise sources can be performed using an analogous design. As dependent variables, these analyses involved ratings for each source (railway or road traffic) with regard to 6 aspects: a) 'useful', b) 'awkward for users', c) 'dangerous', d) 'unhealthy', e) 'comfortable for users', and f) 'ecologically harmless'.

The study has not yet been completed. Thus, only first preliminary results are described.

RESULTS

On the analyses with regard to the *annoyance* variables: The two-factorial multivariate analysis shows that only the two main effects are significant ("source: rail/road": $F= 45.77$; $p<.0001$; "noise level": $F= 77.35$; $p<.0001$), but not the interaction ($F< 1$; $p>.15$; all values for F and p refer to Wilk's lambda and 'partial sums of squares'). The corresponding univariate analyses yielded similar results. (Very similar results are obtained when one consideres further annoyance variables.) The results may be summarized by the following statements (cf. figure 1):

- As expected, for each source the annoyance / disturbance is higher for the upper than for the lower noise levels.
- Within each noise level, the annoyance / disturbance is higher for road than for railway traffic noise ("railway bonus"). - The main effect "source" is confirmed by a one-factorial analysis using the noise level (Lm) as a covariate.

In the analogous analysis of the *attitudes* to / *evaluations* of railway / road traffic only the main effect "source" is significant ($F=163.28$; $p<.0001$ for the multivariate test); neither the factor "noise level" nor the interaction are significant ($F<1$; $p>.40$ for each effect in the multivariate analysis; corresponding univariate tests as well as a one-

factorial analysis of covariance confirm these results). The mean evaluations of road and railway traffic are summarized in figure 2.

Comparisons of the evaluations of road and railway traffic for each of the evaluation aspects show: In comparison to road traffic, *Ss* see railway traffic as less 'unhealthy', less 'dangerous', and less 'ecologically harmful' and as slightly more 'useful'. On the other hand, there are some respects in which road traffic is evaluated more positively than railway traffic: Road traffic is seen as more 'comfortable' and less 'awkward' for users.

In order to summarize these differences, it may be stated that railway traffic is evaluated more positively or less negatively than road traffic with regard to those aspects which are related to potential risks (health, danger, ecological hazard); on the other hand, road traffic is evaluated more positively with regard to aspects concerning the comfort for users.

These differences in the assessment of road and railway traffic are rather independent of the noise levels the subjects are exposed to (insignificant main effect "noise level"). This is confirmed by a correlational analysis: The coefficients of correlation (Pearson's r) between the evaluations for each source and the noise level (Lm for road or railway traffic noise) are rather low; for road traffic all correlations beween Lm on the one hand and the ratings for each of the aspects on the other hand are not significant; for rail traffic only the correlations between Lm and the 'unhealthy' and the 'dangerous' ratings are significant (unhealthy: r=.27; dangerous: r=.24; n=255; p<.001). Finke et al (1980, p. 230) reported similar evaluation differences from a field study in which the effects of noise due to various sources were investigated: Road traffic was seen by *Ss* as more 'dangerous / unhealthy'.

The parallels in the differences between railway and road traffic with regard to annoyance and to at least some of the evaluation aspects suggest the interpretation that the differences in evaluation may contribute to the differences in annoyance. This seems to be plausible as it is known - for instance from a Swedish laboratory study (Johnsson & Sörensen 1967) - that annoyance judgments on the same sound vary considerably depending on the evaluation of the (supposed) source to which subjects attribute the sound; for instance, *Ss* feel that the the sound is more annoying when they are instructed that the sound is produced by a motorcycle.

Such an interpretation would be supported if it could be shown that there is a close relationship between the annoyance variables and the evaluations of road / railway traffic in the present study. But for the majority of the evaluation aspects there is no such relationship; only for two of the six aspects considered significant correlations are found:

- The higher the 'unhealthy' rating (i.e. the more road or railway traffic is seen as unhealthy), the higher the annoyance; this is true for road traffic noise as well as for noise caused by railway traffic (e.g. for the 'general annoyance': *road:* r=.28; n=216; p<.0001; *railway:* r=.45; n=243; p<.0001; the correlations are a little bit lower if the noise level is held constant by means of partial correlation. Furthermore, multiple regression analysis shows, that this evaluation aspect contributes to the prediciton of annoyance independently of the noise level: When only Lm is used as a predictor of the individual annoyance the proportion of variance explained is r^2=.22 for road and r^2=.27 for railway. When the 'unhealthy' aspect is added as a second predictor these values increase to R^2=.26 and R^2=.36, respectively.) Furthermore, only for this aspect

a significant correlation between the individual road - railway annoyance difference and the difference between the 'unhealthy' judgments on road and on railway traffic is found (r=.38; n=459; p<.0001; the correlation is somewhat lower (r=.22) when the corresponding difference in noise level is held constant by means of partial correlation).

- The higher the score for 'dangerous', the higher the annoyance; this holds only true for railway traffic, but not for road traffic noise (e.g. for the general annoyance: *road:* r=.02; n=216; p>.50; *railway:* r=.27; n=243; p<.0001; these correlations do not change considerably if the noise level is held constant).

Finke et al (1980, pp. 205-206) reported similar relationships: There, too, 'unhealthy' was found to be an effective predictor of annoyance (beside Lm); this was true for road traffic noise and also for other sources of noises. They also reported that other evaluation aspects (e.g. 'usefulness') contributed distinctly less to the prediction of annoyance.

SUMMARY AND CONCLUSIONS

Railway noise is less annoying than road traffic noise of equal noise level. As a parallel to this, there are differences in the evaluation of road and railway traffic: Railway traffic is seen as significantly less unhealthy, less dangerous and less ecologiocally harmful.

In spite of the marked differences in the evaluation of these two sources, there is a significant correlation between the evaluation and the annoyance for each of the two sources for only one of these evaluation aspects: The more road (or railway) traffic is seen as 'unhealthy', the higher is the annoyance due to road (or railway) traffic noise.

Thus, only some and not all evaluation aspects, for which there are significant mean differences between the sources (road / railway traffic), seem to be also powerful predictors of the individual annoyance responses (within each source). Only those aspects may be useful predictors of the individual annoyance which represent risks possibly affecting the person and their own health directly. Where the risk is more abstract (as in the case of 'ecological damage') and the person is not affected directly, there is no correlation with the individual annoyance.

Thus the data of the present study support only partly the hypothesis that the evaluation of the noise source influences the annoyance due to this source.

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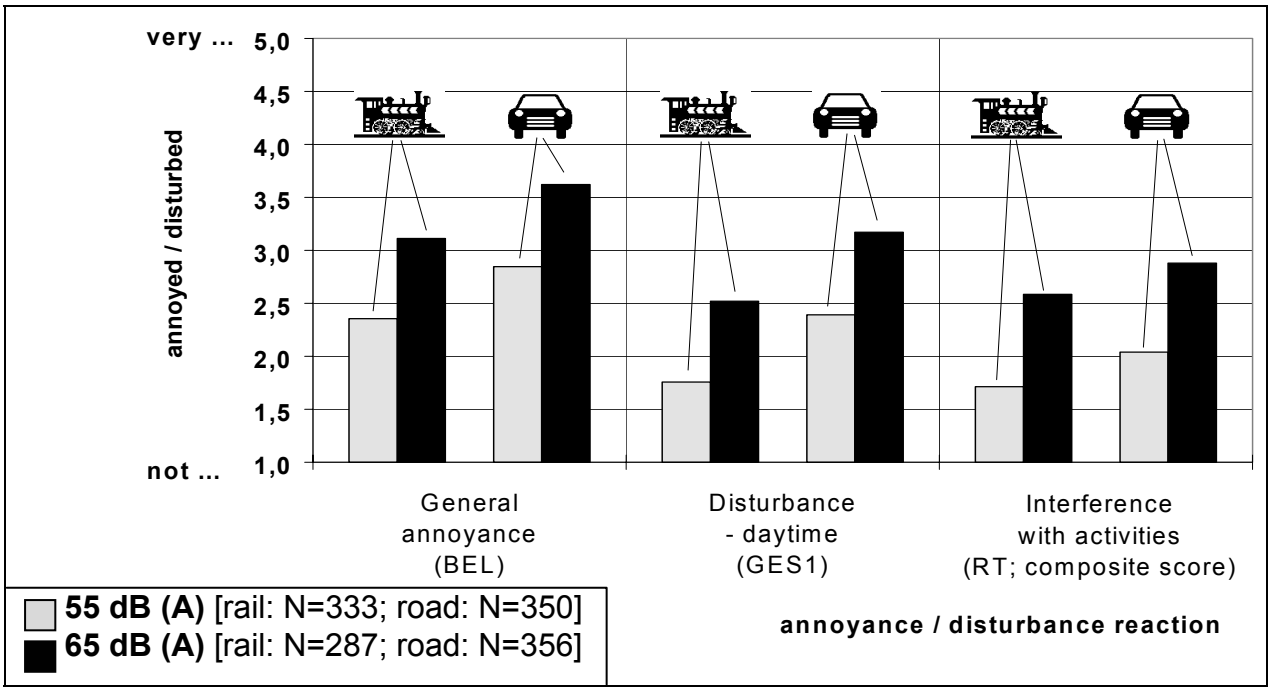

***Figure 1**: Mean annoyance / disturbance reaction by noise source (rail vs. road traffic) and Lm classes (55 dB(A) vs. 65 dB(A))*
The pictograms and symbolize the noise sources "rail traffic" and "road traffic", respectively.

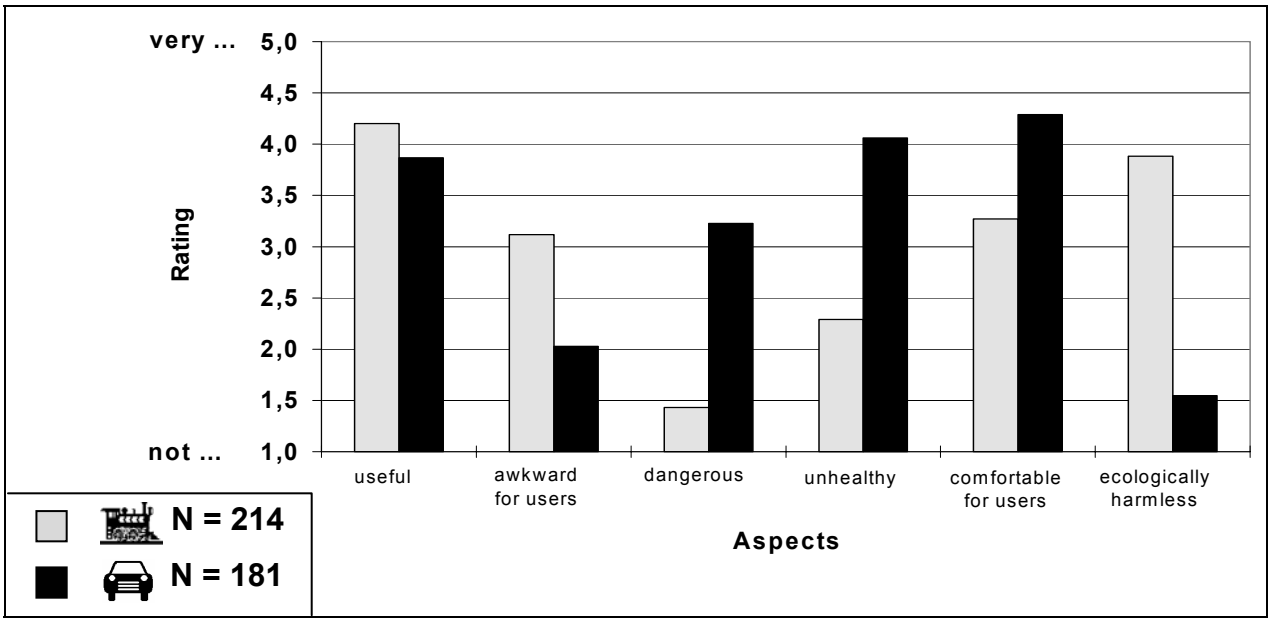

Figure 2: *Evaluation of road / railway traffic*
The figure shows mean ratings for each source (railway vs. road traffic) with regard to 6 aspects. The pictograms and symbolize the noise sources "rail traffic" and "road traffic", respectively.