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DIFFERENCES IN THE ANNOYANCE BETWEEN RAIL AND ROAD TRAFFIC NOISE IN RELATION TO THE ACOUSTIC SITUATION

U. Moehler, M. Liepert

Moehler+Partner, Schwanthalerstr. 79, D-80336, Muenchen, Germany

Tel.: 00498954421711 / Fax: 00498954421799 / Email: ulrich.moehler@mopa.de

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ABSTRACT

The legislation for traffic noise includes in many countries the difference in annoyance between rail and road traffic noise. In most of these countries the difference is expressed as a single value (i.e. in France 3 dB(A), in Germany 5 dB(A)). This value represents a mean average value of the difference between road and rail traffic noise as well as in various areas of disturbance and annoyance as in various acoustic situations. In a study carried out in Germany acoustic data (obtained by measurement and calculation) and disturbance reactions (obtained by questioning) were collected for 1,600 subjects. The influence of the acoustic situation on the evaluation of the annoyance differences between rail and road traffic noise will be shown. The variation in the acoustic situation shows for example different distances between the source specific sound level of rail and road traffic noise in the areas.

1 - INTRODUCTION

The nuisance differences of railway and road traffic noise, as determined in numerous european noise effect studies, flowed into the legislation of some European countries as a single value (i.e. 3 dB(A) in France, 5 dB(A) in Germany). This so called rail bonus is applied so as if only one of the two traffic noise sources would be present in the area or if both traffic noise sources could be regarded independently.

In reality cases frequently appear however, where both traffic noise sources in a residential area lead to disturbance and annoyance reactions. Here it can come to interactions between the noise impacts of both sources.

In present and former German studies concerning railway and road traffic noise annoyance differences were determined by questioning residents exposed to road traffic noise on the disturbance effects of road noise and on the other hand by questioning residents exposed to railway noise on the disturbance effects of railway noise and thus comparing the results. The results of these examinations are listed in [1] – [3].

In this examination the differences are determined by comparing the annoyance and disturbance reactions to road and railway traffic noise of subjects exposed to both noise sources. This means that residents in areas with railway and road traffic noise are questioned about the nuisance effect of both noise sources. The reactions of the same subjects towards both noise sources are afterwards compared.

2 - METHODS

The study was carried out as a field study in residential areas in which traffic noise was present from the two sources (railway/road) in various extent respectively (see [4]). Residents concerned were examined with regard to their annoyance reactions towards the two present noise sources in their natural living homes in the selected areas.

To ensure the noise impact a sufficient variation, 4 impact situations (area types) were examined. These situations are characterized by the dominance of road or railway noise and by a middle or high traffic density. These area types were formed by two various local areas which were examined also within various time periods (spring/autumn). The pass-bye levels and the individual average noise level L_{Aeq} were moreover varied by the distance of the housings to the noise source dominating within each of the areas. A summary of the investigated areas is given in the following table:

	traffic density	study period	number of interviews	
road	> 15,000 vehicles/day	spring 97	522	**890**
	< 15,000 vehicles/day	spring 96 – autumn 97	368	
rail	> 200 trains/day	autumn 96	310	**710**
	< 200 trains/day	spring 96 – autumn 97	400	

Table 1: Study design.

The acoustic impact situation for approx. 400 subjects was described by measuring source specific noise levels in front of the sleeping-room as well as within the sleeping-rooms. Beyond this, source specific noise levels L_{Aeq} in front of the loudest facade were calculated on the basis of the measured input data (e.g. number and speed of trains, vehicles etc.). These calculated noise levels are used for the comparison with annoyance reactions for 1,600 subjects at which the interviews were carried out. The calculations were carried out on the basis of guidelines RLS-90 and Schall03 corresponding to state of the art in Germany.

The measured acoustic data obtained in front of the sleeping-rooms were determined in order to compare them with the physiological data about sleep disturbances (see [4]). However the evaluations to sleep disturbances shall be disregarded here. The following evaluations exclusively refer therefore on the source specific calculated noise levels L_{Aeq}.

The social scientific interview to the annoyance and disturbance reactions caused by railway and road traffic noise took place respectively within the weeks preceding the acoustic measurements. The interview was carried out in form of personal interviews at whose end the subjects were asked by the interviewer to take part in the following sleep examination. Because of the great size of the questionnaire the interview was divided into two parts, before and after the sleep examination. The second interview was carried out essentially only with those subjects who had taken part also in the sleep examination. 1,600 first interviews and 479 second interviews were obtained.

3 - RESULTS

To the representation of the nuisance differences between railway and road traffic noise the following acoustic impact situations were distinguished with the distance between the noise levels of the two sources of noise:

- road and rail traffic noise are almost equal ($ABS(L_{Aeq,road} - L_{Aeq,rail}) < 10$ dB(A))
- road traffic noise is predominant: ($L_{Aeq,road} - L_{Aeq,rail} > 10$ dB(A))
- rail traffic noise is predominant: ($L_{Aeq,rail} - L_{Aeq,road} > 10$ dB(A))

The division of the subjects into the above described 3 cases was carried out with the individual noise levels L_{Aeq} independently of the acoustic source dominating in the area (area type). The referring time period (day/night/24 h) for the calculation of the noise level L_{Aeq} varied according to the time period which the reaction variables referred to. The determination of the nuisance differences was carried out with the reaction variables:

- general annoyance by road/rail noise 24 h (scale 0 to 10)
- general annoyance by road/rail noise at daytime (scale 1 to 5)
- general annoyance by road/rail noise at night (scale 1 to 5)

Evaluations are represented for the reaction variable general annoyance day and night (24h) in the following. Regarding the other variables the results qualitatively are not very different. The mean average values and the standard deviations of the reaction variable general annoyance for day and night are represented for the above mentioned three situations in the following figures 1, 2 and 3:

In the situation with almost equal railway and road traffic noise (Fig. 1) the results of earlier examinations are confirmed, that road traffic noise causes greater annoyance scores than railway noise at same noise levels. The mean average values of the reaction variable for road traffic noise with same noise level lie on average around approx. 1.2 scale units over the scores for railway noise. Regarding the situations

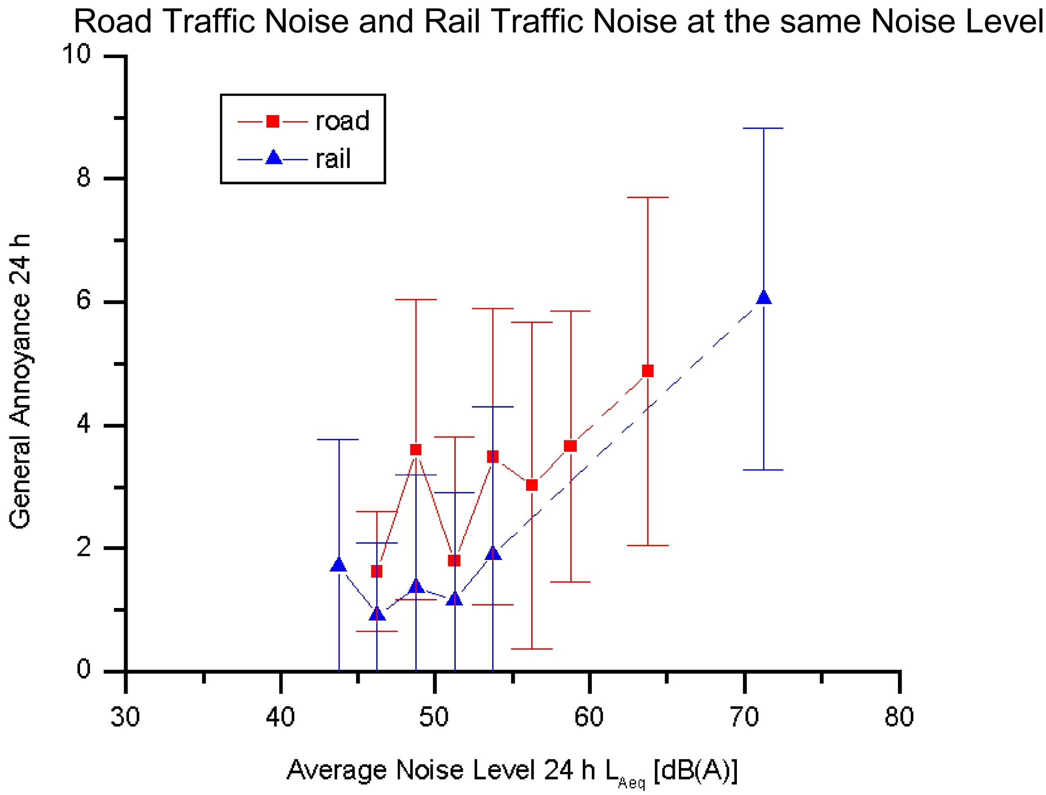

Figure 1: General annoyance by road and rail traffic noise in areas with both sources almost equal.

with a dominating traffic noise source (Figs. 2 & 3) the dominating road traffic noise and dominating railway noise show themselves different trends in the two cases. With dominating road traffic noise the reaction mean average values towards railway noise lies with at least 2 scale units in the whole appearing level range under the mean average values towards road traffic noise. With dominating railway traffic noise the reaction mean average values of road traffic noise already reach at levels around the 40 dB (A) results which are corresponding to the reaction mean average values of the dominating railway traffic at 55-60 dB (A).
A stronger roll plays road traffic noise as secondary sound source in an area with dominant railway noise than reversed railway noise in an area with dominant road traffic noise. Dominating road traffic noise shows no significant rise of the annoyance scores towards railway noise even with levels of the railway noise up to approx. 55 dB (A). This could be caused by the appearance of relatively long duration of pauses at railway noise in which the dominating road traffic noise only is audible. On the other hand in an area with dominating railway noise this may lead to the rising of the annoyance scores towards road traffic noise even at low levels in the there also appearing pauses of the dominating railway noise.
These results are confirmed also in the evaluation of the question "What do you perceive to be more disturbing here – railway noise, road traffic noise or both about the same?" (Fig. 4). Where two noise sources with a noise difference of 0 dB(A) would be expected to be named equally frequently, even if railway noise predominates road traffic noise with a noise level of about 5 to 10 dB(A), both sources are listed as disturbing with equal frequency. In addition, even if railway noise predominates strongly this noise is only given as more disturbing by 60-70% of the respondents in question, whilst, in reverse, when road traffic noise predominates, 80-100% of respondents evaluate road traffic noise as more disturbing (see also [5]).

4 - CONCLUSIONS

The evaluations to the nuisance differences between railway and road traffic noise with a direct comparison by subjects in areas, in which both sources of noise are present, lead to the following results:

- In the situation in which both sources of noise produce approximately the same levels (ABS($L_{Aeq,road} - L_{Aeq,rail}$) < 10) the results of earlier examinations are confirmed. Road traffic noise is more annoying as the railway traffic noise at the same noise level.

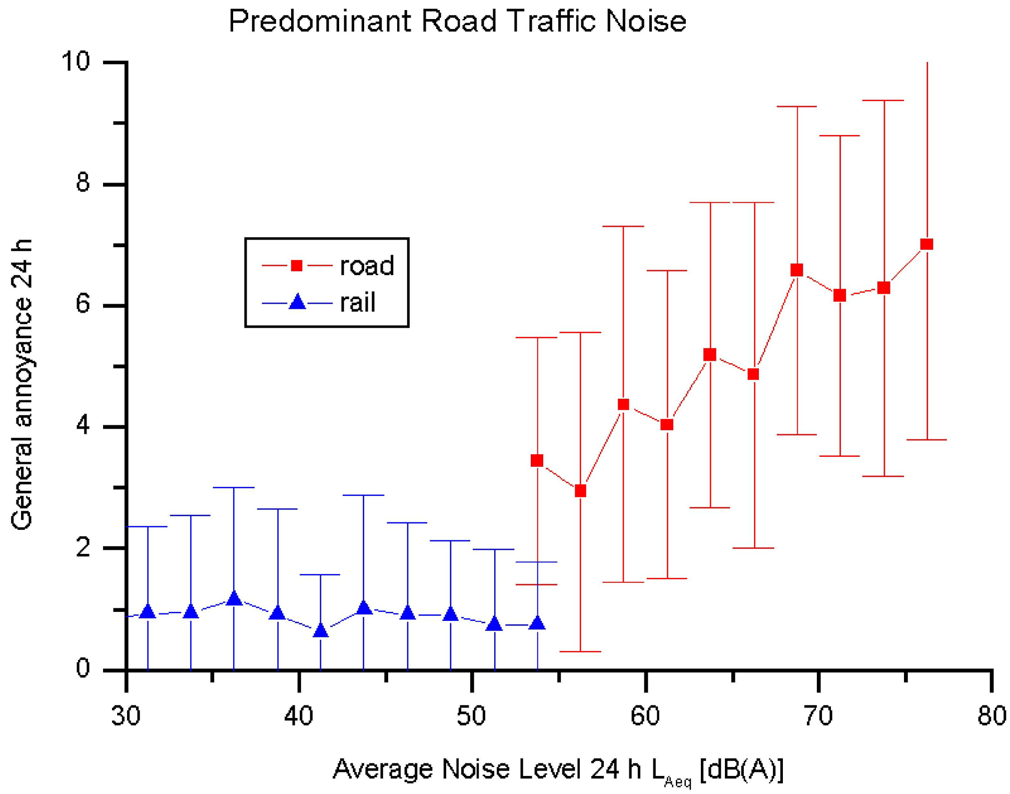

Figure 2: General annoyance by road and rail traffic noise in areas with predominant road noise.

- With dominating road traffic noise ($L_{Aeq,road} - L_{Aeq,rail} > 10$) the railway noise plays a subordinate roll in the effect of annoyance at the range of the noise levels of 30 to approx. 55 dB (A) examined here. A rise of the reaction mean average values on railway traffic noise with rising noise level did not occur.
- With dominating railway noise ($L_{Aeq,rail} - L_{Aeq,road} > 10$) at noise levels below approx. 60 dB (A) road traffic noise even at very low noise levels causes annoyance reactions in the same order of magnitude as the dominating railway noise.

In residential areas in which both traffic noise sources are present, from the view of the noise effect measures of railway noise abatement are only meaningful in the extent in which the noise levels of the railway traffic are reduced to the range of the road noise levels. Measures to railway noise reduction beyond this extend don't yield any relevant reductions of the annoyance reactions. On the other hand measures to reduce road traffic noise can still lead to reductions of the annoyance reactions, if the levels of the road traffic noise are approximately like the ones of the railway traffic.

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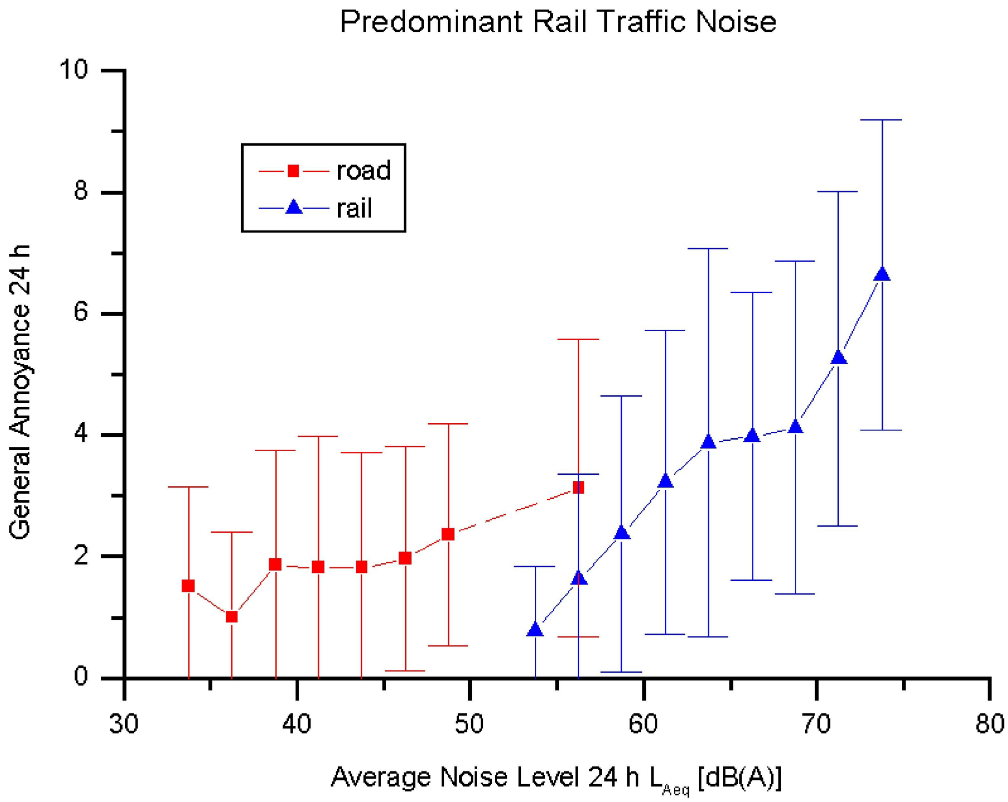

Figure 3: General annoyance by road and rail traffic noise in areas with predominant rail noise.

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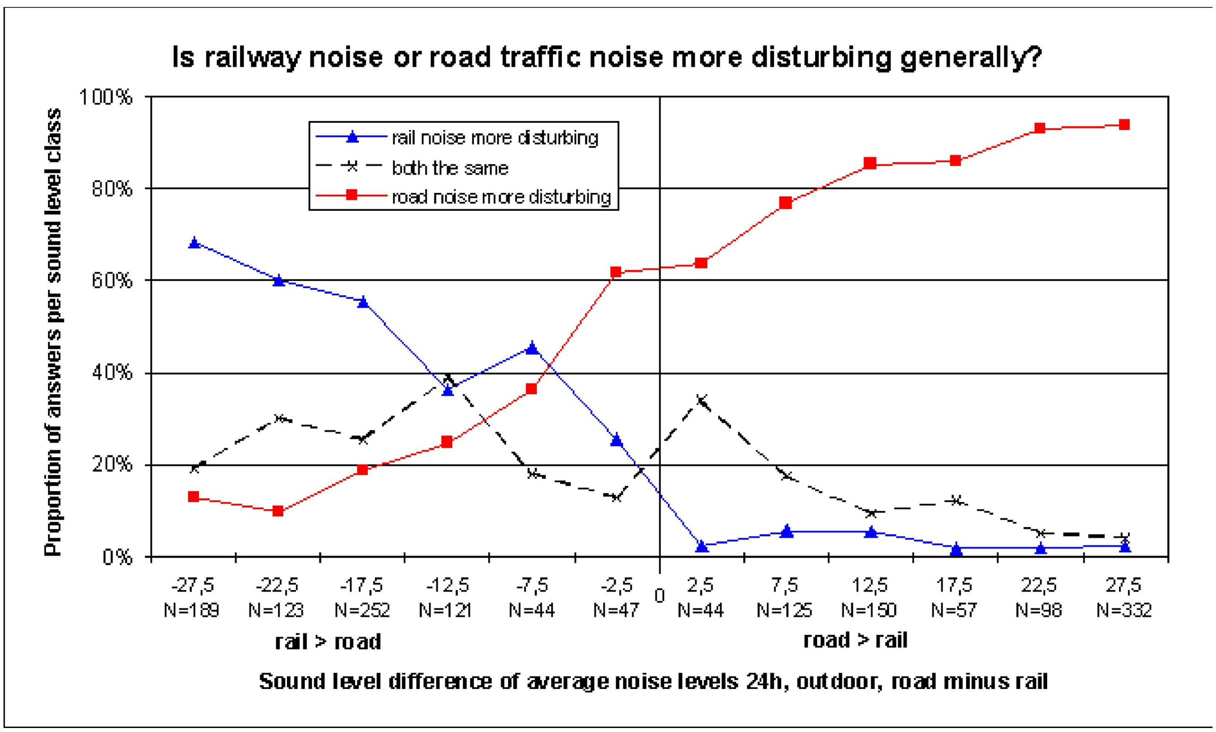

Figure 4: Direct comparison of the disturbing effect of rail and road traffic noise.