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A COMBINED LABORATORY AND FIELD STUDY OF TRAFFIC NOISE

I. H. FLINDELL

I.S.V.R., The University, Southampton, SO9 5NH

Introduction

The ISVR simulated living room listening facility has been designed to investigate subjective response to combinations of environmental noise sources (1).

Previous dose-response type research has tended to concentrate on one source only, eliminating or balancing out noise from other sources. It is useful however, to have some information on the differences in response to different noise sources and to changes in noise environment (2). A social survey and measurement programme becomes unwieldy if it is stretched to accomodate several sources at several different levels, quite apart from the difficulty in finding large enough groups of residents with homogeneous noise exposure environments. Furthermore, such a programme can only investigate response to changes in noise environment by actual manipulation of the environment, which is often undesirable or impossible.

These difficulties can be overcome by using the laboratory, with its economy of subjects and ease of experimental control. The ISVR listening facility is designed to achieve maximum realism of presentations, using high quality stereo reproduction systems, and subjects are made to relax and feel at home by the use of typical domestic furnishings. It was considered worthwhile to test the validity of the experimental technique by comparing laboratory results with social survey data obtained from subjects who were interviewed at home before visiting the laboratory. Satisfactory results from this study would justify confidence in the general applicability of future work on combinations of noise sources.

Design and Procedure

Social and Community Planning Research were engaged to recruit 60 randomly selected individuals willing to visit the laboratory within three days of being interviewed, using a standard twenty minute questionnaire. All subjects were recruited from a site in Southampton, which was divided into three sections with homogeneous high, medium, and low traffic noise exposure. Situational and other variables were controlled as far as possible by choosing a relatively compact site away from other noise sources, and by placing demographic constraints upon the achieved sample of respondents.

The questionnaire included items taken word-for-word from previous major traffic noise social surveys (3,4) and other items with direct counterparts from the laboratory phase of the study.

The site was selected after careful examination of likely street configurations, then the use of standard noise level prediction techniques (5,6) was followed by a considerable investment in noise measurement. Ten minute samples at many sites were analyzed to yield 'A' weighted L_{10} and L_{eq} levels, with an objective of being able to estimate L_{eq} levels outside every residence by extrapolation. Precise locations were not known before the survey because of uncertainty in recruitment.

Spot checks of noise level were made every day during the actual survey period in June and July 1978, to gain additional information on day-to-day and seasonal noise level fluctuations.

Three outdoor noise levels of 70, 63, and 54 dB(A) were chosen before the

survey as being representative of noise measurements corresponding to each subject group. Stereo tape recordings were made at positions having the above noise exposure levels, taking care with microphone to kerbside distances, and the rate of flow of traffic.

Laboratory Technique

Within three days of being interviewed in the field, groups of three or four subjects visited the laboratory for two hours on one evening only. After audiometric screening, they heard four ten minute recordings, the first and last (as a re-test) corresponding to their own home noise environment. The tapes were played back at levels of 60, 53, and 44 dB(A) in the room to simulate typical worst case open window indoor environments. (An attenuation of 10dB see (7)). A pilot study in May 1978 had shown that subjects base judgements solely on noise level in the laboratory and disregarded explicit instructions and other cues as to whether or not the windows were open or closed, when making projected judgements from the laboratory to their own homes. Thus the actual attenuation used could be chosen to obtain a good signal to noise ratio in the laboratory, even for the quietest tape.

After each tape, subjects completed a questionnaire, composed of a battery of 10 point unipolar scales concerning annoyance and activity disturbance, and yes/no direct 'highly annoyed' questions. Each item had a counterpart which had been previously administered in the field, to enable direct comparisons to be made.

Subsequently, subjects were asked individually to match the level of a tape in the laboratory,with the level of traffic noise audible at precisely specified locations at their own homes.

Results and Discussion

A study of this nature generates large amounts of data, some of which still awaits analysis. However the data so far examined tends to justify faith in the ISVR laboratory method.

Satisfactory test-retest correlations were obtained in the laboratory between first and last presentation scores across individuals. Mean scores broken down into order and subject groups also demonstrated no significant order or hysterisis effects. This result made it possible to overcome the limitations of the incomplete factorial design and show that home noise environment did not influence laboratory responses, when scores were averaged across the three subject groups, each individual scoring each tape once.

Field scores were compared with results obtained by Langdon (3) and Yeowart et al (8) using the 7 point dissatisfaction scale (see Fig. 1). There is good agreement between the three points obtained in the present study and Langdon's regression line, although Yeowart's respondents appear to be less sensitive at the lower noise levels.

Relatively high correlations were obtained between 24hr L_{eq} and response over individuals in the present study on each of the main questionnaire scales (0.65 to 0.67) due to the small variation across situational variables in the sample and a concentration of data at each end of the noise level range covered.

Fig. 2 shows a comparison between the laboratory and field data using the 10 point 'not annoying at all' to 'extremely annoying' scale, plotted against noise level in L_{eq}. The laboratory scores show mean response over all subjects to the three tapes, using the question; 'How annoying would this traffic noise be in your own living room, in the evening?' The dotted line shows the mean response by each of the three subject groups when asked to adjust the level in the laboratory to match that heard at home, with the windows open.

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The field response using a counterpart 10 point scale is plotted on the right at outdoor noise levels. These 24hr L_{eq} levels were found to be not significantly different from samples taken between 10 a.m. and 4 p.m. during the day, and between 7 p.m. and 9 p.m. in the evening. The mean level for the medium group was 6dB lower than expected because most subjects from this group came from houses at the far boundary of the selected area (from the nearest main road).

The field response can be brought into line with the laboratory response by applying an 18dB indoor/outdoor attenuation. This figure was obtained from measurements at four residences in the study, with the front room window open by a 'typical' small amount, the indoor mic in the room centre, and the outdoor mic at the usual facade position.

Analysis of the other laboratory/field comparable scales gave a similar result.

Conclusions

Analysis to date has shown that using careful experimental and questionnaire techniques with a realistic sound presentation system in a simulated home listening environment can give a close correspondence between laboratory and social survey responses to traffic noise. The appropriate indoor/outdoor characteristic is an attenuation of 18dB, corresponding to a typical open window, when using 24hr L_{eq} measurements at facades in the field, and 10 minute evening L_{eq} measurements in the laboratory. This 18dB factor is in agreement with field measurements at the site.

Furthermore, laboratory responses were stable, and without a systematic order effect. Mean group responses were not influenced by subjects' home traffic noise exposure levels.

References

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Figure 1

7point dissatisfaction scale comparisons

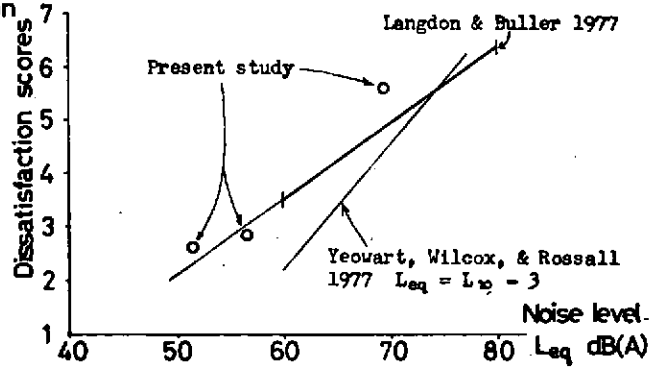

Figure 2

Mean scores on 10 point scale