



The effect of structural differences at regional or community level on noise annoyance curves

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The observed noise – annoyance associations available show large variations at study level. Nevertheless, the claim is made that reliable annoyance estimates can be made by linking the information of large-scale noise mapping efforts to standard noise – annoyance curves. In this paper it is argued that apart from problems related to noise assessment methods the structural differences at regional or community level have not sufficiently been explored or taken into account. Among those differences special emphasis is given to structural factors of the environment (e.g. the area layout, the built environment and housing in relation to noise sources) and differences in the structural distribution of host factors (susceptibility or resilience) that may affect the response of populations in different regions. The potential effects and their relation are outlined and its size will be quantified if possible. By neglecting differences in the distribution of structural variables it will be difficult to accurately evaluate or predict the effects of noise action plans or large scale transportation projects at smaller scales. Therefore, further efforts are needed to quantify the effects of structural variables on annoyance as dominant Public Health outcome measure at regional or community level.

1 INTRODUCTION

The observed noise – annoyance associations available show large variations at study level. In his review paper at the ICBEN-conference in Rotterdam 2003, Fields stated that "on the average communities differ with a standard deviation in annoyance responses that is the equivalent of about a 7 decibel difference in noise exposure". Nevertheless, the claim is made that reliable annoyance estimates can be made by linking the information of large-scale noise mapping efforts to standard noise – annoyance curves. In order to find out the relevant factors that are responsible for the large variations at study level a broader conceptual approach is

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needed. Following the classical epidemiologic triad (agent-host-environment) it is obvious that a simple agent (source) related approach does not suffice. Especially, as noise acts as chronic stressor and successful coping and adaptation to noise strongly depends on the environmental, social and housing context and the innate or acquired susceptibility or resilience of the concerned residents. At the aggregated level of communities, regions or nations variations in the underlying distribution of host and/or environmental factors will largely determine the response to noise.

It is the aim of this paper to review important structural factors known to impact on noise annoyance in the literature and – if possible - extract their quantitative impact on the effect estimates of annoyance. For selected environmental and health factors quantification will be provided from new analyses of the ALPNAP-study (see Lercher et al. 2011). The paper will not address issues related to noise assessment methods and variations that occur due to differences in calculation methods. This has been presented already at ICBEN 2008 and ICBEN 2011.

2 THE ENVIROSCAPE

Job et al. proposed to classify contextual factors related to the community reaction to noise similar to the causal concept of the epidemiological triad as soundscape, enviroscape and psychscape. The enviroscape groups all non-noise features of the physical environment. Among the many factors that have investigated the following were repeatedly mentioned: Population density, mesh size of traffic in cities, various land use variables, history of noise exposure, number of single households, housing types, location of bedroom, existence of quiet façade or courtyards, influence of distant noise sources, large seasonal variations of the soundscape (winter vs summer, behavior related), expectation as a combined variable (including land use, house type, appearance), appearance of neighborhood, presence of air pollution, access to green areas or leisure facilities, satisfaction with neighborhood. However, a reliable and full quantification of the effects of these variables on annoyance in terms of decibel equivalents is still missing for most variables. Particularly it is not clear how these effects are interrelated.

Furthermore, the effects observed on average in larger reviews are often small or even not relevant. This does, however, not mean that in some regions or cities the effects could not be larger and relevant in terms of mitigation or prevention. For instance, we still have not reliable data about the mitigating effect of air conditioning on annoyance in climates with higher annual temperatures. The strongest evidence for a seasonal effect comes from 7 years of continuous daily interviewing of nationally representative probability samples in the Netherlands. Noise annoyance varies over the year, is increased by temperature, and may be increased by more sunshine (Miedema et al., 2005). Recently, the difference in the quiet side effect between two groups with at least 10 dBA difference between the front and back façade was estimated at approximately 2.5 dB (de Kluizenaar et al., 2011).

In the ALPNAP-study we found strong effects (7 to 18 Lden,dBA) of bedroom location towards railway, motorway and main road. (Fig. 1, Fig. 2). For house type (single vs row/apartment) only non-significant differences of 2 to 4 Lden,dBA were observed. These effects were adjusted for age, sex, education, health status and noise sensitivity.

3 HOST RELATED FACTORS (PSYCH- AND PHYSIOSCAPE)

Annoyance has been proposed to be either a possible mediator or moderator in the causal relation between sound exposure and somatic health. However, little data about these pathways are available. Babisch et al., (2005) assumed a possible over-reporting in people with pre-

existing chronic diseases – since a relation between noise annoyance and ischemic heart disease was only present in those subjects free of any chronic disease at the beginning of the follow up.

The opposite pathway has been much better investigated. For instance, the large meta-analysis of Fields concluded that all 14 relevant studies supported the hypothesis that general sensitivity to noise increases annoyance. Based on 34 surveys Miedema & Vos (1999) derived a decibel equivalent of up to 11 dB for noise sensitivity and for fear up to 19 dB as moderator. Higher annoyance is also reported if the education is higher, the occupational status is higher, a home is owned instead of rented and whether a person does not depend on the noise source. These effects are much smaller – between 1 and 3 dB equivalents.

An earlier analysis by Job (1991) calculated equivalents of 6 dB for fear, 9 dB for noise sensitivity, satisfaction with life 10 dB and 14 dB for the belief: “noise harms health”. The range for several attitudes towards the source was calculated from 8 to 15 dB equivalents. We currently lack a combined model that would be able to account for all the interrelations between those factors and the exposure-annoyance relationship.

In stress theory the annoyance reaction is considered to be a biologically adaptive way of reacting to noise induced stress (primary appraisal) and can – given coping efforts are successful – prevent more serious health consequences of noise exposure. The so-called "adaptive capacity" of individuals towards noise has shown to be a significant moderator of the annoyance response in an earlier study by Rohrman. Successful coping depends, however, on the balance between coping resources and the overall stressor load. For instance, a population with a high proportion of people working on nightshifts is more susceptible to the effects of day noise due to their already impaired general adaptive capacity. In this concept potential interactions with the enviroscape are of potential importance. Populations having sleeping and living rooms directed towards really quiet courtyards have the obvious advantages of structurally built in adaptive resources which can buffer against health effects. On the other hand people living within a context of multiple stressor exposures (combined or multi-source exposures) obviously are compromised in terms of their adaptive capacity towards noise (Evans 2001).

In the ALPNAP-study we observed effects of health status and noise sensitivity (4 to 9 Lden,dBA) on annoyance estimates of railway, motorway and main road sound exposure (Fig. 3, Fig. 4). These effects were adjusted for age, sex, education, and health status or noise sensitivity respectively.

4 DISCUSSION AND CONCLUSIONS

The effect estimates from large archives about the importance of environmental or health related factors on the annoyance response at the community level may be both under- and overestimates. Averaging and insufficient adjustments make it risky to extrapolate these estimates to the regional and city level. Further efforts are needed to quantify the effects of these variables for the application at smaller scales. The use of local survey information is always the better choice.

5 REFERENCES

Available from the author by request (Peter.Lercher@i-med.ac.at)

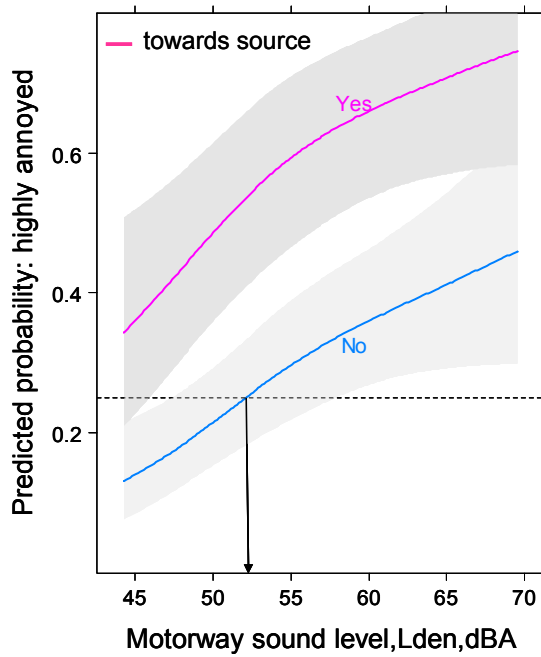


Fig. 1 – The effect of bedroom location on the annoyance estimates: motorway sound

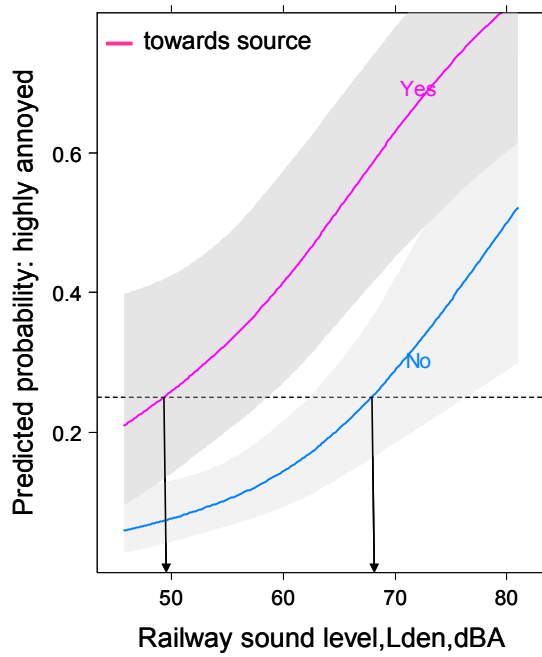


Fig. 2 – The effect of bedroom location on the annoyance estimates: railway sound

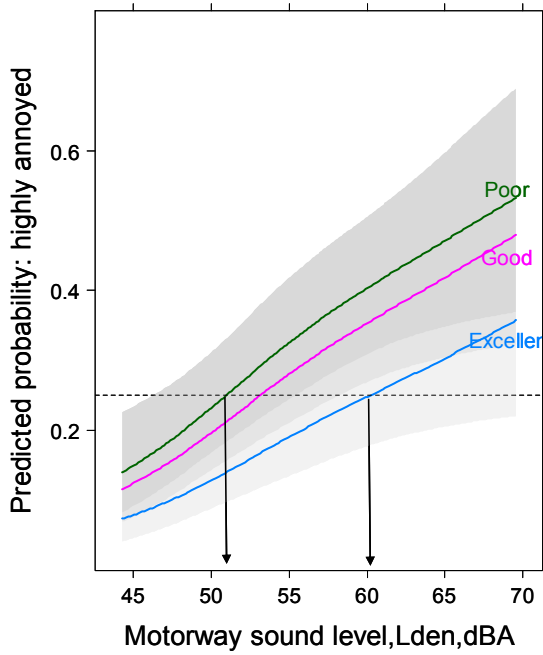


Fig. 3 – The effect of health status on the annoyance estimates: motorway sound

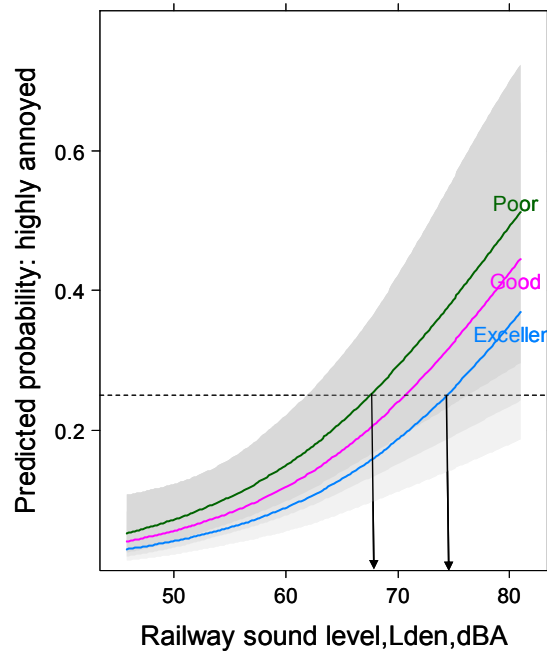


Fig. 4 – The effect of health status on the annoyance estimates: railway sound