

## **Annoyance and Disturbances due to Traffic Noise at Different Times of Day**

D. Schreckenberg<sup>a</sup>, R. Guski<sup>b</sup>, I. Schmaus<sup>a,b</sup>, U. Moehler<sup>c</sup>, and R. Schuemer<sup>a</sup>

<sup>a</sup>ZEUS GmbH, Universitaetsstr. 142, D-4799 Bochum, Germany

<sup>b</sup>Ruhr-University Bochum, Faculty of Psychology, D-44780 Bochum, Germany

<sup>c</sup>Moehler & Partner, Schwanthalerstr. 79, D-80336 Munich, Germany

<sup>a</sup>[schreckenberg; schmaus; schuemer]@zeusgmbh.de;

<sup>b</sup>rainer.guski@rub.de; <sup>c</sup>ulrich.moehler@mopa.de

**Abstract [527]:** It is hypothesized that effects of noise exposure on disturbance and annoyance differ depending on different times of day. Acoustical parameters of noise exposure including weightings for different times of day base on this hypothesis. In particular the European parameter  $L_{DEN}$  includes penalties to noise for the evening (5 dB) and night (10 dB) relative to the rest of the day indicating that there is a need for higher protection at these times of day. The aim of the study is to provide empirical data of dose-response relationships for different times of day. In about 1200 interviews of residents from 4 areas with dominant road traffic noise and from 2 areas with dominant railway noise annoyance and disturbances are assessed. About 120 persons of the total sample take part in an additional study in which the hourly noise annoyance is measured for four days using electronic diary reports. For each subject individual source-specific immission noise level ( $L_{eq}$ ) for each hour of the day is calculated. The study is not yet finished. First results on time-dependent annoyance and disturbances due to traffic noise will be presented.

### **1 INTRODUCTION**

The aim of our study was to analyse residents' reactions to road traffic noise and railway noise. The main focus of this study was the question whether residents' annoyance and disturbance varies depending on time of day and/or depending on the current activity carried through. It is hypothesized that the effects of noise exposure differ depending on the time of the day (e.g. Guski et al. 1999; Schreckenberg et al. 1999). Fields (1986) for example gives an overview over 25 surveys which have analysed questionnaire items concerning time-period annoyance. He comes to the disappointing conclusion that this data does not satisfactorily support any difference in annoyance due to time of the day. The short-comings of retrospective research as questionnaires or interviews have been documented widely (e.g. Fields, 1986). Even if it is asked for an estimate of the annoyance during different times of the day (or different periods of the day), this data remains retrospective i.e. cumulative for a longer period of time. We do not know if the respondent remembers a certain day or situation which he/she refers to, or if the answer contains an aggregation of several noise events. Thus, concerning the effects of noise exposure it is still unclear how single noise events amount to overall annoyance of residents. Hallmann et al. (2002) could show in a qualitative study that overall annoyance is influenced by several factors, one being the time of the day when an annoying noise event occurs.

Felscher-Suhr et al. (1996) went beyond the survey method. In their time-sampling study residents living close to an airport were called by phone ten times a day and asked to give an estimate about their current noise annoyance and activity disturbance. Even though the disturbance depended on

the activity carried through at the moment and on the time of the day as well, there was only low correlation with the  $LEQ_{60}$  in that area. It seems that when asked for current annoyance, people follow this instruction and do not aggregate their annoyance during the last hour. Kastka (1998) used an event-sampling method asking his participants to push a button whenever event-related disturbance reached the threshold of being unbearable. Unfortunately, annoyance was not in the focus of this study.

In order to address the problematic character of retrospective data we decided for a two-fold method. First, we conducted interviews with residents exposed to road traffic noise or railway noise respectively. The interview focussed on noise annoyance in general and noise annoyance at different times of the day as well as during night time. We also asked about the degree to which traffic noise disturbs different activities.

Additionally, we conducted a diary study with a sub sample in order to obtain more detailed data on annoyance and disturbance at different times of the day. The participants of the diary study were asked to give an estimate of their noise annoyance in an hourly interval, aggregating the annoyance of the last hour (time-sampling method). The diary study lasted four consecutive days, from Monday to Thursday, and was accompanied by acoustic measurements of the noise pressure level in order to be able to provide the hourly  $LEQ$ .

## **2 METHOD**

### **2.1 Diary study**

In diary studies traditionally paper and pencil are used. This method has the advantage that it is easy to use for the participants. Disadvantages are that participants might forget to write down their observations. The data might then be missing, or the helpful participant might fill in the data at a later point of time. For the researcher there is no way of knowing if the data has been filled in at the supposed point of time. Another disadvantage is the time consuming and error prone data entry from paper into the computer.

For those reasons we were looking for other possibilities to realize a diary study. The new method needed to meet several criteria in order to be judged better than the traditional paper and pencil method (for detailed discussion see Bolger, Davis & Eshkol, 2003). The aim was to find a method which would meet most of the following criteria:

1. remember participants whenever entry of their observations is needed /asked.
2. possibility for the researcher to control the time when the participant entered the data
3. control of place where the data was entered, since we only wanted ratings of noise annoyance at the participants' home
4. make data entry less time consuming and error prone
5. have high usability
6. be economically
7. must not exclude any part of the population from taking part in the study

One possible method we checked was using mobile phones. The participant would receive an SMS remembering him/her that it is time to rate the noise annoyance of the last hour. The participant would send his/her judgement via SMS to the research institute. This method would meet criteria 1 (remembering) and 2 (time control), but not criterion 3 (place control). Estimating the costs (criterion 6) of this method is rather difficult. In order to make optimal use of the fact that the data would be coming via SMS from the participants, the telephone system would need to transfer the data instantly into a databank (criterion 4). That would have meant quite an investment to link the telephone system to the computer system. Another disadvantage of that method would have been,

that assuming the participants use their private mobile phone, this would exclude all people from the study who do not own a mobile phone (criterion 7) or who do not know how to write and send SMSs (criterion 5 and 6).

Since we only wanted the participants to respond in the case they were at home at the point of time, we checked if using the so called “t-vote call” (known from the EUROVISION singing contest) would be possible. People would receive a call from (or an SMS to their mobile phone) and deliver their rating of the noise annoyance by calling one of five possible numbers. Unfortunately, the German national phone company (German Telekom) may not provide this service due to the German data protection law. Telekom is not allowed to transfer the number of the calling person, making any long term data comparison impossible.

After comparing several methods we decided to use handheld computers by Palm (Tungsten E) for several reasons:

1. It is possible to program the palm in a way that it provides the reminder peep for data entry (criterion 1). At the same time the palm displays the question for the annoyance rating and additional questions as current window position (open/closed) and current activity. We used java to program the questionnaire.
2. The palm saves the answers given as well as the time when the answers were given. No data entry is possible between the hourly intervals nor can participants type in any data afterwards (criterion 2).
3. Participants are instructed that the palm needs to stay at their home during the entire duration of the study. In that way we expect that the place of data entry is in any case the home of the participant (criterion 3).
4. After the palm has been returned the data is easily transferred to a computer via infrared port and can be processed further in MS-excel file format.
5. Usability is considerably high: The palm is programmed in such a way that it automatically starts the questionnaire when the reminder peep appears. The palm then first displays the question, then the possible answers appear on the screen. An answer is chosen by tipping on to it on the touch screen. Causing the next question to appear. After answering all questions the palm turns off automatically. The participants' exclusive task is to answer the questions by pressing the corresponding field on the touch screen.
6. Even though prices of handheld computers have been dropping in the last few years, the investment seems quite high in the beginning. This is rewarded on the other hand by the fact that the traditionally very time consuming data transfer to the computer can be cut down to a few minutes. And once an institution has introduced palms for diary or questionnaire methods, they can of course be reused in any other project, such as distributing the costs over several research projects.
7. Compared to the two methods making use of telephones (either SMS or t-vote-call) the handheld option has two advantages concerning usability: first, since we provide the device, the participant does not have to get into the details of the technology (and we make sure that all the devices have the same technological standard). Second, answering a small questionnaire using a touch screen is far more convenient than writing an SMS or dialling a ten digit phone number.



Figure 1: Illustration of the question asking for annoyance and the possible answers.

## 2.2 Interview

We used a slightly reversed version of the standardized interview for noise annoyance and noise disturbance we had been using in former studies (Felscher-Suhr, U.; Guski, R. & Schuemer, R., 2000). It contains questions to general noise annoyance and source specific annoyance as well as annoyance and disturbance through the main noise source (road traffic noise or railway noise respectively) at different times of the day and while carrying out different activities. We also took into account different moderator variables known or assumed to have an effect on the correlation of noise pressure level and annoyance (e.g. housing situation (rental or owned house, duration of living there, type of windows, main window setting, general sensitivity, activities against noise annoyance etc.).

## 3 DESIGN

We selected 6 residential areas exposed to traffic noise: 4 areas with predominantly road traffic noise and 2 areas with railway noise as the dominant source of environmental noise. In each neighbourhood we conducted interviews with 200 residents living close to the noise source (specific road or railroad tracks respectively). Altogether 1200 interviews were conducted. In each area a sub sample of about 20 people participated in the diary study (120 altogether).

## **4 RESULTS**

### **4.1 Interviews**

While writing this paper we have contacted residents in three of the six areas: two with road traffic noise as the dominant source of noise and one area with railway traffic noise. Interviews are still running in all of them.

### **4.2 Diary study**

In the first two areas – one with road traffic noise, the other with railway noise - the diary study has already been finished, in the third area it just began.

We were surprised by the openness, yet even curiosity of our (survey) participants to take part in the handheld-run diary study. Before hand we had not been sure about how the individual openness to new technologies would play a positive or negative on the response rate. But even people who do not seem to be a member of the target group for handhelds could be motivated to take part in the diary study, maybe because we strengthened the usability of the devices in the acquisition process (at the end of the interview). Response rate changed between the different areas, but in general 15-25% of the residents who agreed on an interview, later agreed on participating in the diary study (until we stopped recruiting). Participants' age ranged from 22 to 80 years. Social status was as well rather mixed: blue collar workers, white collar workers, a professor emeritus, several undergraduate students, an unemployed blue collar worker, house wives etc. The distribution of males and females was about even.

## **5 CONCLUSION**

Even though the project is still going on our experiences with the handheld computers indicate that this seems to be a method adequate to be used in diary studies. First results will be presented at the conference.

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