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THE INFLUENCE OF SOME NON-ACOUSTICAL FACTORS ON REACTIONS TO ROAD AND RAILWAY TRAFFIC NOISE[1)]

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AIM OF THE STUDY

The 'Minister for Traffic' of the FRG initiated an interdisciplinary field study (IF-II) on the relative effects of road and railway traffic noise [1]: At equal level of annoyance road-railway differences from about -4 dB(A) (disturbances of communication) to +14 dB(A) (disturbances of sleeping) resulted - depending on the reaction and level of L_{eq} concerned.
The aim of the present paper is to show that these differences are also influenced by non-acoustical factors or 'moderators' (such as personal characteristics of the recipient).

DESIGN AND METHODS

Selection of Areas. 20 areas - selected from almost 400 - were investigated: a) 7 areas with predominant road and 7 areas with predominant railway traffic noise; in these areas the secondary noise source (rail resp. road traffic) must be at least 7 dB(A) lower than the predominant source, b) 4 areas with almost equal immission of road and rail traffic noise (mixed immission areas), and c) 2 areas with low immission both of rail and road traffic noise (control areas). The physical loudness - defined in terms of L_{eq} - of the road traffic areas varied between 48 and 72 dB(A) by day (16 h: 6 a.m. to 10 p.m.) and between 36 and 68 dB(A) by night. The corresponding measurements for rail traffic noise vary between 49 and 70 dB(A) by day and between 46 and 69 dB(A) by night.
9 of the areas selected were urban and 11 were rural (communities with less than 20,000 inhabitants). In these areas 1516 Ss were selected at random.

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Measurements of Annoyance and of 'Moderators'. Annoyance was measured by means of a questionnaire. Out of its questions several scales to measure the reactions to rail or road traffic noise were constructed. From these only the following two composite scores were here considered:

RT: 'general annoyance by day' (composed of 5 variables: such as 'disturbances of rest and leisure', 'somatic and vegetative complaints', 'disturbances of communication')

RN: 'general annoyance by night' (composed of 2 variables: 'disturbances of sleeping', 'general disturbance by night').

The questionnaire also contained items to measure personal characteristics, from these measures only the following are here considered:

M1: 'general noise susceptibility'

M4: 'general lability' (M1, M4: each composed from 4 subscales)

M3: negative attitude to technique,

Dividing the 5-point-scale (M1) at the scale-midpoint results in the dichotomy: M1D = {0,1} (0: non susceptible; 1: susceptible to noise) - suitable to define subsamples of Ss.

Furthermore Ss were divided in those tending to open the window (FENST = 0) and those tending to close the window whilst sleeping in the summer time (FENST = 1).

RESULTS

The influence of the non-acoustical variables on annoyance shall be shown

a) by dividing Ss in subsample by M1D and FENST and

b) by means of multiple regression.

Subsample Analyses.

Seperately for each subsample and seperately for road and rail traffic noise 'straight lines' [2] between the annoyance scores (RT, RN) and L_{eq} were computed. Each line is based on 13 areas and connects the corresponding mean reaction scores of the subsample considered and the L_{eq}-values of the areas.

Then for each subsample the lines for road and rail traffic noise were compared and differences between them at equal levels of annoyance were computed (see table 1).

The table shows:

- overall sample: The same amount of annoyance is reached for railway noise at L_{eq}-levels which are higher than for road traffic noise (rail benefit). This benefit is greater by night (RN) than by day (RT) and greater at higher than at lower L_{eq}-levels.
- Subsamples of susceptibility: For Ss susceptible to noise the rail benefit is distinctly higher than for Ss not-susceptible to noise.

- Subsamples according to window opened/closed: For Ss tending to close the window whilst sleeping in summer the rail benefit is greater than for Ss tending to open the window.

Multiple Regression Analyses.

To analyse the relative effects of acoustical and non-acoustical factors on the annoyance reactions multiple regressions were carried out. As 'dependent variables' or 'criterion' the annoyance reactions RT and RN resp. and as 'independent variables' or 'predictors' M1, M3 .. M4 were used. In table 2 three solutions are summarized:

S1: RT (RN resp.) versus L_{eq} (simple regression)

S2: RT (RN resp.) versus L_{eq} and M1

S3: RT (RN resp.) versus L_{eq}, M1, M3 and M4.

Each solution was done seperately for each source (road/rail noise). Differently from the subsample analyses these regression analyses were done on the base of the individual reactions of the Ss.

Table 2 shows:
(1) The overall level of coefficients is rather small;
(2) From the simple correlations (r) between one predictor and the criterion the coefficient for L_{eq} and the reaction is higher than those for the other predictors;
(3) Considering the relative contribution of the predictors (β) in S3 it can be seen, that - apart from L_{eq} - M1 has greater predictive power than M3 or M4; M3 is the weakest predictor.
(4) Comparing the simple L_{eq}-reaction-solution (S 1) with the solution 'reaction' vs. L_{eq}, M1 (S2) shows: Taking into account a non-acoustical predictor such as 'susceptibility' (M1) in addition to L_{eq} increases the 'explained variance' (r^2, R^2 resp.) of the model.

REFERENCES

[1] IF-II: Interdisziplinäre Feldstudie II über die Besonderheiten des Schienenverkehrslärms gegenüber dem Straßenverkehrslärm. Planungsbüro Obermeyer, München 1983.

[2] Madansky, A.: The fitting of straight lines when both variables are subject to error. J. Am. Stat. Assoc., 54, 173-205, 1959.

Table 1: Road/rail-L_{eq}-differences for different samples			
sample	reaction variable	difference in L_{eq} at dB(A)=50	dB(A)=70
overall	RT	0.4	3.4
	RN	9.0	11.0
Ss not-susc. to noise	RT	0.1	0.6
	RN	6.8	5.7
Ss susceptible to noise	RT	0.4	4.6
	RN	10.4	12.8
opened windows	RT	0.1	2.0
	RN	7.9	8.3
closed windows	RT	1.7	1.9
	RN	9.6	10.1

Table 2: Multiple regressions: criterion: annoyance (RT, RN); predictors: L_{eq}, M1, M3, M4

β: standard regression coefficient; r: product moment corr.; R: multiple correlation coefficient. Predictors: S1: L_{eq}; S2*: L_{eq}, M1; S3*: L_{eq}, M1, M3, M4

		L_{eq}	M1	M3	M4
ROAD					
RT	β	.563/.537	.390/.330	-/.093	-/.136
	r	.52	.32	.22	.30
	R		.65		.67
RN	β	.487/.464	.402/.367	-/-.001	-/.145
	r	.44	.35	.14	.29
	R		.59		.61
RAILWAY					
RT	β	.507/.487	.284/.237	-/.111	-/.087
	r	.46	.19	.20	.20
	R		.54		.56
RN	β	.337/.315	.305/.262	-/.069	-/.116
	r	.28	.24	.16	.20
	R		.41		.43

* before '/': S2; after '/': S3