

Proceedings of The Institute of Acoustics

SUBJECTIVE RESPONSES TO CHANGED LEVELS OF TRAFFIC NOISE

I D GRIFFITHS and F J LANGDON

University of Surrey and Building Research Establishment

INTRODUCTION

Few studies of subjective responses to environmental noise have been made where populations have been exposed to changes of a permanent kind in their ambient conditions. Indeed, the majority of investigations have taken place in the context of very stable conditions (1, 2, 3). The UK Transport and Road Research Laboratory (TRRL) has, however, carried out an extensive appraisal of the effects of the opening of new by-pass roads upon the environment as perceived by residents (4, 5, 6, 7). In West Germany investigations have been made into subjective response to the introduction of noise barriers (8).

This small corpus of information has not been analyzed so as to reveal any significant differences between evaluations made of noise levels which have been stable for some considerable time and those of levels which have changed recently.

The present paper provides a statistical comparison between the authors' own data and the results of the TRRL studies and then applies a similar analysis to the German data.

THE TRANSPORT AND ROAD RESEARCH LABORATORY DATA

A series of studies has been carried out by the TRRL (4, 5, 6, 7) to ascertain, inter alia, the effect of noise reductions produced by the opening of relief roads. In each of six towns investigated the 18hr dBA L_{eq} was measured at the road subject to relief, both before the opening of the by-pass and some months after. A social survey was also carried out among the residents, on a before and after basis. On the average the before condition was 2-3 months before opening and the after 4-6 months after the event.

Subjective appraisals were made in terms of how 'bothered' respondents were by traffic noise, expressed in terms of four categories, 1: not at all, 2: a little; 3: moderately, 4: very much (bothered by traffic noise). This response scale has not previously been used in studies of traffic noise annoyance, but bears a close resemblance to McKennell's scale used in the London (Heathrow) study (9).

Table 1 gives the 18hr L_{eq} dBA and median bother scores for the towns involved in the TRRL study. It will be immediately apparent that the range of noise levels in the before study is too small to allow any regression between noise level and bother to be calculated.

However, a recent study by the present authors (3, 10) used McKennell's scale over a very much wider range of L_{eq} (52.5 - 78.4 dBA) and the relevant results are summarized in Table 2. Correlation of the physical and psycho-

Proceedings of The Institute of Acoustics

SUBJECTIVE RESPONSES TO CHANGED LEVELS OF TRAFFIC NOISE 2

logical data in that table gives a coefficient of $r = 0.8$, significant at beyond the 1% level and associated with a prediction equation

$$\text{median bother} = 0.046 L_{eq} \text{ dBA} - 0.817.$$

This formula may be used to 'predict' the median bother scores at the TRRL sites, yielding the information found in Table 3, where the observed values are repeated for comparison with the 'predictions'. The significance of the differences has been tested with Student's t test for matched pairs and it is apparent that prediction and observation are not different in the before condition; after the opening, however, the predicted bother scores are all higher than those observed, the significance of which exceeds the 0.1% level. Thus, while the prediction before the change is reasonably accurate, afterwards the same equation over-estimates bother to a considerable degree.

THE WEST GERMAN DATA

Kastka and Paulsen (9) report the results of a study of the effects of erecting noise barriers in Dusseldorf and Wuppertal, having gathered data before and after the noise reduction. Their study involved the use of three subjective rating scales, the scores upon which the present authors have analyzed in an analogous manner to that employed for the TRRL data, with one change of procedure: the range of noise levels in the before condition was sufficient (50 - 70 dBA L_{eq}) for correlation. Thus the prediction equation in this case arises from within the before data themselves. The correlations between mean responses and L_{eq} were all between 0.96 and 0.99 but nevertheless the t tests carried out between predicted and observed means after noise reduction were significant at beyond the 1% level for two of the three scales.

In both significant cases (and indeed where the difference was nonsignificant) respondents were more disturbed by noise levels after the erection of barriers than the statistical prediction on the basis of conditions before (Table 4).

DISCUSSION

The analysis of the TRRL data shows that while the responses before the noise reduction are consistent with independent data on their relation to ambient noise levels the same predictive procedure significantly overestimates bother after the opening of a relief road. Calculation shows that the benefit obtained by a reduction from 75dBA to 65dBA may equate subjectively to a reduction to 55dBA. The German data agree in indicating that steady-state or before data do not predict response after change, but the significant discrepancies are here in the opposite direction: the subjective benefit of the environmental improvement would be significantly overestimated by consideration of the L_{eq} levels alone. The magnitude of the overestimation could be such that a physical reduction from 75dBA to 65dBA would be subjectively equal to a reduction to no less than 70 dBA.

These findings raise at least two important problems:

- 1 Will these discrepancies from prediction reduce over time, and if so, over what period?
- 2 Do they indicate that there are significant differences in subjective reaction to different methods of noise reduction?

Proceedings of The Institute of Acoustics

SUBJECTIVE RESPONSES TO CHANGED LEVELS OF TRAFFIC NOISE 3

While the results presented here cannot be considered conclusive they clearly indicate the need for more research.

REFERENCES

- 1 I D Griffiths and F J Langdon (1968) JOURNAL OF SOUND AND VIBRATION
8 16-32 Subjective response to road traffic noise
2 F J Langdon and I B Buller (1977) BUILDING RESEARCH ESTABLISHMENT
CURRENT PAPER CP10/77 The effects of road traffic noise in residential areas
3 I D Griffiths, F J Langdon and M A Swan (1980) JOURNAL OF SOUND AND
VIBRATION 71 227-240 Subjective effects of traffic noise exposure: reliability
and seasonal effects
4 TRRL (1977) REPORT No 746 Before and after study of the environmental
effects of the Tring bypass
5 TRRL (1978) SUPPLEMENTARY REPORT No 359 The environmental effects of
bypassing small towns - case studies at Boughton, Dunkirk and Bridge
6 TRRL (1978) SUPPLEMENTARY REPORT No 428 Environmental effects of
road traffic - case study at Mere
7 TRRL (1981) Before and after studies of road changes at Lewes,
Ludlow and East Grinstead (A W Mackie, personal communication)
8 J Kastka and R Paulsen (1979) UNTERSUCHUNG UBER DIE SUBJEKTIVE UND
OBJEKTIVE WIRKSAMKEIT VON SCHALLSCHUTZEINRICHTUNGEN UND IHRE NEBENWIRKUNGEN
AUF DIE ANLIEGER Institut fur Hygiene, Universitat Dusseldorf, FRG
9 A C McKennell (1963) GOVERNMENT SOCIAL SURVEY REPORT SS 337 AIRCRAFT
NOISE ANNOYANCE AROUND LONDON (HEATHROW) AIRPORT HMSO London
10 F J Langdon and I D Griffiths (1982) JOURNAL OF SOUND AND VIBRATION
(In Press) Subjective effects of traffic noise exposure II: comparisons of
noise indices, response scales, and the effects of changes in noise levels.

Proceedings of The Institute of Acoustics

SUBJECTIVE RESPONSES TO CHANGED LEVELS OF TRAFFIC NOISE 4

TABLE 1 TRRL RESULTS

SITE	BEFORE		AFTER	
	dBA Leq	Median bother	dBA Leq	Median bother
1	72.5	1.9	67.5	1.5
2	74	2.3	66	1.8
3	72	2.5	56.5	1.3
4	76.5	2.7	73.5	2.2
5	73	2.2	67.5	1.8
6	72	2.4	67	1.6

TABLE 2 GRIFFITHS et al RESULTS

SITE	dBA Leq	Median bother
1	78.4	2.5
2	74.8	2.9
3	67.2	2.3
4	60.5	1.9
5	61	1.4
6	55	2.1
7	74.5	3.1
8	52.5	1.7

TABLE 3 TRRL DATA: COMPARISON OF PREDICTED AND OBSERVED BOTHER SCORES IN BEFORE AND AFTER CONDITIONS

SITE	BEFORE		AFTER	
	Observed	Predicted	Observed	Predicted
1	1.9	2.5	1.5	2.3
2	2.3	2.6	1.8	2.2
3	2.5	2.5	1.3	1.8
4	2.7	2.7	2.2	2.6
5	2.2	2.6	1.8	2.3
6	2.4	2.5	1.6	2.3
	mean difference			
		0.22		0.53
		t 2.13		8.25
		p > 0.05		< 0.001

TABLE 4 GERMAN DATA: t TESTS FOR COMPARISONS OF PREDICTED AND OBSERVED SUBJECTIVE RESPONSES AFTER NOISE REDUCTION

Response scale	N (sites)	Mean difference	t	p
Sensory response	7	0.32 s = 0.5	1.7	> 0.05
Somatic/Emotional	7	0.73 s = 0.5	3.6	< 0.01
Acoustic	7	0.84 s = 0.4	5.9	< 0.001