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Comparing results from annoyance surveys - Factors affecting the results of a survey

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ABSTRACT

Social surveys are conducted to determine how annoyed people are in a certain noise situation. The results are typically presented as exposure-response curves showing the percentage highly annoyed as a function of the noise exposure level. A re-analysis of previously reported surveys shows that the results are not only dependent on the noise situation, but also to a large extent dependent on other factors like wording of the annoyance questions, how the questionnaires are presented, response scales, methods of scoring highly annoyed, etc.
The paper discusses and quantifies differences and suggests ways of comparing results from surveys that are conducted according to different protocols and different modes of presentation.

Keywords (3-6): Annoyance, survey, exposure-response function

INTRODUCTION

Schultz published his synthesis of social surveys on noise annoyance in 1978 (1). In this paper he introduced the concept *percentage highly annoyed* to quantify the prevalence of annoyance in a community. He defined *highly annoyed* as a response in the upper 27-29 percent of the annoyance scale. He chose a relatively high degree of annoyance in order not to trivialize the concept. He wanted to include only those for which noise was a serious issue, and not just annoyed persons in general.

Later the US Federal Interagency Committee on Noise, FICON, declared “Annoyance is its preferred summary measure of the general adverse reaction of people to noise, and that the percentage of the area population characterized as “highly annoyed” by long-term exposure to noise is its preferred measure of annoyance” (2). Since then, this has become a *de facto* standardized way of presenting the results from social surveys on noise annoyance: the results are shown as so-called dose-response curves or exposure-response curves showing the percentage highly annoyed residents as a function of the noise exposure.

A lot of work has been concentrated on finding ways to describe the noise exposure in detail, either by direct measurements or predictions, but there has been little concern about the quantity *percentage highly annoyed.* So, how annoyed is actually a person that is *highly annoyed* and how is the degree of annoyance determined.

The ISO Technical Specification ISO/TS 15 666 specifies how social or socio-acoustic surveys should be conducted, but the first version of the document did not define *highly annoyed* at all. Researchers therefore relied on the original ICBEN definition (3) or they used their own. It was only in the revised 2021 version of the technical specification that a definition of *highly annoyed* was introduced (4). But still there are a number of variables that need to be taken into account.

RESPONSE SCALES

The technical specification recommends two standardized questions to be included in a survey. Both deal with the assessment of long-term noise annoyance for a specified period of time (e.g., 12 months). One question specifies a 5-point verbal response scale and the other an 11-point numerical scale. *Highly annoyed* is defined by the two upper categories of the verbal scale and the three upper categories of the numerical scale. The document also underlines that these two definitions of *highly annoyed* do not yield identical answers. When reporting the survey results it is therefore necessary to specify how the quantity *highly annoyed* was derived; HA_V from the verbal scale and HA_N for the numerical scale. HA_V is normally the larger. The technical specification has also a procedure for transforming HA_V to a quantity, HA_{VN} , that can be readily compared with the numerical response.

Gjestland and Morinaga has shown that the average difference between the two quantities is equivalent to a 6 dB shift in the noise exposure (5). Brink et al. have shown how a response based on the numerical scale can be transformed into a virtual verbal response (6).

MODE OF SURVEY PRESENTATION

The earliest surveys were usually conducted as face-to-face interviews in the respondent's home. Later on, telephone interviews became a favorite method being faster and less expensive to carry out. Postal surveys have also been used. The potential respondents are contacted by mail, and are requested to complete a self-administered written questionnaire, which in turn is returned by mail. US Federal Aviation Administration recently conducted a large survey by mail (7) but Miller et al. complemented the survey with a smaller number of telephone interviews in the same communities to check the influence of the survey mode. They found that people responding to a written questionnaire seem to be more annoyed than people responding to a telephone interview. The difference was found to be equivalent to a 5 dB shift in the noise exposure.

Fidell et al. have analyzed 45 surveys conducted either face-to-face, via telephone or as a postal survey. They found no significant differences between face-to-face and telephone interviews, both involving contact with a live agent. However, mail surveys produced a higher prevalence of highly annoyed respondents with a difference equivalent to a 10 dB shift in the noise exposure (8).

OPERATIONAL CHANGES

This effect has been observed for aircraft noise studies, but it is plausible that the same effect may be present in other situations as well. Most airports experience a gradual increase in traffic over the years. In most cases this growth is small and week-to-week changes in the noise exposure will hardly be noticed by the neighborhood community.

However, occasionally abrupt changes will occur such as the opening of a new runway, the introduction of a new fleet of aircraft if a major airline is moving to a new hub, introduction of new operational procedures and new flight trajectories, etc.

Janssen and Guski (9) have presented a study on temporal trends in the aircraft noise annoyance response. They analyzed a set of 32 aircraft noise studies contained in the TNO database. They recognized that abrupt changes in the airport operations will affect the annoyance response, and therefore introduced a classification procedure as follows: *We call airports "low-rate change airports" (LRC), as long as there is no indication of a sustained abrupt change of aircraft movements, or the published intention of the airport to change the number of movements within 3 years before and after the study. An abrupt change is defined here as a significant deviation in the trend of aircraft movements from the trend typical for the airport. Each trend is calculated by means of total movement data during a five-year period. If the typical trend is disrupted significantly and permanent, we call this a "high-rate change airport" (HRC). We also classify an airport in the latter category if there has been public discussion about operational plans within 3 years before and after the study.*

Gelderblom *et al.* (10) have analyzed a set of 62 aircraft noise annoyance surveys to study the stability of community tolerance to noise. They found that the average difference in the annoyance response between an LRC airport and an HRC airport was equal to a 9 dB shift in the CTL value. People living near a high-rate change airport seem to tolerate 9 dB less noise in order to express the same degree of annoyance as residents of a low-rate change airport community.

It is plausible that a similar effect may be observed for other noise sources as well, for instance the construction of a new road or the refurbishing of an existing one.

TRAFFIC VOLUME

When the traffic volume increases, the noise level increases and consequently the annoyance also increases. However, the annoyance seems to increase at a faster rate than the equivalent level. Gjestland *et al.* (11) have studied the prevalence of noise induced annoyance and its dependency on the number of aircraft movements. They analyzed the results from 32 aircraft noise surveys and concluded that for a given noise exposure level the percentage of highly annoyed residents increased equivalent to a DNL increase of 1.8 dB per doubling of the number of aircraft movements. This increase comes in addition to the regular 3 dB per doubling.

A similar analysis of road traffic noise surveys shows the same tendency, but a slightly smaller effects: 1.5 dB per doubling. Consequently, residents living near a small airport therefore seem to tolerate about 6 dB more noise than neighbors to an airport with ten times more traffic in order to express the same degree of annoyance.

The standard reference curve for aircraft noise annoyance, the so-called *Miedema curve* is almost identical to a CTL function anchored at L_{CT} = 73.3 dB. This curve can be used to predict the dose-response function for an airport with 250,000 aircraft movements per year. The corresponding CTL value for an airport with annual traffic of half a million movements would thus be 71.5 dB. The *Miedema curve* for road traffic noise seems to fit a situation with a traffic volume of 2000 ADT (annual daily traffic).

COMPARISON OF SURVEY RESULTS – AN EXAMPLE

The exposure-response functions presented by Miedema & Vos (12) have been widely accepted by national regulatory authorities. The standard reference curve for aircraft noise annoyance, the so-called *Miedema curve* is almost identical to a CTL function anchored at L_{CT} = 73.3 dB. This curve can be used to predict the dose-response function for an airport with 250,000 aircraft movements per year.

The results from the recent 20 US airports study (7) were used to construct a new *US national average dose-response curve.* This curve indicated a much higher prevalence of annoyance than the earlier FICON curve. The average CTL value for the responses at 20 airports was L_{CT} = 60.2 dB. For comparison the Miedema curve for aircraft noise has a CTL value L_{CT} = 73.3 dB. A closer look at the Miller et al. report reveals that the two curves cannot be directly compared.

The surveys that were the basis for the Miedema curve were conducted as face-to-face interviews whereas the 20-airport study was a mail survey. Miller et al. have shown that the difference is equal to a 5 dB shift in the exposure.

Similarly, the scoring of high annoyance done by Miedema and Vos was based on a cut-off around 72 % on the annoyance scale. Miller et al. defined high annoyance as the two upper categories of a 5-point verbal scale, equivalent to a 60 % cut-off. The individual verbal responses of the 20-airport study have been re-calculated as described in the standard ISO 15666:2021 with category #5 counted in full and category #4 given a weight 0.4. The difference between the two procedures for scoring prevalence of high annoyance turned out to be equal to a 5 dB shift in the noise exposure.

So, the reported exposure-response curve for the 20-airport study, described by the CTL value L_{CT} = 60.2 dB, should be adjusted by 5 dB to account for mail vs. face-to-face mode, and an additional 5 dB for the definition of high annoyance. The new value L_{CT} = 70.2 dB (60.2 + 5 + 5) can be compared with the Miedema curve. The two curves are quite similar for exposure levels below about L_{DN} = 60 dB, the range of primary interest for regulatory purposes, see Figure 1.

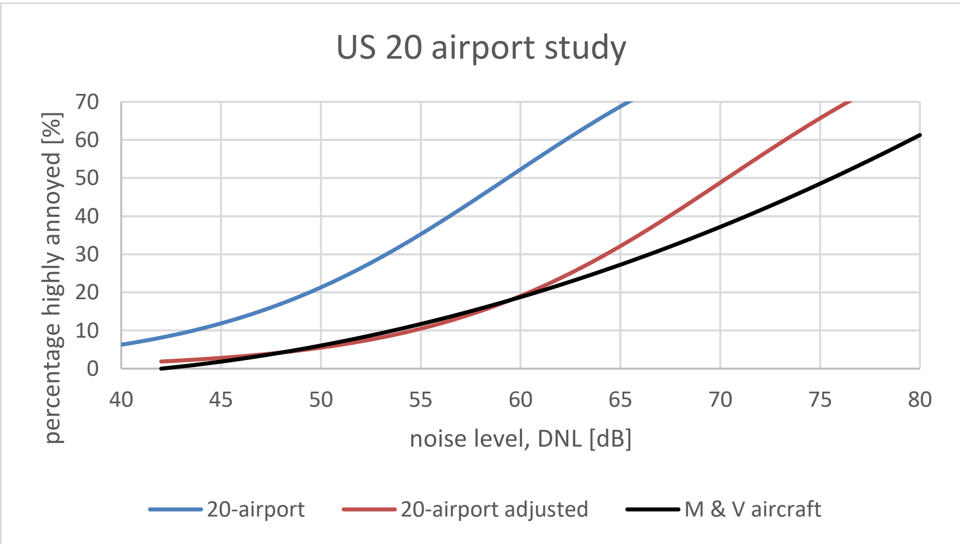

Figure 1. Exposure-response curves for the US 20 airport study

CONCLUSION

A review of previous surveys reveals that the results are not only dependent on acoustic and community-specific parameters, but also on the way the survey has been conducted. The traditional way of comparing results from social surveys is to compare exposure-response functions. The Miedema and Vos reference curves were constructed on the basis of surveys conducted as face-to-face or telephone interviews and the scoring of high annoyance was based on a 72 % cut-off of the annoyance scale. For comparison purposes new exposure-response curves must either be constructed on the same basis, or they must be adjusted as explained in this paper.

A detailed analysis of many previous surveys shows that what has been presented as "new" results most often are caused by differences in survey design and analysis methods rather than actual differences in the annoyance response.

There are few indications that the annoyance caused by transportation noise has changed significantly over the past 50-60 years.

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