Proceedings of The Institute of Acoustics

THE RELIABILITY OF NOISE INDICES

I D GRIFFITHS and M A SWAN

UNIVERSITY OF SURREY and LONDON BOROUGH OF CAMDEN

1. INTRODUCTION

While studies of aircraft noise annoyance and resulting noise control measures relate to the period of the year during which there is maximum annoyance (the summer), the situation for road traffic is less clear. It was therefore considered worthwhile to investigate the seasonal fluctuation in noise exposure and noise annoyance at the type of suburban site which has been the focus of such studies before (1,2).

Similarly, it is now known (3) that the predictive ability of noise annoyance scales used in social surveys is potentially much reduced by the scale of differences in response by the same subjects in the same noise exposure conditions but at different times. The magnitude of this problem could be assessed within the format of a seasonal study if the measurements were repeated on the same individuals. In addition this would permit the development of more reliable measurements of annoyance (by averaging across seasons), the predictive power of which could be tested against the results of a programme of noise measurements of a variety of kinds.

Repeated interview surveys were therefore made at eight sites in suburban residential areas of London, with noise levels between 57 and 82 dBA (L10, 06.00 - 24.00). At six of these sites four sets of interviews were conducted between Autumn and Spring, and at two sites two sets of interviews were carried out in the Summer period. The total number of interviews carried out was 1363.

At each site traffic noise levels were measured for 24hrs at each interview phase with a microphone 1m from the facade at first floor level. The programme of measurement yielded estimates of the L10, L50, L90, and Leq, all both linear and A-weighted.

2. SEASONAL EFFECTS

It has been reported (4) that there can be important seasonal differences in noise exposure at some locations. This was not the case for any of the London suburban sites, where the maximum difference between any pair of measurements was 2.4dBA. It is also interesting to note that there was an extremely high correlation between the L10 for 06.00 to 24.00 and that for the evening period 17.00 to 23.00.

Statistical analysis of the annoyance data showed that there was no significant difference between subjective responses at different times of year.

3. RELIABILITY OF ANNOYANCE INDICES

Reliability of subjective indices is defined as the correlation between two or more independent measurements on the same people, taken individually. The present study allowed us to calculate it both for the seven-point dissatisfaction scale (1,2) and the four-point bother scale used in aircraft noise studies (5). The basic (single test-retest) coefficient was 0.64 for the seven-point scale and 0.63 for the four-point, both of which are highly significant statistically but only amount to an estimate that the proportion of variance in annoyance which is reliable is of the order of 40%. By averaging over the four non-summer phases of the study this coefficient was raised to 0.88 in both cases, corresponding to 77% of the variance being reliable. Averaging over three phases gave an indistinguishable result from averaging over four.

4. CORRELATIONS WITH NOISE INDICES

Correlation coefficients were calculated between individual dissatisfaction and bother scores and the eight noise indices mentioned in the introduction. The average score for the four phases was also calculated for each subject and correlated with the same indices. The four-point bother scale was always less highly correlated with the noise indices than the seven-point dissatisfaction scale. All noise indices correlated to approximately the same degree with dissatisfaction, for both linear and weighted sound levels. Averaged dissatisfaction and bother both correlated more highly with noise levels than did the scores from single interview phases, there being 40% more variance explained by noise than in the case of raw scores. Once again, there was no distinction to be drawn between the different indices of noise exposure in terms of their ability to predict annoyance. Average correlation coefficients are given below.

TABLE 1

Mean correlation coefficients between noise exposure indices and dissatisfaction and bother scores.

raw dissatisfaction	0.39
dissatisfaction averaged over 4 measurements	0.46
raw bother	0.26
bother averaged over 4 measurements	0.32

all coefficients are significant at beyond 1% level

5. DISCUSSION AND CONCLUSIONS

It seems clear that the L10 18hr dBA is an extremely reliable indication of noise exposure since any single weekday measurement seems to give a good estimate of the weekday level at any time of year. This finding relates to London and probably to other large cities but may not apply to areas where there is a large seasonal element in traffic flows. There is a high intercorrelation between L10 for a restricted part of the evening and the conventional 18hr statistic, which could be of significance where more rapid assessments of nuisance are required, particularly because the evening is the period of highest domestic occupancy.

The finding which is perhaps the most surprising is the lack of seasonal influence on annoyance. It is clear from general considerations as well as from the date gathered in the survey that in the more equable seasons people spend more time out-of-doors and have more windows open in their houses. These factors do not, however, influence their level of annoyance, which seems to be much more dependent on the external noise exposure rather than on individual noise dosage. This clearly strengthens the case for planning criteria based on external noise standards rather than on the levels of noise received within the dwelling. It thus has possible implications for noise insulation strategy but also means that no particular time of year needs to be specified as the optimum measurement period for noise exposure assessment (this may, however, be restricted to the case in which the dwelling shields the private garden at the rear from the road noise).

The reliability of annoyance measurements is substantially the same as that estimated in an earlier study (3) and thus the initial finding that use of the distribution of raw annoyance scores significantly overestimates the scatter between individual people in their annoyance caused by the same noise exposure is replicated. It is possible to increase the reliability of the measurement of annoyance by averaging the scores for the same individual over a number of measurements and this technique increases the correlation with noise exposure to an appreciable extent.

It is quite clear from the data presented that there are no grounds for the selection of any particular noise index for planning purposes on the basis of its correlation with the human response, since L10, L50, L90 and Leq all correlate with the measures of annoyance to the same extent, whether they are linear or A-weighted. Any decision must therefore be based on such matters as ease of prediction in a variety of circumstances. There is reason to suppose that there is still need for further studies of the effects on annoyance of distance from the noise source.

In terms of research methodology it is clear that the seven-point scale of dissatisfaction is to be preferred to the four-point bother scale, for, while they have similar reliabilities, the longer scale has clear advantages as a correlate of noise exposure. Where maximum precision is required the measurement of dissatisfaction should be repeated to a total of three measurements, thus maximizing reliability. This is particularly important where intercorrelations on an individual basis are proposed with inherently more reliable measurements (personality inventories, noise measurements).

6. 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 1976 Journal of Sound and Vibration 47 243-263 Noise nuisance caused by road traffic in residential areas: Part 1.

3. I D GRIFFITHS and F R DELAUZUN 1977 Journal of Sound and Vibration 55 93-107 Individual differences in sensitivity to traffic noise.

4. L C FOTHERGILL 1977 Applied Acoustics 10 191-200 The variation of environmental noise outside six dwellings between three seasons.

5. MIL Research Ltd 1971 Second survey of aircraft noise annoyance around London (Heathrow) Airport. HMSO: London.