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Community Response to Railway and Road Traffic Noise - a Review on German Field Studies

Ulrich Moehler,^a Lou Marcel Greven^b

^aMoehler + Partner, Schwanthalerstr. 79, D – 80336 Muenchen, Germany

^bDB Systemtechnik, T.TZF 12 Voelckerstraße 5, D - 80939 Muenchen, Germany

^aulrich.moehler@mopa.de ^bmarcel.Greven@bahn.de

Abstract. Studies on special aspects, e.g. with respect to sleep disturbances, to high speed train, to high number of passing trains, to freight trains to habituation and fear an railway noise, on the annoyance due to railway noise were carried out in Germany between the years 1996 and 2003. The results of these studies show, that in general railway noise is less annoying than road traffic noise even in the above mentioned special situations. Further more the results of a longitudinal study on the fear of new built train lines show, that there is remarkable overestimation of the annoyance before the beginning of operations.

1. INTRODUCTION

Railway noise is - over all - at the same L_{eq} less annoying than road traffic noise; this is the result of studies in several European countries [1, 2]. This annoyance - difference has been fixed due to the results of surveys in Germany in form of the so-called "railway - bonus" on 5 dB (A). In 1995 the German railway company initiated field studies on special topics in context with the annoyance due to railway noise and -in some cases- in comparison to road traffic noise. Starting point of this studies were the literature surveys. The studies were carried out in an interdisciplinary team and were accompanied by an international commission with members from Germany, Austria, France and the Netherlands. The studies include especially the quantification of differences in the annoyance

- between road and railway traffic noise in the night period,
- inside and outside of sleeping and living rooms regarding also the position of the windows (open/closed),
- between low and high number of pass bys,
- to passenger trains and freight trains,
- to the effects of high speed trains,
- to the changing of reactions with the time near newly built railway lines

The study designs were planned as field studies in selected areas. The acoustic parameters were determined by a combination of noise measurements and calculations, the reactions

were measured with questionnaires and actimeters. Following the method used and the main results will be reported and discussed

2. ANNOYANCE - DIFFERENCES BETWEEN ROAD AND RAILWAY TRAFFIC NOISE IN THE NIGHT PERIOD

Problem: The study covers the question whether and on which scale annoyance differences between road and rail traffic noise can be stated in the night time. It was shown in several field studies in Europe to the relative annoyance of road and rail traffic noise that railroad traffic noise is found less disturbing and annoying at the same L_{eq} than road traffic noise. On the one hand, the annoyance differences are related on the general annoyance during the night time, on the other hand also to interviewed sleep disturbances. However, it has to be asked whether sleep disturbances asked on the day - time in the interview is a valid indicator of a reduced sleep quality. The recording and the comparison of sleep disturbances by road and rail traffic noise was object of the survey by means of physiological sleep indicators

Methods: The study was carried out in the year 1996 and 1998 and is documented in [3, 4]. In 8 selected areas with predominant rail or road traffic noise acoustic measurements, interviews and physiological measurements were carried out. The number of pass bys in the areas varied between 1000 und 15000 autocars / 24h and 60 to 200 trains / 24 h. The individual acoustic impact was determined by a combination of measurements and calculation. [5]. The sleep disturbances were measured in this areas in about 1600 interviews; furthermore the body movement was recorded using actimeters; about 350 participants were observed.

Results: The relationship between noise impact and the reactions was calculated on the basis of the average sound level L_{eq} in the night time (22:00 to 06:00). The main results are shown in fig 1 and 2:

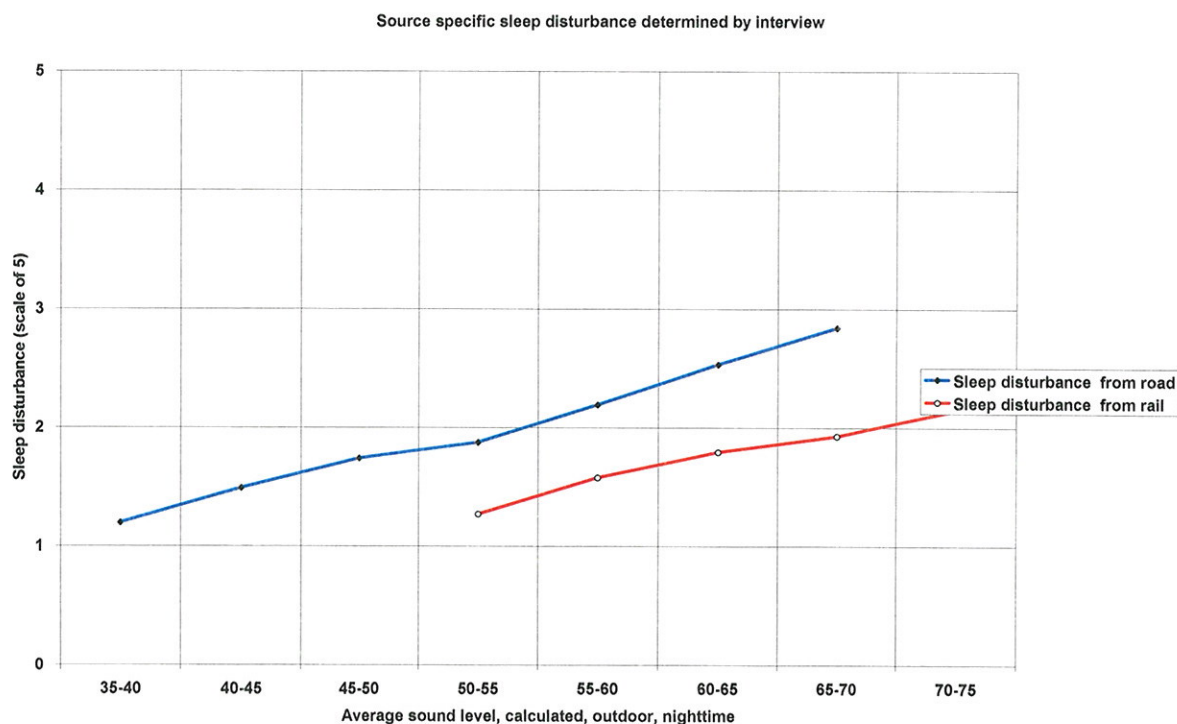


Figure 1: Source specific sleep disturbance determined by interview, depending on sound level.

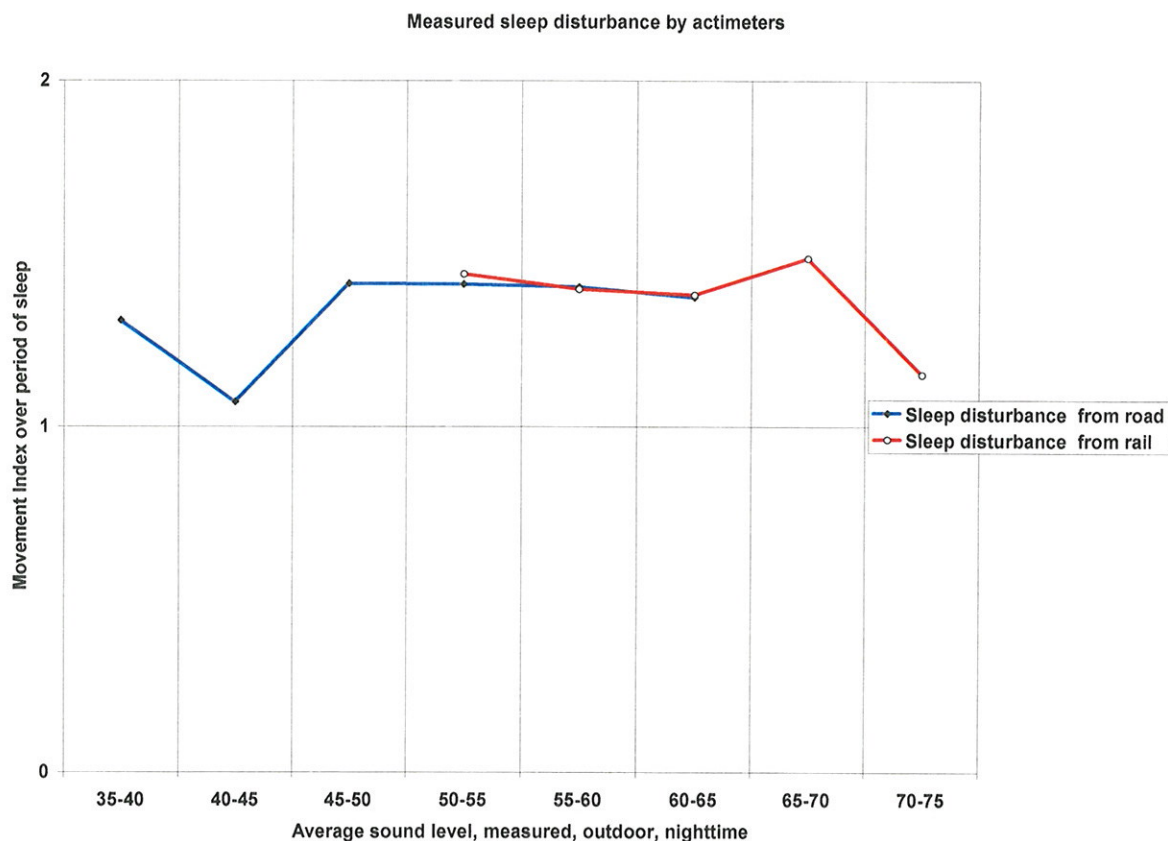


Figure 2: Measured disturbance of sleep by actimeters depending on sound level

The results of the interdisciplinary evaluations basically show the following results:

- The differences found in earlier studies [1,2] between rail and road traffic noise in terms of night-time disturbance determined through interviews were confirmed: according to this, although the average sound level is the same, night-time disturbance from rail traffic is considerably less than disturbance from road traffic noise.
- In contrast, measurements of sleep movements using actimeters were unable to find any correlation between sleep movements and the noise nuisance from rail and road traffic noise. Therefore, it was also impossible to find any difference in the sleep reaction measured by actimeter for rail and road noise.

3. ANNOYANCE - DIFFERENCES INSIDE AND OUTSIDE OF ROOMS

Problem: At some daytime disturbances related to the interior side of dwellings a greater disturbance by railroad traffic noise than by traffic noise let itself be seen. It is therefore suspected that the different annoyance of the sources can partly be explained by the different habitual window - position and the disturbance reactions related to the interior

Methods: For the clarification of the well known inside – outside question the data of the o.m. study on the noise effect on road and railway traffic were extended with additional acoustic calculations inside and outside of dwellings. The interviews and the acoustic evaluations in the additional areas took place essentially comparable to those in the comparative ex-

amination. Acoustic measuring and elevations additional to the determination of the inside levels dependent on the window position took place in the areas. Interviews and acoustic data were determined for 2000 persons. (This study is documented in [6])

Results There is a typical difference in the habitual position of the windows between the occupants near railway tracks and roads: The results to the window position is shown in figure 3:

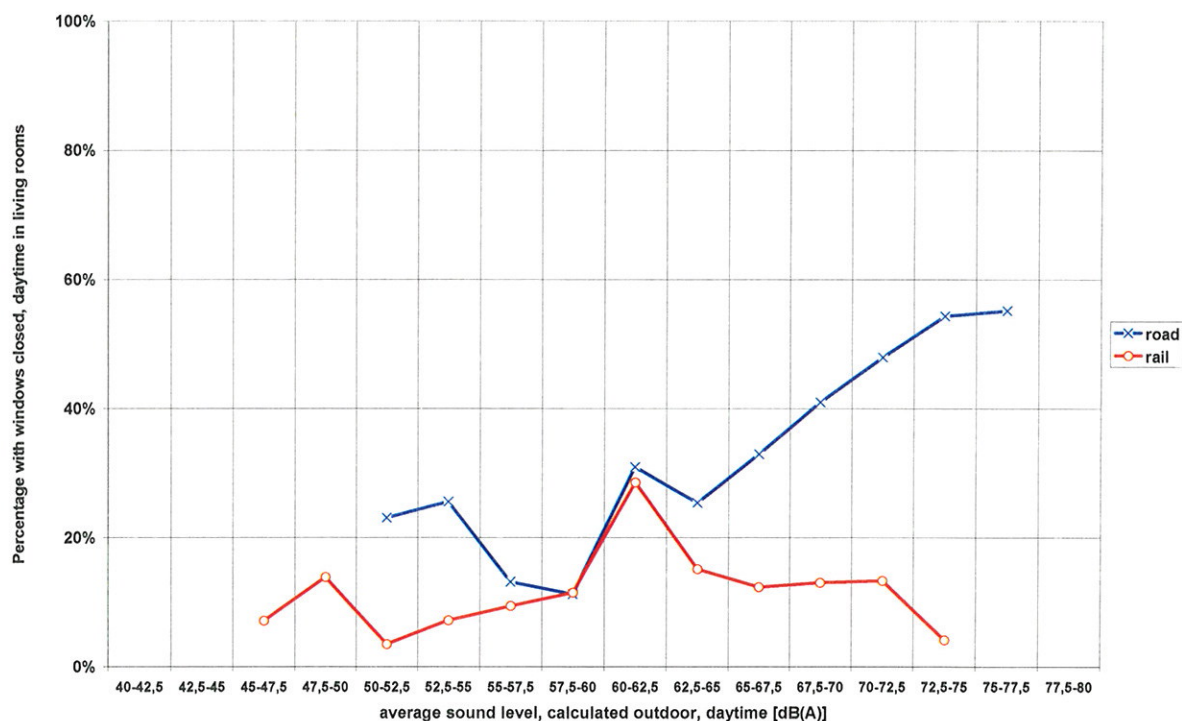


Figure 3: Percentage of interviewed persons with windows closed during the daytime in the living room

Despite the very high noise pollution ($L_{m,day}$ up to 80 dB (A)) in the areas with predominant railway noise is shown, that residents hold the windows opened almost independently of the individual noise pollution to railway routes both in the daytime and at night. Only a little share of the people interviewed on railway routes, namely 11% keeps the windows closed mainly during the day and 15% at night (standardized over the complete level range). Increasing level on the other hand rises the share of the residents who hold the window closed clear in the areas with predominant road traffic noise.. For example more as 50% of the people interviewed in the road traffic areas with L_{eq} more than 70 dB (A) report the window during the day closed. Over the complete level range standardized 32% during the daytime and at night 30% of the people interviewed in the road traffic areas hold the window predominating closed.

4. ANNOYANCE - EFFECTS OF PASSENGER TRAINS AND FREIGHT TRAINS

Problem: Complaints about annoyances by freight railroad traffic are made by residents increasingly. The general validity of the "railway bonus", which is established in the German legislation with a value of 5 dB(A), is also doubted on railway lines with greater load due to

freight traffic. The stated troubles concern disturbances of the night's rest particularly by freight trains.

Methods: The study was conceived as a field study: The residents of railway lines with a different noise impact of freight and passenger trains were interviewed on their subjective annoyances, disturbances or impairments by the train traffic in particular with respect on freight trains and passenger train. The asked subjective annoyance and disturbance of the residents concerned were compared to noise impact, found out by calculations. 1174 train residents were questioned about subjective annoyances and impairments by the train noise using a standardized questionnaire along different railway lines in 16 residential areas. (This study is documented in [7])

Results: Freight trains are found considerably more annoying or disturbing by the residents as the noise of other train types. It turns out that at the same sound level, from the freight trains, the annoyances are considered more annoying than those from the passenger trains. Besides these noise features, however, the longer duration of pass by and therefore the longer disturbance duration of the freight trains also contribute to the more negative verdict.

5. ANNOYANCE - EFFECTS OF HIGH SPEED TRAINS

Problem: The introduction of the new high-speed trains with speeds up to 200 - 300 km/h in Germany has led to fears with many train residents concerned about an additional noise impact and noise annoyance due to high speed trains. Many of the residents show oneself strongly uncertain and fear of planned new tracks and till now unknown noise effects due to the increased speeds.

Methods The study for the consequences of the high speed traffic with speed between 200 and 250 km/h had character which is mainly finding out and describing. The aim was to collect information about the annoyance situation at a high speed way of the German railroad. (This study is documented in [8])

Results: From the results can be read that no stronger noise nuisances and disturbances of the train residents altogether result from the high speed traffic (intercity express train) than for loads due to a conventional railroad traffic for the load situations looked at in this examination.

6. ANNOYANCE - EFFECTS WITH HIGH NUMBER OF PASSING TRAINS

Problem: The results of examinations to the "railway bonus" include a train frequency train of up to approx. 250 trains / 24 h. For the examination of a possible annoyance difference at higher number of passing trains a special study was carried out.

Methods In the context of a field study a reanalysis of the acoustic data and interview results of available noise effect studies of the years 1996 to 2000 was carried out. The existing data were completed by additional collections of acoustic and social data in areas with a very high number of passing trains. Over all data were collected in 13 areas with dominating railroad traffic and 6 areas with dominating road traffic. (This study is documented in [9])

Results: The number of passing trains was shared in 3 groups: low number of passing trains with 150 to 200 passing trains/24 h; medium number 250 to 300 passing train / 24 h and high number 350 to 500 passing trains / 24 h. The relation between the L_{eq} and the general annoyance is shown in following fig. 1

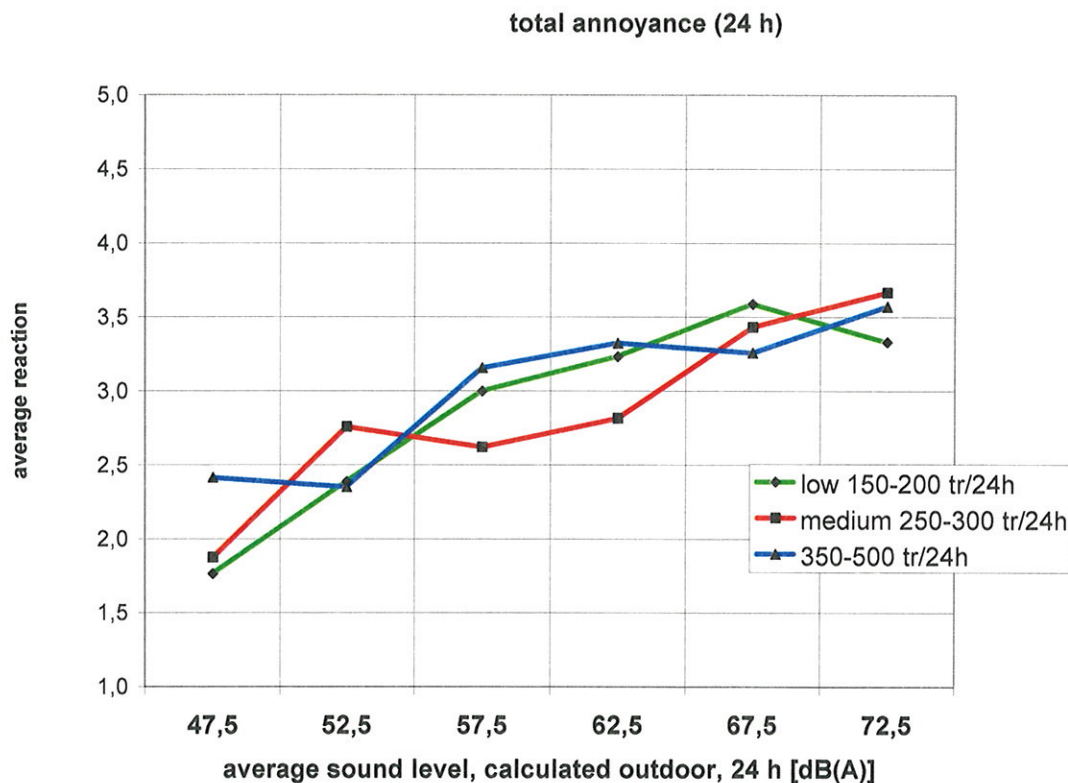


Figure 4: Average annoyance reaction on railway noise in areas with low, medium, high number of passing trains

There is no significant increasing annoyance or disturbance reaction with increasing number of passing trains

7. HABITUATION ON RAILWAY NOISE

Problem: Residents of future track ways often express considerable doubts about the reasonableness of the noise pollution to be expected in future. The aim of this survey is to consider the change of the reactions related to the noise of residents concerned at new railway routes with special respect on the contents to different phases of the new building measures. Special attention applies the comparison to the expected nuisance by the residents and the nuisance actually arrived by the new train traffic noise

Methods A comparative survey of the reactions of the residents of railway lines which respectively are between the planning and the putting into operation in different phases was carried out. The study design represents a compromise between a cross section study and a longitudinal study. Interviews were carried out at three removal and two new building track sections of the German railroad as well as at 4 comparison areas without building measures. Altogether, 493 interviews were to new building ways, 996 interviews at removal line sections and 722 interviews in comparison areas were carried out. (This study is documented in [10,11])

Results: Interviews could be carried out both before and after putting into operation of the fully developed way at a railway route. Clear differences between the expected annoyance before putting into operation and the actual annoyance are found after putting into operation: The annoyance after putting into operation turns out considerably lower than you had expected before the putting into operation. This clarifies the following fig.6.

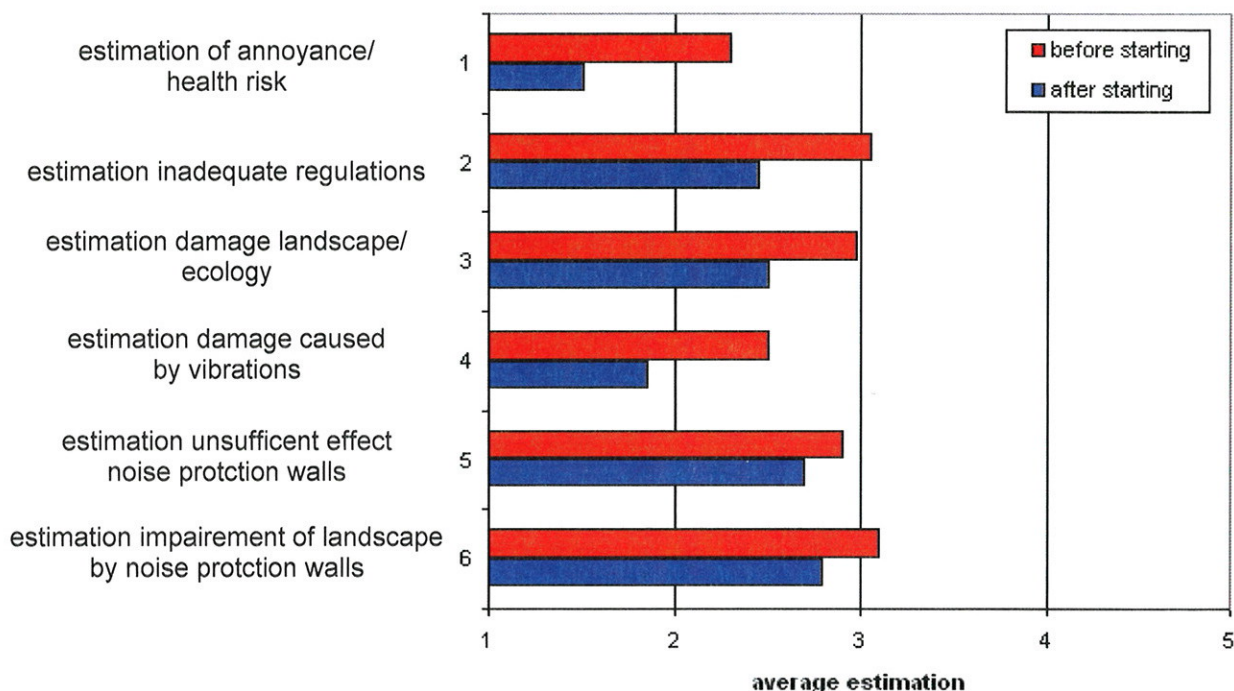


Figure 6: Expected and real disturbance reaction in an area before and after beginning operations on a railway line

The results show that the expecting fears lie considerably over the annoyances and disturbances actually arrived after beginning operation on the new railway line.

8. CONCLUSION

The results of the studies show, that also in the described special situation railway noise is less annoying and disturbing than road traffic noise. Also the expected annoyance on railway lines to be built is remarkable higher than the real annoyance after beginning the operations on the new railway line. A differentiated description of the effects of annoyance and disturbance due to railway and road traffic noise with special respect on the social effects of noise annoyance is shown in [12]

9. ACKNOWLEDGEMENTS

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