Factors affecting Annoyance Response to Road Traffic Noise in Hong Kong

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ABSTRACT

Commissioned by the Environmental Protection Department of the Hong Kong SAR Government, a large scale survey interviewing 10,077 randomly selected households was undertaken by an international team in Hong Kong in 2009-2010. A binary logistic regression was performed relating whether or not the interviewee was highly annoyed to noise exposure level and a host of factors including access to a quiet room, habit of window closing, crowdedness, household density, perception of neighbourhood environment, home ownership, type of living quarter, length of residence, noise sensitivity, disease, health status, hearing problems, poverty, gender, age, employment, shift-worker, education level, occupation and monthly household income. The results showed that level of noise exposure has only a relatively small effect on annoyance. Factors which intensify the annoyance response include, in order of importance, noise sensitivity, window closing and whether the respondent is the owner of the dwelling. On the other hand, factors which can mediate annoyance reaction include: access to a quiet room in the dwelling, satisfaction with the neighbourhood environment and the number of households in the living quarters. It can be seen that window closing has a positive association with annoyance. Implications of these findings for managing the urban acoustic environment are discussed.

INTRODUCTION

This paper reports a study of the annoyance response of the Hong Kong to road traffic noise. In this exposure-effect study, exposure refers to the level of road traffic noise obtained by a territory-wide noise mapping exercise, and effect to human annoyance response. The latter was measured through a carefully designed large scale survey interviewing 10,077 randomly selected households. This paper examines the factors affecting the annoyance response of the Hong Kong population to road traffic noise; and discusses the relative importance of various factors.

The key findings of this large scale survey have been given by various research team members in a number of reports (Lam et al., 2012) and papers. For example, the one by Brown et al. (2014) provides reliable estimates of the exposure of the Hong Kong population to road traffic noise and the resultant extent of annoyance and self-

reported sleep disturbance. This paper primarily focuses on the determinants of human annoyance. Elucidation of the determinants is significant not only academically but also practically. In the last three decades, an increasing number of studies have been undertaken in different geographic areas exploring factors, both acoustical and non-acoustical, affecting human annoyance response to transportation noise. Practically, the findings of such investigation can help formulation of noise management strategies and identification of acoustically amicable urban forms and design.

The significance of this analysis rests not only on the sheer size of the household survey, but also the high-rise and dense urban form in Hong Kong which is different from that of western cities in which majority of the human response studies have been undertaken. The findings of this study will shed light on whether human annoyance response is shaped, among other factors, by density, culture and urban morphology.

METHODS

Social Survey

Details of the study methodology are reported in Lam et al. (2012), and it is sufficient to note here that this is the first systematic city-wide study of exposure-response for road traffic noise in Hong Kong. Response to noise was measured in a total of 10,077 households randomly selected across Hong Kong in part of the periodical thematic social surveys undertaken by the Census and Statistics Department (Hong Kong CSD, 2012), achieving a 76% response rate.

The population sampled was all residential addresses in the Hong Kong Special Administrative Region from which a random sample was drawn and prior letters sent to selected addresses. House calls were made between November 2009 and March 2010 and in each household, an adult aged 18 years or above was randomly selected for interview. Annoyance was measured using a questionnaire designed by the study team, following the international standard for measurement of noise annoyance [ISO/TS 15666, 2003], and the percentage of people highly annoyed (% HA) with road traffic noise is defined as 8, 9 and 10 on the 0 to 10 numeric scale as per Miedema and Oudshoorn (2001). In addition to the question on annoyance, a host of other questions were also posed, which fall into three categories:

- Group A: Factors which modify indoor noise level - access to a quiet room within dwelling, habit of closing windows, crowdedness and number of households in the living quarter
- Group B: Factors affecting perceptions - residential satisfaction, home ownership, type of living quarter and length of residence
- Group C: Personal factors - noise sensitivity, disease, health status, hearing problems, poverty, gender, age, employment, shift-worker, education level, occupation, monthly household income.

The above factors had been identified in previous studies as potential determinants of human annoyance response. The questionnaire survey was administered by trained staff and the data obtained was validated by follow-up phone calls on 15% of the sampled households with regard to six factual questions. All dubious cases were discarded.

Noise Exposure

Noise exposure, LDEN, at the most exposed side of each of the 10,077 successfully interviewed households was obtained by a city-wide traffic noise mapping used 3D technology (Law et al. 2011) and the ISO 9613-2 (1996) method.

Statistical Analysis

Based on the factors affecting annoyance identified in the preceding section, a binary logistic regression analysis was performed. The dependent variable was a dichotomous one indicating whether or not the household respondent was highly annoyed by road traffic noise. Independent variables were grouped into four blocks with the first being the noise exposure level (LDEN). The second, third and fourth group of variables were related to modifiers of indoor noise exposure, perception and personal variables as described above. These variables were chosen because of their significance reported in earlier studies elsewhere (e.g. Belojevic et al. 1997; Fyhri & Klæboe, 2006; Fyhri & Klæboe, 2009; Ryu & Jeon, 2011). Considering the strong interrelation between some of the variables, they were entered into the analysis per group, with 0.05 as significance criterion and results expressed in “odds ratios”. An odds ratio > 1 indicates that a particular variable intensifies the annoyance reaction. Conversely, a ratio < 1 signifies the variable reduces or moderates reaction.

RESULTS

The binary logistic regression analysis (Table 1) shows that level of noise exposure has only a relatively small effect on whether or not the respondent is highly annoyed. The results also show that factors which intensify the annoyance response include, in order of importance, noise sensitivity, window closing and whether the respondent is the owner of the dwelling. On the other hand, factors which can reduce annoyance reaction include: access to a quiet room in the dwelling, satisfaction with the neighbourhood environment and the number of households in the living quarters. It can be seen that window closing has a positive association with annoyance. This association does not tell whether window closing is the outcome of noise exposure or a casual factor of annoyance. The study also ascertained that the annoyance reaction can be reduced if the respondent can access a quiet room in the dwelling or is satisfied with the neighbourhood environment. These findings are generally in line with previous studies.

Table 1: Logistic regression of factors affecting annoyance

Block	Description	Beta coefficient	Significance Level	Odds Ratio	Cumulative Nagelkerke R^2	Change in Nagelkerke R^2
I	Noise Exposure	.074	.000	1.077	.058	
II	Quiet room	-.758	.000	.469	.088	.03
	Closing windows	.257	.000	1.293		
	No. of households	-.275	.005	.760		
III	Res satisfaction	-.602	.000	.548	.119	.031
	Ownership	.218	.008	1.244		
IV	Noise sensitivity	.453	.000	1.573	.140	.021
	Hearing problem	.481	.012	1.618		
	Education	.132	.032	1.141		

DISCUSSION

This is one of the largest exposure-response studies for road traffic noise ever undertaken. The sheer sample size (n = 10,077), rigorous random strategy, high response rate of 76% have put the findings on a sound and solid basis worthy of consideration by all those interested in annoyance response to road traffic noise. The findings presented in Table 1 also shed some light on some of the frequently discussed issues concerning human annoyance response to road traffic noise.

The most notable is the finding that noise exposure level has a very small effect (odds ratio = 1.077) on invoking annoyance reaction. The results also show that factors which intensify the annoyance response include, in order of importance, noise sensitivity, window closing and whether the respondent is the owner of the dwelling. Personal sensitivity to noise has long known to be the key determinant of annoyance and this study has affirmed that.

Of significant interest are those factors, identified in this study, which can moderate annoyance reaction. They include access to a quiet room in the dwelling, satisfaction with the neighborhood environment and the number of households in the living quarters. It can be seen that window closing has a positive association with annoyance. This association does not tell whether window closing is the outcome of noise exposure or a factor causing annoyance. The study also ascertained that annoyance reaction can be reduced if the respondent can access a quiet room in the dwelling or is satisfied with the neighborhood environment. These findings are in line with recent studies with regard to the accessibility to a quiet facade (Ohrstrom et al., 2006; Gidlöf-Gunnarsson & Ohrstrom, 2010; Kluizenaar et al. 2011) and a pleasant neighborhood environment (2005 Li et al., 2010). Our findings re-affirm the importance of having access to a quiet side of the dwelling. In the case of Hong Kong where most dwellings are apartments in high-rise towers, the study has found that having access to a quiet room inside the dwelling can have the same moderating effect. Similar to a few other studies, this study has affirmed that a good neighborhood environment can also help moderate annoyance reactions.

To sum up, this study has three major findings. Firstly, it has re-affirmed that noise exposure level has only a limited positive association with annoyance response. Secondly, accessibility to a quiet room and satisfaction with the neighborhood are positive factors that can reduce annoyance. Finally, the study has not found any demographic or socio-economic variable that my intensify or moderate annoyance reaction. All these suggest that whilst noise reduction is important in managing the urban acoustic environment, other urban design and soundscaping measures can be also be useful.

CONCLUSIONS

A large scale survey interviewing 10,077 randomly selected households was undertaken in Hong Kong to explore the relationship between annoyance response to road traffic noise and a host of noise exposure level. The results have ascertained the limited effect of noise exposure level on human response and highlighted the positive role of accessibility to quiet room with the dwelling and to an amicable neighborhood environment. These urban design measures can be potentially useful tools to create a livable urban environment.

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