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AN EXPERIMENTAL STUDY ON THE PERSONAL EVALUATION STRUCTURE OF SOUND ENVIRONMENT

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ABSTRACT
In this study we conducted an experiment to learn the overall structure of psychological evaluation of environmental sounds. Thirty-five cards with the names of environmental sounds in daily life were used in the experiment. Subjects did the following three tasks: 1) to sort the cards into groups by the similarity of impressions of imagined sounds; 2) to give each group the word that best represented their overall impression of the group; 3) to evaluate all sounds on the cards using the words obtained in the previous task. These tasks were done twice: once imagining the environment inside their home and once outside on an urban street. The following main findings were obtained by means of factor analysis: the major three factors of evaluation were interpreted as pleasantness, activity and feeling of daily life; the evaluations of sounds, especially in the evaluations related to attention, changed with context.

1 - INTRODUCTION

The sound environment gives us not only noise annoyance, which is the subject of much research, but also some pleasant feelings. When we walk down the street, sounds of birds or fountains make us feel at ease. Even such urban noises as a crowd of people or a traffic jam can promote the "city atmosphere" that we expect in an urban area.
We believe that we should, in addition to noise control, take such pleasant feelings into account when designing or evaluating the sound environment, especially in urban areas. In this study, we carried out experiments to learn the overall structure of what people feel about the sound environment. The results of this study are not decisive enough to describe a general trend. Here, we aim to discuss methods to determine people's impression structure, and to present, as an example, results from an experiment designed for that purpose.

2 - EXPERIMENT

The experiment, based on the Personal Construct Theory of G. A. Kelly [1], was designed to obtain each subject's construct structures of impression. The experiment consisted of the following four tasks.

1. Subjects were given 35 cards with the names of environmental sounds in daily life (Table 1, [2]). They were asked to sort the cards into groups by the similarity of their impressions of imagined sounds.

2. They were then asked to assign to each group a word that best represented their overall impression of the group, then to think of a word with the opposite meaning. These pairs of words were considered to be constructs for evaluating environmental sounds.

3. They were then asked to evaluate all sounds on the cards using the word pairs they had chosen in task #2 as the endpoints of 7-step scales.

4. After all subjects completed the first three tasks, we carried out an additional experiment to determine the difference in evaluation between contexts. This experiment was similar to task #3 but in which all the subjects used the same 19 scales, selected based on analysis of answers to task #2 and #3, as it was necessary to use shared scales to compare two conditions.

1	sounds of gong of a temple
2	aircraft noise
3	noise from factories
4	super express train noise
5	noise from motorcycle gangs
6	road traffic noise
7	murmuring of a brook
8	construction noise
9	sounds of water supply or drainage in toilets or bathroom
10	sounds from a festival
11	sounds of insects
12	sounds of musical instruments
13	cries of crows
14	banging of doors or windows
15	car horns
16	sounds from air-conditioners
17	sounds from school or kindergarten
18	traffic signals
19	commercials from a loudspeaker
20	indling sounds of cars
21	announcements of street venders using a loudspeaker
22	cries of pets
23	Train noise
24	sounds of sea waves
25	sirens of ambulance or patrol car
26	helicopter noise
27	sounds from televisions or stereo sets
28	KARAOKE in restaurants or bars
29	Sounds from special events
30	voices of children
31	sounds from a car collecting garbage
32	twittering of birds
33	chimes
34	sounds of fireworks
35	cries of babies

Table 1: List of environmental sounds.

For all four tasks, subjects were asked to imagine the sounds on card as if they heard that sound in the following two contexts: once assuming they heard the sounds at ease inside their home and once while walking outside on an urban street.
The 12 subjects were all students in their twenties.

3 - RESULTS

3.1 - Clusters of environmental sounds

A similarity matrix was made from the groups of sounds formed in task #1. Similarity between sounds was counted by whether or not a sound was put in the same group as another sound. The matrix was then analyzed with cluster analysis (centroid method). Figure 1 shows the dendrogram of clusters for each context.
Clusters of related sounds such as sounds of transportation, household and nature were made for both contexts. As for differences between the contexts, transportation sounds were in a single cluster *at home* while they were divided into two groups, *Road Traffic* and *Airplane & Train on an urban street*. There were also differences in the contents of clusters related to *household* and *public* sounds. The reason for that seemed to be whether the sound would attract attention or whether the sound was outside or inside.

Thus we were able to obtain an overview of how environmental sounds were perceived through this simple task of grouping.

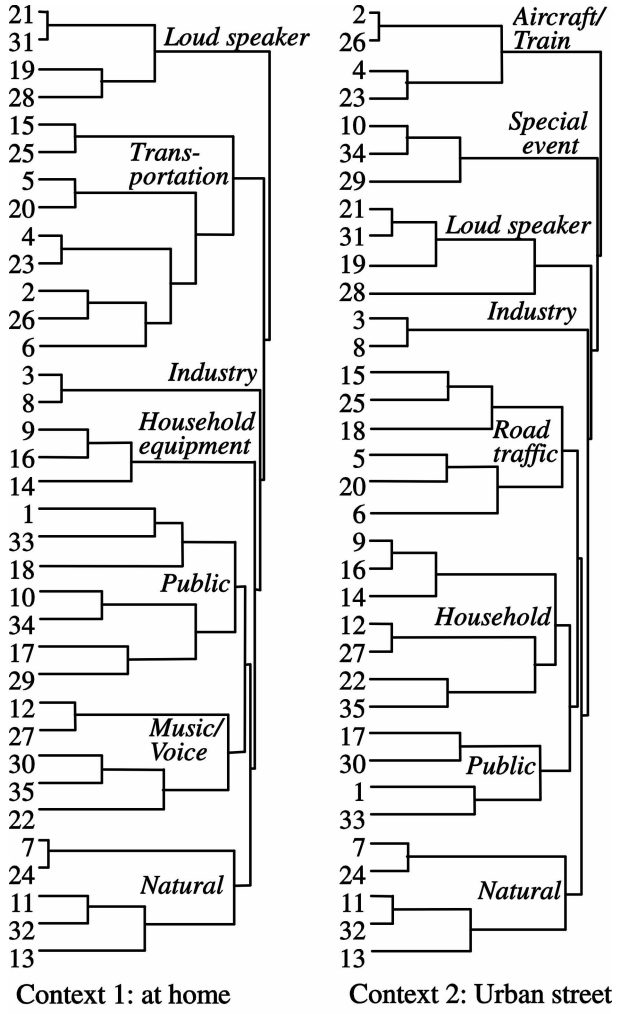

Figure 1: Clusters of sounds.

3.2 - Structure of constructs represented by subjects' words

The data from task #3 were analyzed with factor analysis, in which the variables were all of the subjects' word pairs used as evaluation scales: 180 variables *at home* and 182 *on an urban street* . Table 2 shows the factor loading values of a few of the variables *at home* (the factor pattern *on an urban street* was similar). The first three factors were interpreted as liking or pleasantness, activity, feeling of daily life. The forth and fifth factors were ambiguous, but could be described as pertaining to meaningfulness and distance. The contribution of these factors to the total variation of the subjects' evaluation were 37.4%, 13.6%, 8.1%, 4.7%, 3.8% (34.1%, 12.5%, 8.9%, 5.1%, 4.8% *on an urban street*) respectively.

The highest absolute factor loading value of each subjects' words was plotted in Figure 2 to see how the structure was common among subjects. The reason we used the highest factor loading value is that if at least one of a subject's words has high correlation with a factor, we can assume the subject evaluates environmental sounds based on that factor. As indicated in Figure 2, the first factor had high correlation with at least one word of each subject. The second and third factors had high correlation with the words of most of the subjects, while the following several factors had high correlation with the words of only a few subjects.

From these results we determined that the common dimensions in evaluating environmental sounds were three, namely pleasantness, activity and feeling of daily life.

	Factor loading				
Words	1	2	3	4	5
annoying / calm	0.94	0.06	-0.15	-0.12	0.03
noisy / quiet	0.93	0.08	0.02	-0.07	0.03
noisy / comfortable	0.92	0.13	-0.15	-0.12	0.02
bustling / quiet	0.04	0.83	0.04	-0.21	0.02
crowded / empty	0.15	0.82	-0.21	-0.21	0.05
active / quiet	0.03	0.79	-0.10	-0.26	0.07
presence / absence of community	0.00	0.26	-0.81	0.03	0.13
daily / rare	0.10	-0.10	-0.78	0.07	0.26
daily / unusual	0.12	0.01	-0.75	-0.19	0.25
continuous − intermittent	-0.33	-0.07	-0.10	-0.55	-0.26
bothersome − background	0.61	0.27	0.00	0.54	-0.14
presence / absence of message	0.17	0.11	0.34	0.01	0.57
meaningful − meaningless	0.21	0.44	0.08	-0.04	0.52

Table 2: Factor loading of subjects' words (partial).

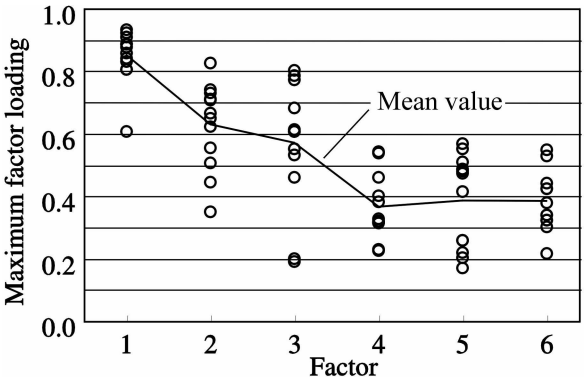

Figure 2: Maximum values of factor loading of each subject's words.

3.3 - The change of evaluation with contexts

The result from task #4 was analyzed with factor analysis. The data consisted of 19 variables (subjective scales) and 840 cases (35 sounds × 12 subjects × 2 contexts). The first three factors were interpreted as pleasantness, attracting attention and feeling of daily life, and the contributions of these factors were 36.4%, 15.5%, 11.4% respectively. The factor scores of sounds averaged over subjects are plotted in Figure 3, in which the corresponding sounds between two contexts are linked by arrows from *at home* to *on an urban street*.

As can be seen in Figure 3, almost no changes appeared along Factor 1 (pleasantness factor). This means the liking or preference of sounds does not change with contexts. Significant changes of averaged factor score were observed along Factor 2 (attracting attention factor), that is, almost all the sounds attracted less attention *on an urban street* than *at home*. One of the reasons may be that people *on an urban street*, as they would be more active than those at ease *at home*, would tend to be less disturbed by or less likely to notice sounds. On the other hand, the scores of sounds that were assumed to strongly attract attention such as "motorcycle gang" or "special event" changed very little between contexts. Along Factor 3 (feeling of daily life), almost all the scores changed slightly to "not feel presence" *on an urban street* with a few exceptions such as "KARAOKE" and "construction noise".

4 - CONCLUSION

We presented a set of procedures to determine the structure of impressions of environmental sounds and applied the procedures to find the structure in the context of daily life.

As we used only the names of environmental sounds in the experiment, the subjects are considered to have made judgement based on typical and prototype sounds in their memories. We think, therefore, that the influence of specific sounds, for example when the sound of a specific neighbor causes a noise problem for a specific person, requires for other methods. We also believe that the method presented in this study is more suitable for case studies than for revealing general findings, and that further investigation should be successful if combined with concrete sound environment planning.

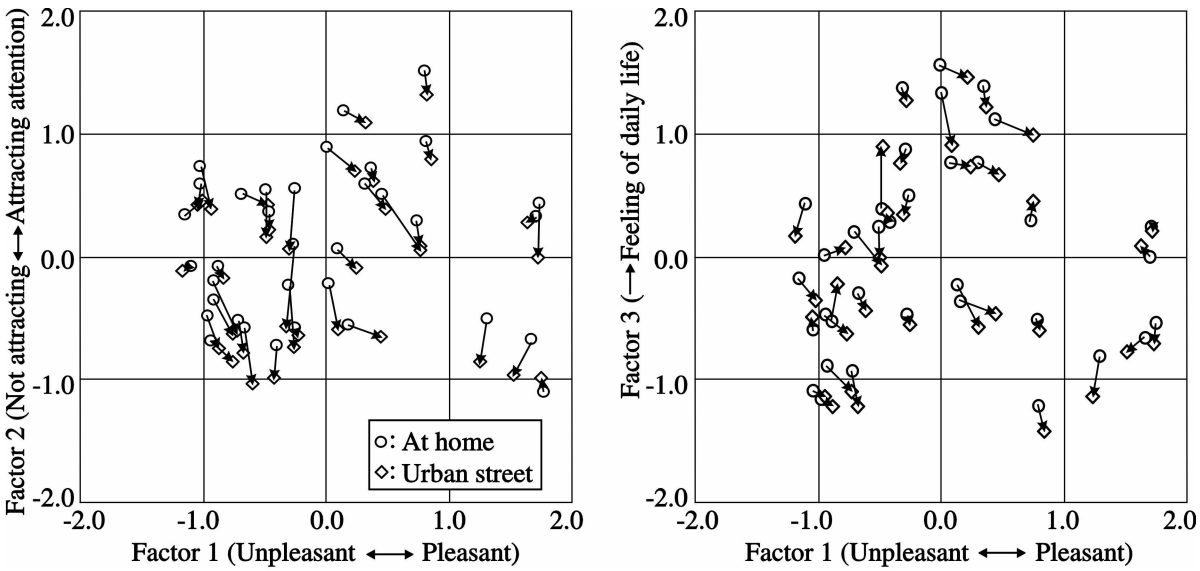

Figure 3: Changes of factor scores of sounds with context (averaged value over subjects).

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