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THE DEFINITION OF LOUDNESS, NOISINESS AND ANNOYANCE IN LABORATORY SITUATIONS

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INTRODUCTION

Several researchers have tried to define "loudness", "noisiness" and "annoyance" for the evaluation of the effects of noise on man.[1] For example, Kryter[2] descibed 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 (BS-661, 1969), that is, "an observer's auditory impression of the strength of a sound". Other definitions are also similar to these definitions. "Loudness" basically corresponds to the intensity of sounds if their frequencies and durations are equal.

"Noisiness" is defined as "unpleasant impression caused by sound itself. Bad quality of sounds" in the Dictionary of the Acoustical Terms[3] edited by the Acoustical Society of Japan. Other reseachers also treated noisiness as unpleasant quality of sounds.

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

The definitions mentioned above are subjectively defined. We would like to try to adopt psychological procedures in order to define these terms. Operational definition is necessary in experimental procedures.

WORKING DEFINITION BY EXPERIMENTAL PROCEDURES

Experiment using semantic differential without sounds[4]

The concept of the terms "loudness", "noisiness" and "annoyance" was judged using semantic differential in Japan, Germany, U.K., U.S.A. and China. Profiles for noisiness and annoyance in five countries are shown in Figs.1 and 2. In Japan and China, the connotative meaning of loudness was neutral, while those of noisiness and annoyance were negative and had similar profiles to each other. Distinction between loudness and annoyance was unclear in Germany, and between loudness and noisiness in U.K. and U.S.A. It is difficult to distinguish between noisiness and annoyance by means of terms alone in laboratory situations.

Experiments using the method of selected description[5]

A list of 32 adjectives was prepared including loud, noisy and annoying. Subjects were asked to select adjectives from the list which they thought most appropriate to express their impressions of actual sounds. The experiment was conducted in Japan, Germany, Sweden, U.S. and China. The results confirmed the results of semantic differential.

Experiment on actual sounds and simulated sounds using magnitude estimation.[6]

Loudness, noisiness and annoyance of actual sounds and simulated sounds were judged using magnitude estimation by Japanese and German subjects. When actual sounds were used as stimuli, well-trained subjects could discriminate the differences between loudness, noisiness and annoyance. However, there was little difference between their judgments of loudness, noisiness and annoyance when artificial sounds were used which simulated the level patterns of actural sounds with pink noise. This suggests that frequency components and subjective meaning of sounds arae important to discriminate these three terms.

DISCUSSION

When acutual sounds were used, well-trained subjects could make different responses under different verbal instructions. However, when a similar experiment was conducted using untrained subjects, there was no difference between loudness, noisiness and annoyance judgments. This suggests that the concept of loudness, noisiness and annoyance cannot be differentiated by means of terms alone. The experimental design should be devised so that the difference between the three terms can be made clear. Verbal instructions must carefully be prepared to explain the situations which express the differences

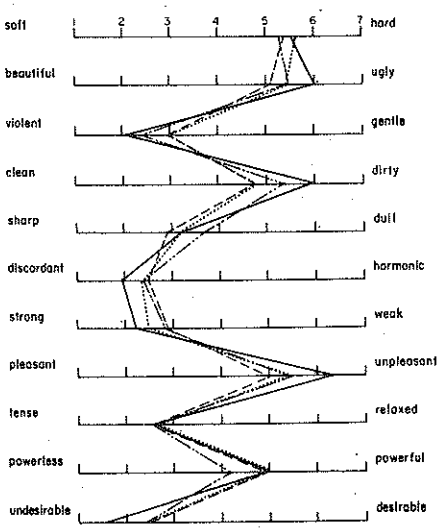

Fig.1 Semantic profiles for noisiness.
——— Japan, ····· U.K.,
– – – U.S.A, – · · – China

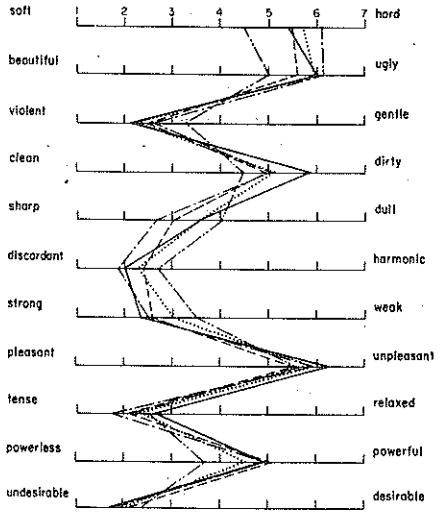

Fig.2 Semantic profiles for annoyance.
——— Japan, – · – U.K., ····· Germany
– – – U.S.A, – · · – China

between loudness, noisiness and annoyance. It is still doubtful, however, whether the three terms are differentially used in daily life situations and whether their difference in daily life situations, if it exists, can be appropriately reflected in experimental situations.

The concept of "annoyance" suggests a situation that people are disturbed by noise and they feel like escaping from it. It is useful, therefore, to adopt non-verbal responses (e.g. avoidance behavior) for measuring annoyance. There are following examples of experiments using non-verbal responses.

Acoustic Menu[7]

This is a method which Molino has proposed. A sound presented to subjects was changed at regular time intervals. Subjects could select a sound they wanted to listen to among a prepared set of sounds. If subjects did not like the sound presented, they could change at any time. The duration for which subjects select a sound to listen to was used as an index of the effect of noise.

Subject-interrupted noise source method[8]

This method has been developed modifying Molino's Acoustic Menu. Subjects were motivated to do a mental task very hard while various noises were presented. They could interrupt the noise if it was disturbing. The interruption was used as an index of noise disturbance.

Experimental social psychology

There are other studies using the procedures of social psychology.[9] For example, Page[10] tried to measure the effect of noise from the behavior to help others who were in trouble.

It is possible to find some factors which affect annoyance from the results of well-designed experiments using verbal or non-verbal procedures. However, how well laboratory situations can simulate the real life situations is a problem. It is very difficult to realize "Virtual Reality" of noise situations in laboratory. The limit of validity of experimental procedures still exists.

Operational definition based on experimental procedures is necessary to measure loudness, noisiness and annoyance in laboratory situations. We would like to propose procedures for discriminating loudness, noisiness and annoyance.

"Loudness" is defined as subjective intensity of sounds. Using a set of stimuli with the same frequency components and the same envelope patterns, but with different intensities, subjects can make judgment which sound is louder/softer than the other. Subjects can easily understand the meaning of loudness as an attribute of sound. Loudness can be measured by psychophysical methods. It would be effective to give a training to subjects using the artificial sounds before doing experiments on the loudness of more complicated sounds, e.g. everyday sounds.[11] The master scale proposed by Berglund[12] is also useful.

"Noisiness" is unpleasant quality of noise. There are various physical factors which deteriorate the quality of noise, such as spectral and temporal pattern of sounds and duration. Subjects can make judgment which sound is better/worse than the other in one dimensional scaling. It may be necessary to train subjects using typical, if possible, standardized, sounds before doing experiments. It would be desirable to use sounds with similar loudness, but with different noisiness by varying spectral and temporal factors of sounds so that they can understand the meaning of noisiness. In this case, "noisiness" is a technically controlled attribute. There is some difference between "noisiness in daily life" and "noisiness in laboratory situations".

It is also questionnable to treat noisiness as a one-dimensional attribute. Noisiness is defined as bad timbre. Since timbre is multidimensional, it would be more appropriate to measure noisiness using semantic differential from multidimensional aspects.

"Annoyance" is a nuisance aspect caused by sounds or sound sources. Many factors (physical and psychological) can affect the degree of "annoyance", such as subjective meanings or values of sounds or sound sources, individual and social situations involving sounds or sound sources, and individual differences of sensitivity to noise. These factors should be controlled when annoyance is to be measured in laboratory situations. This is almost impossible and it is very difficult to examine the relationship between annoyance and factors which affect annoyance. Rice[13] has proposed to use the term "reported annoyance" for the judgment of annoyance in laboratory situations. What is usually done in laboratory situations is to ask subjects using questionnaire sursvey or interview methods. Only verbal responses can be obtained in laboratory experiments on annoyance except when subjects' behavior is used as an index of annoyance. A standardized questionnaire may be helpful. The Research Committee of the Acoustical Society of Japan has proposed a questionnaire form commonly used in the survey of noise problems. This form is helpful to make standardized questionnaire on annoyacne.

SUMMARY

The results of experiments on loudness, noisiness and annoyance using various languages show that it is difficult to discriminate their differences by means of terms alone. Though it is doubtful whether the difference between loudness, noisiness and annoyance in daily life situations can be appropriately reflected in experimental situations, it may be possible to train subjects to discriminate their difference. The concept of loudness can be understood by a set of sounds the intensity of which vary keeping other factors constant. Loudness can be measured by psychophysical methods. Noisiness is a bad quality of sounds and can be measured using semantic differential. Annoyance is highly dependent on situations and difficult to measure in laboratories. Procedures based on behavior and questionnaire survey asking subjects the annoyance experience during experiments are proposed for measuring annoyance in laboratory situations.

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