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MEASURES, PERCEPTIONS AND VALUES OF NOISE FROM ROAD TRAFFIC

E. Arsenio*, A.L. Bristow*, J. Patricio, A. Pinelo***, F. Silva****, M. Wardman***

* Institute for Transport Studies, University of Leeds, LS2 9JT, Leeds, United Kingdom

** Laboratorio Nacional de Engenharia Civil- Nucleo de Acustica, Av. do Brasil 101, 1700-066, Lisboa, Portugal

*** Laboratorio Nacional de Engenharia Civil, Transportation Department, Av. do Brasil 101, 1700-066, Lisboa, Portugal

**** Technical University of Lisbon-CESUR, Av. Rovisco Pais, 1049-001, Lisboa, Portugal

Tel.: 00-44-113-2335225 / Fax: 00-44-113-2335334 / Email: earsenio@its.leeds.ac.uk

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ABSTRACT
Recent studies in the field of environmental economics using discrete choice models have suggested that valuation models based on individuals' perceptions might perform better than those using objective attribute measures. This fact has motivated the development of an innovative computer stated preference survey for valuing noise impacts from road traffic at the community level, using both perceptions and objective noise measurements inside respondents' homes. This paper presents some preliminary results on the relation between perceptions, objective noise measures and householders' annoyance levels.

1 - INTRODUCTION
In urban areas, noise is generally perceived by the exposed residents as the most important problem associated with road traffic, as people feel more directly affected by noise than by any other form of pollution [1]. Evidence suggests that individuals mostly perceive the adverse effects of noise through the annoyance it causes in their everyday life and behavior, but they are unable to understand objective measures of noise such as L_{eq} dB(A) when used to describe different circumstances. This has meant that there has been a tendency for local decision makers to ignore the social costs of road traffic noise.
Although annoyance is not only a function of the physical noise exposure, but is related to other factors [2], the correlation between noise levels and the average of the annoyance scores in a residential area is relatively high, which means that the individual non-noise differences tend to average out [3]. Therefore, it is assumed that noise levels (and perceived noise levels) can be a good predictor of the mean average annoyance at the community level for valuation purposes.

2 - OBJECTIVES AND SCOPE
The work presented here is part of an on-going research study on the valuation of environmental externalities from road transport, focusing on noise impacts at the community level. Following recent findings in the field of environmental economics using discrete choice models, an innovative computer valuation model was developed using both perceptions and objective noise measurements taken indoors at respondents' homes. During 1999, this computer survey was administered to more than 400 households living in high-rise buildings near three main roads in Lisbon Metropolitan Area.
This paper presents initial findings from the analysis of one residential lot with 114 households living in high-rise buildings of the same type (four households per floor, two fronting the main road and two located at the back) near the North-South Ring Road. As an intermediate step in the noise valuation model,

this paper focuses on the relation between households' perceptions of noise levels indoors (assessed by means of a rating scale), with objective noise measures taken in each location, and perceived annoyance levels. One important question to ask is whether absolute perceptions or relative perceptions are more closely correlated with objective noise measures.

3 - THE SURVEY WORK

It is not the objective of this paper to provide a detailed explanation of the noise valuation model, but it aims to combine several types of data using different valuation techniques to derive monetary values per unit of dB(A). The survey covered the following issues:

- block layout (orientation to main traffic road) and traffic noise exposure (position of respondents' bedroom and sitting room to main traffic road, etc.) and window type;
- socio-economic data and other relevant information (health problems, etc.) about the household;
- familiarity with different flat choices through the specification of several attributes (price, area, etc.);
- housing tenure and mortgage;
- perception of the general noise levels indoors, considering the external dominant source (road traffic);
- stated preference questionnaire for different flat options;
- willingness-to-pay to improve the noise environment indoors (or to avoid a noise degradation);
- attitudes towards noise reduction indoors (type of noise averting measure installed and costs);
- factors related to the attitudes of the respondent when indoors (window open, weekends spent home, number of hours normally home, etc.);
- annoyance levels during the day and night.

After the computer aided personal surveys were conducted, noise measurements were taken at respondents' flat indoors and outdoors (samples of 15 minutes) using two contiguous rooms in the flat located in the same exposed facade. The level of sound insulation was then derived for each flat considering each type of window. During the experiment, several noise parameters were reported: L_{eq}, L_{50}, L_{10}, L_{90}, L_{95}, L_{max} and L_{min}. Noise levels are relatively constant during the day near the North-South Ring road (Fig. 1). Therefore, the energy equivalent continuous A-weighted sound pressure level in dB(A) will act as the preferred physical noise measure to represent the general noise levels inside respondents' homes.

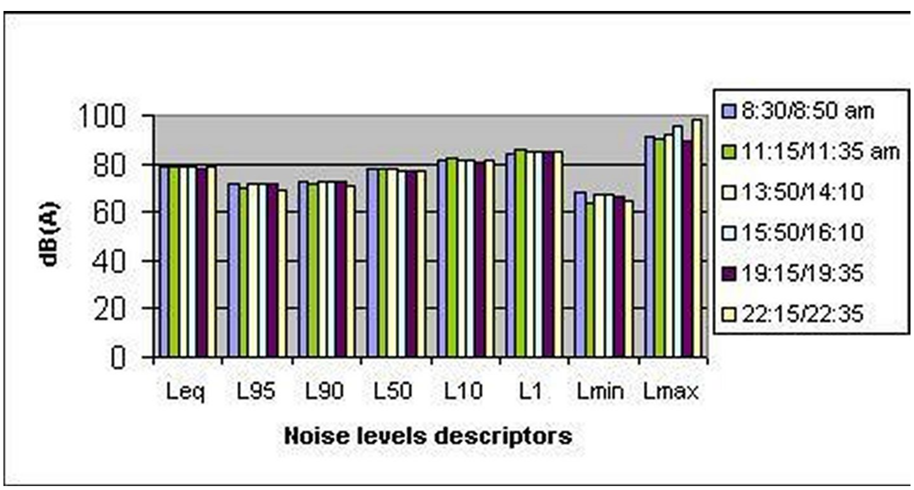

Figure 1: Noise measurements outdoors in the proximity of the North-South Ring Road.

Noise measurements were also taken outdoors on normal weekdays, at front and back facades of each building. The mean equivalent sound pressure level outdoors near the buildings at the ground floor ranges from 66.4 dB(A), facade front to main traffic road, to 55.5 dB(A) at the back. Recent studies recommend the value of 50 dB (A) L_{eq} not to be exceeded during the day-time outdoors in order to protect the majority of people from being moderately annoyed [4].

4 - RESULTS

The layout of the blocks is such that 44 households were located at the back of the blocks, 67 were fronting the main road and only 3 were laterally exposed to the main road. Considering the way traffic noise affects households' everyday life when indoors, 29% were very much annoyed during the day (7am till 10pm), and 23% were very much annoyed during the night (10pm till 7am). Overall, 20 % of the respondents in this lot were simultaneously very much annoyed during the day and night.

During the survey, respondents were asked in a single step (same screen) to rate the general noise levels inside their own flat and for other three flats. The other three flat options presented were a function of the position of the household flat in relation to the main road (combinations of front and back facades; upper and lower floors). Therefore, households' relative perceptions of the variation in noise levels with height as well as between back and front on the same floor can be obtained.

The rating scale for quietness chosen was a numeric one, with the bipolar adjectives "very quiet" (corresponding to 100) and "very noisy" (corresponding to "0") on the extremes.

Since the advent of Fechner's law in 1960 [5], there has been a great deal of discussion around the relationship between sensory magnitudes and the physical intensity of the stimulus. Considering the reinterpretation of the results of direct psychophysical judgment in terms of the relation theory conducted by Shepard [6], it is primarily the relationship between the stimulus (difference of noise levels indoors, e.g. between flat front and back to main traffic road) and not the individual magnitude themselves that are perceived by the individuals. Because the stated preference experiment for noise valuations considers several combinations of differences between two levels of the noise variable, we are interested on assessing the correlations between relative perceptions and noise measures.

Therefore, we have computed respondents' relative perceptions of the noise levels indoors, considering the differences in ratings between the ones given to their own flats and i) the flat in the same floor and located in the opposite facade (DP_1); ii) the flat in the same facade but located at the extreme floor (DP_2); iii) the flat located in the opposite facade and the extreme floor (DP_3). The results of regression analysis, when the dependent variable is DP_i (i=1,3), and the independent variable is the relative differences for each case in noise levels indoors, DL_{eq} dB(A) is represented in Table I.

	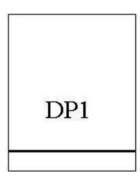	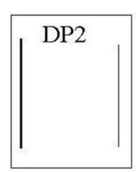	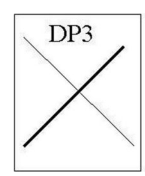
	Model R1	Model R2	Model R3
α (t value)	.973 (.479)	-1.972 (-1.227)	1.142 (.433)
β (t value)	-2.13 (-7.94)	-1.999 (-6.690)	-3.864 (-7.446)
Adj R^2	.361	.399	.472
Durbin-W	1.878	1.914	1.878

Table 1: Regressions of relative perceptions on L_{eq} differences.

From Table I, all β coefficients of the three regression equations are statistically significant at 95% confidence levels ($p < .05$). The intercept values (α's) of the regression equations are statistically insignificant and can be removed. This indicates a proportional relationship between relative perceptions and actual noise levels differences. Also, a significant proportion of the variance in the dependent variable is explained by relative physical noise measures (Adj R^2). The Durbin-Watson test for serial correlation of residuals shows that residuals of consecutive observations are uncorrelated.

The regressions between absolute perceptions of noise levels indoors for each flat position type, and the correspondent noise measurements L_{eq} dB(A) indoors are represented in Table II. This regression uses the 0 to 100 ratings for each flat.

	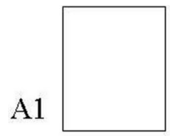	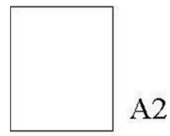	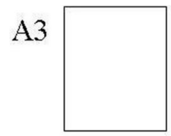	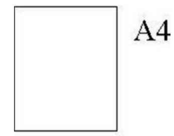
	Model A1	Model A2	Model A3	Model A4
α (t value)	96.381 (6.07)	84.362 (7.109)	93.754 (5.588)	79.129 (6.081)
β (t value)	-1.444 (- 3.228)	-1.09 (-3.142)	-1.245 (-2.714)	-.782 (-2.172)
Adj R^2	.079	.083	.055	.033
Durbin-W	1.937	1.735	1.614	1.832

Table 2: Regressions of absolute perceptions on L_{eq} dB(A).

Comparing the results in Tables I and II, we have verified that relative perceptions have a higher correlation with relative noise measures, DL_{eq} dB(A), than do the absolute values of the variables. A lower proportion of variance in the ratings is explained by the regression equations (Table II), suggesting that absolute perceptions are much influenced by other behavioral and attitudinal variables of the respondent (e.g. habit of having the windows open, number of hours normally spent indoors, type of activities conducted, etc.).

Our initial results seem to indicate that relative perceptions can be used for valuation purposes in the noise valuation model, and in all situations where respondents are familiar with the different magnitude of the stimulus presented (in this case general noise levels indoors in known situations at the community level). If so, the use of ratings (relative perceptions) could lead to lower the costs in noise valuations studies by avoiding the need for extensive noise measurements.

However, further analysis is required, and comparisons will be made with other residential lots where noise barriers have been installed.

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