

inter.noise 2000

*The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE*

I-INCE Classification: 6.3

ON THE DEFINITION OF ANNOYANCE IN SOCIAL SURVEYS OF NOISE PROBLEMS IN THE CASE OF CROSS-CULTURAL COMPARISON

S. Namba*, S. Kuwano**

* Takarazuka University of Art and Design, 7-27 Tsutsujigaoka, Hanayashiki, Takarazuka, 665-0803,
Hyogo, Japan

** Osaka University, 1-2 Yamadaoka, Suita, 565-0871, Osaka, Japan

Tel.: +81-727-56-1231 / Fax: +81-727-58-7869 / Email: qzw00041@nifty.ne.jp

Keywords:

DEFINITION OF ANNOYANCE, SOCIAL SURVEY, CROSS-CULTURAL COMPARISON

ABSTRACT

The importance of the definition of loudness, noisiness and annoyance is discussed in this paper. These attributes have clearly different aspects of noise and should be investigated with different procedures. The definitions of these attributes based on terms alone bring several problems into experimental situations. The authors proposed the operational definition of the terms and discussed the equivalency of questionnaires for noise research in different countries.

1 - INTRODUCTION

Many studies concerning annoyance caused by noise have been presented in almost every meeting of Inter-Noise. However, very few studies made clear the definition of annoyance. In laboratory situation usually sounds are presented to subjects and subjects are asked to judge the annoyance of the sounds. The term "annoyance" is used in the instruction to subjects without any definition. This is a typical example of annoyance experiments in laboratory. In this case, there is no guarantee that subjects judge the annoyance properly.

Berglund [1] suggested the possibility that perceived annoyance is strongly affected by perceived loudness. Swedish researchers [2] found that annoyance caused by diesel engine noise was mainly determined by loudness level rather than qualitative indices (e.g. sharpness and harmony). Without additional information, it is impossible to examine whether the judgments are based on loudness, noisiness or annoyance. In social surveys questionnaires are used to ask the respondents the disturbance caused by noise in their daily lives. The terms of loudness, noisiness and annoyance are almost synonym in daily life situations and people do not differentiate these terms strictly.

Several researchers have tried to define the terms, loudness, noisiness and annoyance for the evaluation of the effects of noise on man [3-6]. For example, Kryter [3] described that "loudness is defined as subjective intensity of sound, independent of any meaning the sound might have". This is similar to the definition of loudness by British Standard [7], that is, "an observer's auditory impression of the strength of a sound". Other definitions [4-6] are similar to these definitions.

Noisiness is defined as "unpleasant impression caused by sound itself. Bad quality of sounds" in the Dictionary of Acoustical Terms edited by the Acoustical Society of Japan [8].

Annoyance is the nuisance aspect of sound. There are many complicated non-auditory factors which affect annoyance, such as human relationship, personality, usefulness of sound sources, etc.

Loudness, noisiness and annoyance indicate the different aspects of noise and should be distinguished from each other in noise research. The definitions above mentioned are subjectively defined. In noise research, the definitions based on empirical examinations are necessary. Especially, for the international comparison, we should learn the difference of the connotative meanings of the terms equivalent in dictionaries in different languages. The authors have tried to adopt experimental procedures in order to define the terms.

2 - EXPERIMENT

2.1 - The comparison of connotative meanings of the terms in different languages using experimental procedures

In international meetings and international journals, English is usually used as a common language. But there is no guarantee that the translated English terms have the same meaning as their native languages. In international comparisons using English, even if noise problems are discussed with the same English terms, there is a possibility that aspects may differ. As the first step, the connotative meanings of the terms which are used to describe noise were investigated using different methods:

- Semantic differential applied to the concepts
 Connotative meanings of the concepts (terms), loudness, noisiness and annoyance were measured using semantic differential in five countries [9,10]. In Japanese language, the connotative meaning of loudness is neutral, but noisiness and annoyance are negative and show profiles similar to each other as shown in Fig. 1. It is difficult to distinguish noisiness and annoyance in Japanese by terms alone. It was also found that it is difficult to distinguish loudness and annoyance in German and loudness and noisiness in English. According to the results of semantic differential, it is difficult to discriminate between loudness, noisiness and annoyance on the basis of the terms alone.
- Selected description
 In the experiment using semantic differential, subjects are forced to judge stimuli with given adjective scales even if they do not use the adjectives in order to express their impressions in their daily lives. This may cause the apparent correlation between terms. The method of selected description has been developed in order to improve this problem [11].
 In this method, a list of adjectives is prepared and subjects are asked to select adjectives, which they think are appropriate to express their impression. When recorded actual sounds are presented, there are some difference in the usage of the terms among Japan, Germany, Sweden, China and the U.S. There was little difference in the selection between "noisy" and "annoying" in Japan, and the percentages with which annoying is selected are not correlated with sound level in the other countries except for Japan. "Loud" is not so much selected in Sweden and China while it is often selected in the U.S. This tendency shows that the meanings of loudness, noisiness and annoyance are different in each country and suggests that it is difficult to distinguish these terms from each other by the terms alone.
- Magnitude Estimation applied to actual and simulated sounds
 - Comparison between Japanese and German subjects.
 The subjective meaning of sound sources and its effect on the judgment of loudness, noisiness and annoyance were examined using recorded actual sounds and their simulations with pink noise as a carrier. When subjects listened to actual sounds, they could identify each sound source. But in the case of simulated sounds whose temporal patterns were similar to actual sound sources, subjects could not identify each sound source. These stimuli were judged using magnitude estimation in Japan and Germany [12]. When actual sounds were used as stimuli, there were big differences among the judgments of loudness, noisiness and annoyance. Especially, German subjects showed bigger differences among attributes than Japanese subjects. On the other hand, there were little differences between loudness, noisiness and annoyance when simulated sounds were used as stimuli. An example of the results is shown in Fig. 2. This suggests that the identification of sound sources (subjective meaning of sounds) is important to discriminate between loudness, noisiness and annoyance.

2.2 - Annoyance index by behavior

It seems that subjects can make different responses under different verbal instructions when recorded actual sounds are used. Verbal instructions must carefully be prepared to explain the situations, which express the differences between loudness, noisiness and annoyance.

However, it is still doubtful whether this difference reflects the real difference between loudness, noisiness and annoyance in daily life situations. To avoid the difficulties of verbal responses, especially when annoyance is measured, it is helpful to use non-verbal responses as shown in the following procedures. When the experiments using non-verbal procedures are well designed, it is possible to find some factors which affect annoyance:

- Acoustic Menu
 Acoustic Menu is a method proposed by Molino et al. [13] using the behavior of subjects as an

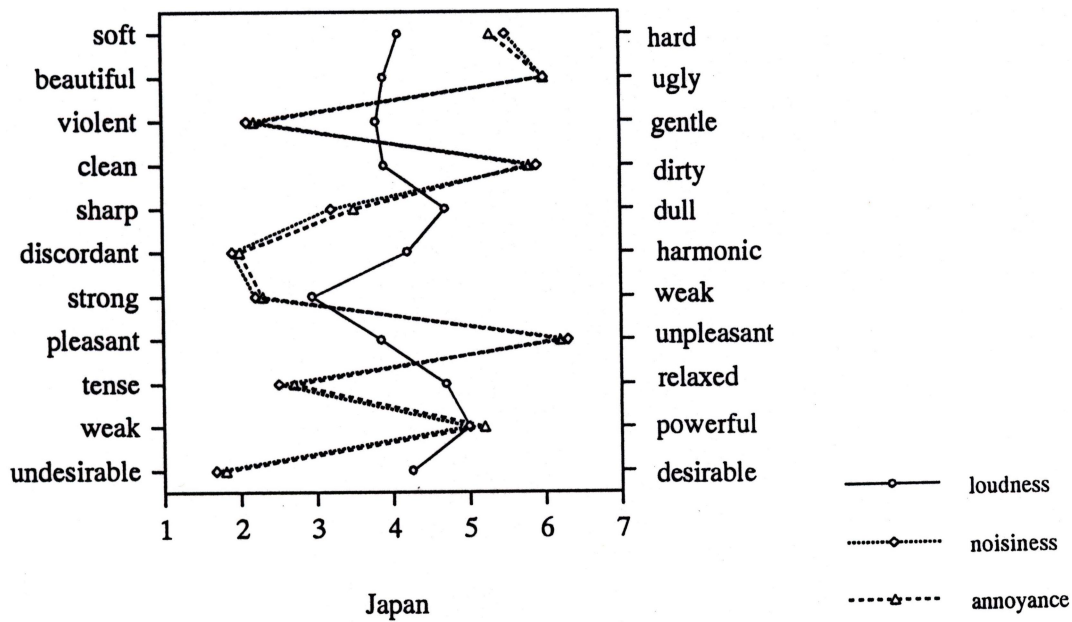


Figure 1.

index of annoyance. A pair of noises were prepared and one of them was presented to subjects. Subjects were allowed to change the presented noise to the other at any time during the session. The presented noise was also changed according to the experimental program. The noise, which was presented longer, was admitted as less uncomfortable noise.

- Subject-interrupted noise source method

This is a method developed by the present authors [14]. Subjects' behavior is used as an index of annoyance as Acoustic Menu [13]. Various noises are presented to subjects while they are devoted to mental tasks. If subjects feel that the noise is disturbing, they are allowed to switch off the noise. Various social pressures can be settled which subjects have to overcome in order to switch off the noise. This is a kind of simulated situation to claim other people about noise.

3 - PROPOSAL OF OPERATIONAL DEFINITION OF THE TERMS

There are many problems when loudness, noisiness and annoyance are measured in laboratory situations using verbal definition (expression) alone. Operational definition is useful. The authors would like to propose tentative definition.

Loudness is defined as subjective intensity of sounds. Subjects can judge which sound is louder (softer) than the other in a set of stimuli which have the same frequency components, the same envelope patterns and different intensities. Subjects can easily understand the meaning of loudness as an attribute of sound. Noisiness is defined as unpleasant quality of noise. Subjects can judge which sound is better (worse) in sound quality than the other. Before experiment, using typical (if possible, standardized) sounds, it may be necessary to train subjects so that they can understand the meaning of noisiness. In this case, "noisiness" is technically controlled attribute.

Annoyance is defined as nuisance aspects caused by sounds or sound sources. Many factors such as subjective meaning or value of sounds or sound sources, individual and social situations involving sounds or sound sources, individual differences of sensitivity to noise, other non-physical properties of sounds can affect the degree of "annoyance". If we try to measure "annoyance" in laboratory situations, we should control these factors. There is a limit in simulation and the problem of validity of experimental procedures on noise problems still exists. It is very difficult to realize "Virtual Reality" of noise situation in laboratory. Also, there are some differences between "annoyance in daily life" and "annoyance in laboratory situations". Surveys in daily life are necessary.

4 - THE NECESSITY OF NOISE ANNOYANCE SOCIAL SURVEY AND INTERNATIONAL COMPARISONS

Social survey is an effective method to measure the degree of disturbance of noise in daily life situations. It takes much time to conduct a social survey including preparation of the questionnaire, sampling of

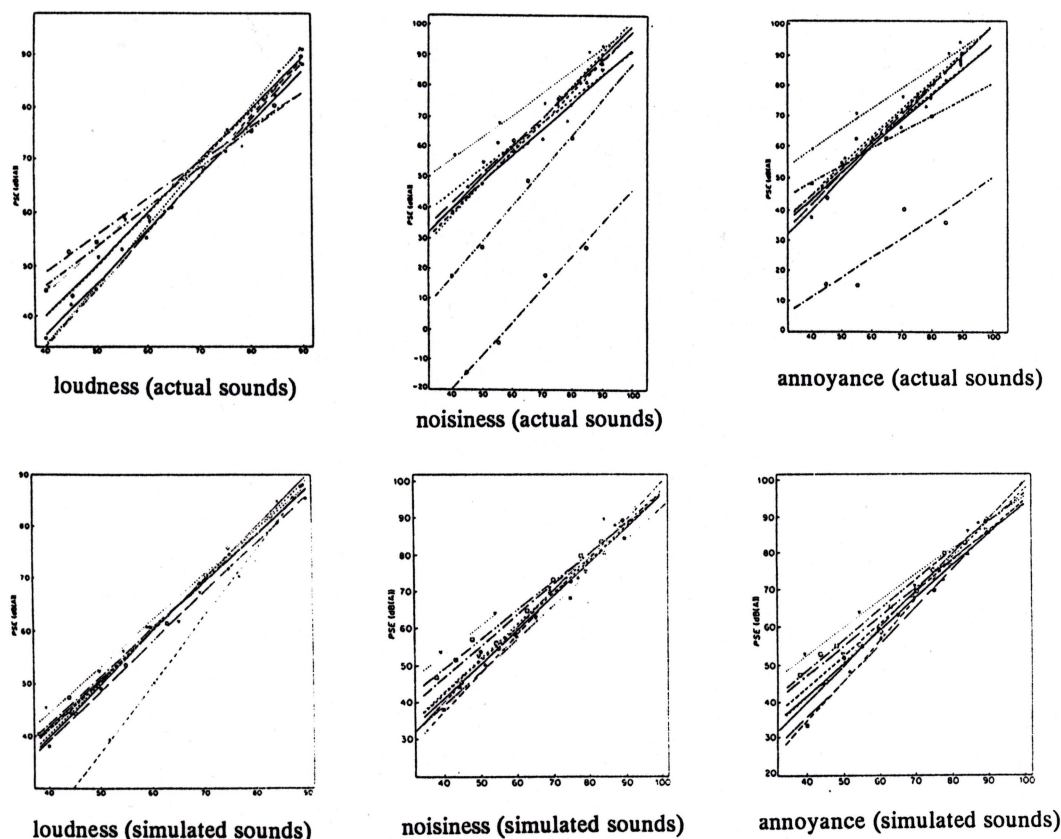


Figure 2: Results with German subjects.

the respondents, distribution and collection of the questionnaire and analysis of the data. Especially designing of the questionnaire is very important. The questionnaire must be designed so that the disturbance of noise can properly be measured. If there were a standardized questionnaire, it would be very helpful. Many social surveys conducted in various places can be compared with each other and much more information can be obtained by the comparison than by a single social survey. It would be necessary to have a standardized questionnaire by confirming the validity and the efficiency of the questionnaire in different research institutes. An example of such standardized questionnaire has been proposed by the Acoustical Society of Japan [15,16]. An example of the results is shown in Fig. 3 [17]. In this questionnaire, the percentage of negative responses to noise sources is an important index. This is effective to avoid the problems caused by ambiguity of "adjectives" and "adverbs", which are often used in questionnaires without careful scaling.

Annoyance of noise is much affected by social and cultural factors. A successful study of cross-cultural comparison can provide us with very useful information. When there is close agreement in the findings from different countries, general observations will be established or confirmed. When there are discrepancies, they may be clues to the social factors, which affect the formation of attitudes, and thus an approach to cross-cultural understanding. In order to make reliable generalizations, there are some requirements which must be fulfilled. Needless to say, the equivalency of the terms in the various languages used for questionnaires is important. If the connotative meanings of the terms used are not equivalent, it is almost impossible to distinguish whether differences in the results are due to the differences between the countries or those between the questionnaires. In undertaking a cross-cultural study, special care must be taken. The equivalency of questionnaires in different languages is especially important for the international comparison. To achieve this, objective example of nuisance caused by noise should be normalized. It is desirable that this session will contribute for this purpose.

REFERENCES

1. **B. Berglund**, The role of loudness as guide for community noise, In *Proceedings of the International Congress on Noise Control Engineering*, pp. 45-48, 1991

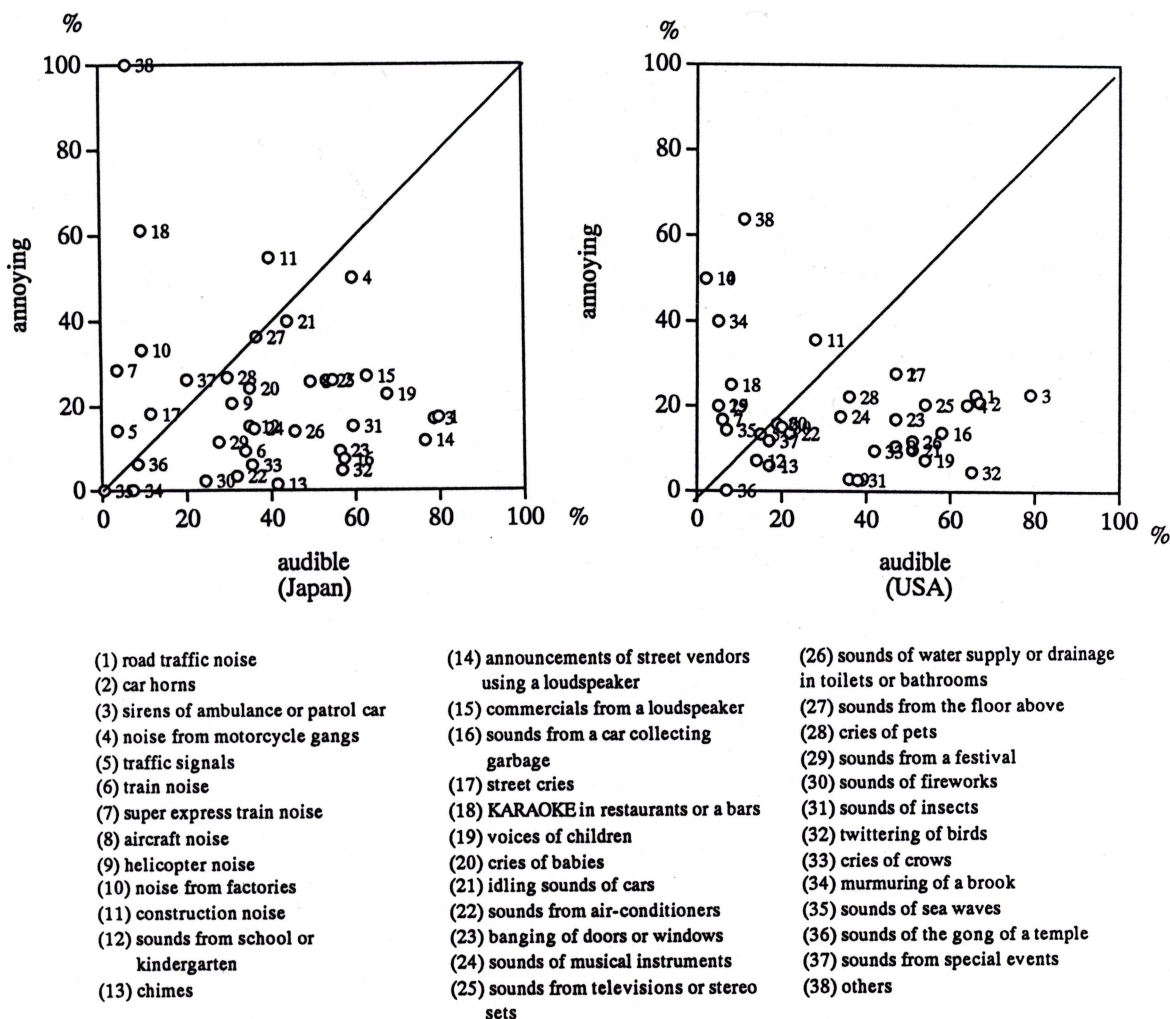


Figure 3.

2. M. S. Kahn et al., Development of an annoyance index for heavy-duty diesel engine noise using multivariate analysis, *Noise Control Engineering Journal*, Vol. 45, pp. 157-167, 1997
3. K. D. Kryter, *The Effect of Noise on Man*, 2nd Ed. Academic Press, 1985
4. B. Berglund et al., Scaling of loudness, noisiness and annoyance of community noise, *J. Acoust. Soc. Am.*, Vol. 60, pp. 1119-1125, 1976
5. K. Izumi, On the measurement of annoyance in the laboratory - 5 case studies to validate the simulated environment method, *Trans. Tech. Noise, Acoust. Soc. Jpn.*, Vol. N86-10-2, pp. 1-12, 1986
6. J. A. Molino, Annoyance and noise, In C. M. Harris (Ed.), *Handbook of Noise Control (2nd ed)* (McGraw-Hill), pp. 16.1-16.10, 1979
7. BS-661, *Glossary of Acoustical Terms*, BS, 1969
8. Acoustical Society of Japan (Ed), *Dictionary of Acoustical Terms*, Corona Publishing Co. Ltd., 1988
9. S. Namba et al., A cross-cultural study on noise problems, *J. Acoust. Soc. Jpn. (E)*, Vol. 7, pp. 279-289, 1986
10. S. Namba et al., A cross-cultural study on noise problem: comparison of the results obtained in Japan, West Germany, the U.S.A., China and Turkey, *J. Sound Vib.*, Vol. 151, pp. 471-478, 1991

11. **S. Namba et al.**, Verbal expression of emotional impression of sound: A cross-cultural study, *J. Acoust. Soc. Jpn. (E)*, Vol. 12, pp. 19-29, 1991
12. **S. Kuwano et al.**, On the judgment of loudness, noisiness, and annoyance with actual and artificial noises, *J. Sound Vib.*, Vol. 127, pp. 457-465, 1988
13. **J. A. Molino et al.**, Use of the "acoustic menu" in assessing human response to audible (corona) noise from electric transmission lines, *J. Acoust. Soc. Am.*, Vol. 66, pp. 1435-1445, 1979
14. **S. Namba and S. Kuwano**, Measurement of annoyance by subject-interrupted noise source method, In *Proceedings of the International Conference on Noise Control Engineering*, pp. 1407-1410, 1985
15. **Committee of Social Survey on Noise Problems**, Report of the Committee of Social Survey on Noise Problems, *J. Acoust. Soc. Jpn.*, Vol. 48, pp. 119-122, 1992
16. **S. Namba et al.**, Report of the Committee of the Social Survey on Noise Problems, *J. Acoust. Soc. Jpn. (E)*, Vol. 17, pp. 109-113, 1996
17. **S. Kuwano et al.**, Introduction to experiences with efforts to standardize social noise surveys, In *Proceedings of the International Congress on Noise Control Engineering*, pp. 2047-2052, 1996