NOISE ANNOYANCE STUDIED IN DIFFERENT SITUATIONS: A COMPARISON OF RESULTS OBTAINED IN SITU AND LABORATORY CONDITIONS

Felcyn Jan[1*] **Preis Anna**[1] **Gogol Robert**[1] **Emche Martyna**[1]
[1] Department of Acoustics, Faculty of Physics, Adam Mickiewicz University, Poznań, Poland

ABSTRACT

Noise annoyance is one of the most common non-health effects of noise. Although related somehow to the sound level values, annoyance ratings are not only dependent on this factor. Thus, other factors are discussed, among them a measurement condition. Researchers ask people to rate the annoyance in their place of living or in laboratory conditions. Some studies suggest that results obtained for these two conditions cannot be compared, as different non-acoustical factors influence people's judgments. To answer this question we conducted a study in which people were asked to rate noise annoyance in both conditions (in laboratory and in situ conditions) of the same noise stimuli. Results obtained so far show that there are no statistical differences for all noise levels.

Keywords: *noise annoyance, laboratory experiment, in situ, psychophysics*

1. INTRODUCTION

Although noise annoyance research is conducted for many years now, there are still two main conditions in which people are asked to rate noise. One condition is in their place of living/residence (in situ). The other way is to invite listeners to the laboratory and present them noise using loudspeakers/headphones. Circumstances and possible factors influencing answers differ between these two situations. As was mentioned by [1], "an important difference between laboratory studies and field studies is that in a laboratory the subject concentrates on the noise, contrary to what happens in a real situation where residents concentrate on everyday activities". According to [2] people at their place of living tend to rate long-term noise annoyance (several months or even a year preceding the research) while in laboratory only just-heard stimuli are rated (short-term noise annoyance, [3]). Differences in measuring conditions can lead to differences in ratings. As [4] suggest, standard deviations of answers in situ are greater than those from laboratory tests. Moreover, field studies have much more visual factors, which influence people's answers. For example, for the perception of streets their geometry is crucial (width-to-height ratio, width and sound level values, [5]). For wind farms, it is very important to estimate the visual influence of the farm on the neighbouring landscape [6]. Moreover, vegetation and its presence in front of the noise sources could be – but not always is – essential to deteriorate noise annoyance [7]. Taking into account all these aspects, it seems difficult to directly compare results of research conducted in situ and in laboratory conditions. However, a procedure of 'unifying' factors can be helpful here. Since in our project we wanted to compare noise annoyance ratings given for wind turbine noise by residents in the field and in laboratory, we developed a protocol to keep the same circumstances in both conditions. We will describe it in the next section and then present results of such a framework. We used the same stimuli in situ and in laboratory conditions and then compared gathered data.

2. METHOD

When talking about annoyance of wind turbines' noise, several challenges arise. First of all, the concept of annoyance can be tricky or unclear for respondents. Moreover, wind turbines' noise is specific and sometimes even not heard before by respondents. So there is a need to have common knowledge before the main part of an

[*]***Corresponding author***: *janaku@amu.edu.pl*

experiment starts. To get people know what is noise annoyance and how wind turbines sound like, we created a preliminary study which is conducted in each of our experiments.

Based on findings from our previous studies [8], we created a set of teaching stimuli. There are 7 (each lasting 15 seconds) stimuli which are recordings of everyday life in a city – like a boardwalk, small local market, streets and parks. We know what are the mean annoyance ratings of them (as they were rated by people in a previous experiment, on a 11-point numerical ICBEN scale [9], [10]). So at the beginning of the new experiment we present our listeners these stimuli and inform what was the annoyance rating of each of them. After that, a set of 5 different wind turbines noise recordings (taken from [11]) is presented. We ask people to rate them (using the same numerical ICBEN scale) based on the knowledge from the teaching stage. Both parts are conducted using headphones (Beyerdynamic DT-150 paired with a small laptop with the same gain level for all people) and random order of stimuli presentation. In field studies the equipment was used in the place of residence of a given person while in laboratory conditions people were in a small acoustically-adapted laboratory. Only after this two-stage preliminary study we start the main experiment. In situ we used it before asking people to fill in a survey related to wind farms' noise. In laboratory conditions, it was the preliminary part before the main experiments. Thus, as the procedure was the same in both conditions we assume that respondents should have the same concept of noise annoyance when starting main experimental parts.

3. RESULTS

To find out if the developed procedure unifies results between different conditions, we compare results obtained during in field studies (with number of samples = 50) with answers given in the laboratory conditions (n = 33). As was mentioned before, the procedure in each situation was exactly the same. Results are presented in Table 1 and Fig. 1.

Table 1. Results of bayesian ANOVA computed in JASP software.

Models	P(M|data)	BF_{10}	error %
Null model	1.630×10^{-43}	1.000	
SoundLevel + ResearchType	0.519	$3.183\times10^{+42}$	1.458
SoundLevel + ResearchType + SoundLevel ✻ ResearchType	0.254	$1.558\times10^{+42}$	6.264
SoundLevel	0.227	$1.396\times10^{+42}$	0.006
ResearchType	1.170×10^{-43}	0.718	0.026

In Table 1 the most important values are Bayes Factor (BF). BF depicts the likelihoods of two statistical models: BF_{10} a likelihood of the alternative hypothesis over the zero one, and BF_{01} – the reverse ratio. The larger the value, the stronger evidence in favor of the first model is. According to Jeffreys [12] values of BF greater than 100 are ‘decisive’ while lower than 1 support a theory in favor of zero hypothesis (no influence on dependent variable). Taking a look in Table 1, all first three models have very high BF_{10} values; the greatest for a model with both sound level (45, 50, 55, 60 and 65 dBA) and research type (field and laboratory studies). However, when only research type is considered, BF_{10} is lower than 1, providing a theory that it has no influence on dependent variable (noise annoyance). On the other hand, as one can see from Fig. 1, the louder stimuli are, the bigger differences are. Nevertheless, they are not statistically significant. Even for 65 dBA the Bayesian difference has BF_{10} around 9.5 meaning that the evidence is only ‘substantial’. Of course results differ regarding various sound level values, but they are the same for a given single value. What could be interesting is that standard deviation for laboratory conditions are higher than for field studies. However, it is not surprising taking into account smaller sample size for the latter group. Experiments are still carried out and we plan to gather similar amount of data to compare both conditions more reliably.

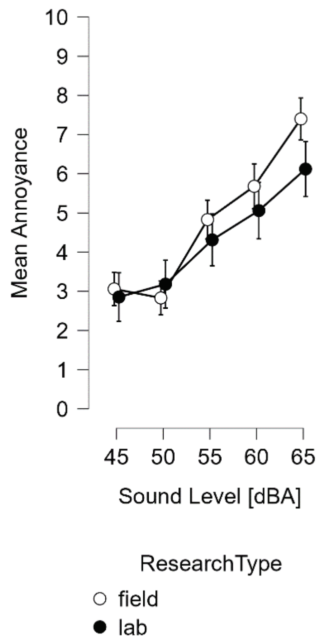

Figure 1. Mean annoyance ratings computed for different sound level values and experimental conditions.

4. DISCUSSION

Based on Bayesian analysis and graphical representation of the data, no statistically significant differences were found for both in situ and laboratory conditions. Nevertheless, for higher sound level values mean annoyance ratings are slightly higher ~~for~~ in field studies. It is the opposite phenomenon than was observed by Hermida Cadena et al., 2017 – in their research answers given in the field reported more pleasantness and uneventfulness. However, the data ~~is~~ are still collected and most importantly, this small changes are still not statistically significant.

5. LIMITATIONS AND CONCLUSIONS

The procedure proposed in this paper is the way to unify conditions of both in situ and laboratory experiments. Of course, one can tell that it is somehow a 'mobile laboratory' approach. But only in this way we can apply the same procedure regardless place of conducting the experiment. Obviously, in field studies there are still some factors which could influence people's answers (i.e. visual aspects, familiarity of the space around and so on), but their importance is limited due to the usage of headphones.

This procedure is also helpful to introduce participants in the concept of noise annoyance. This term could have different meanings, regarding experience and feelings of listeners, so creation of the common definition is needed.

As we have shown, usage of the proposed procedure in both conditions gives the same results. Although for higher sound levels answers given in field studies are marginally higher, this difference is not statistically significant. There are some differences in standard deviation values (they are higher for laboratory conditions), but this is probably due to the smaller sample size. The data is still collected and this phenomenon probably will disappear.

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