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Auditory memory and evaluation of environmental sounds

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The present study was designed to examine whether it is possible to memorize the loudness of sounds by varying the sound levels. A series of experiments were conducted concerning the memory of environmental sounds. Twelve kinds of sound were presented with soft background noise of about 6 min to participants. They were asked to recall the sound sources and to judge the loudness of the recalled sounds some period after they listened to the sounds. The recalled loudness was examined in relation to the length of the period between the presentation of sounds and the judgment of loudness, the method to measure the memory, L_{Aeq} of each sound source, etc. The results suggest that it is possible to judge the loudness of the memorized sounds and that the judgments seem reliable.

1 Introduction

Long-term evaluation of environmental noise is needed in order to examine how residents evaluate the sound environment in their daily lives. The target term will be one day, one week, one month or one year. Most of the sounds in our environment are temporally fluctuating. It would be important to find an appropriate measure for the evaluation of long-term temporally varying sounds. Many social surveys have been conducted [e.g. 1-3] and good relation is usually found between the responses of the residents and L_{Aeq}. Kaku et al [4] also tried the social survey using an internet and reported a good dose-response relationship between the responses of the residents and L_{Aeq} Social survey is a suitable method to obtain the responses of the residents in their daily life situations. However, in order to find the effect of crucial factors to improve the sound environment, experimental approach is effective. The authors have been conducted a series of experiments in order to find how the memorized loudness of sounds is determined [e.g. 5-8]. The main findings of our former studies are as follows.

(1) Memorized loudness shows fairly good correlation with L_{Aeq}.
(2) The length of the period between listening to sounds and recall of the sounds may have a significant effect on loudness
(3) Overall loudness is not always determined by the simple average of the constituent sounds.
(4) Subjectively prominent sounds have a greater effect on the overall loudness than less prominent sounds. Subjective prominent sounds are not always loud sounds. Sometimes very soft sounds are impressive and have a significant effect on the overall loudness.
(5) The method of measurement of memory has an effect on the result.

The present experiment was designed to examine whether participants can memorize and recall the loudness of sounds they listened to some period before. Since sounds that can be easily identified are used in the experiment of memory, there is a possibility that the participants may judge the loudness based on their daily life experience.

2 Experiment

2.1 Stimulus

A stimulus of about 6 min was prepared which consisted of twelve sound sources. The sound sources used in the experiment are listed in Table 1. These twelve sound sources are the same as those used in our former experiments, but the sound level of each sound was increased or decreased by 10 dB compared with the sounds used in our former experiments. These are the sounds often heard in an office or at home. Steady state background noise of 30 dB was added to these stimuli.

Table 1

	sound source	L_{Aeq}
1	melody	58.8
2	footsteps	50
3	train	47.6
4	vacuum cleaner	60.6
5	dish washing	55.8
6	people's talk	44.2
7	airplane	58.1
8	fire engine	51.5
9	dog barking	68.1
10	telephone bell	46.1
11	car	67.7
12	printer	59.5

2.2 Procedure

Experiment consisted of 3 parts. In part 1, the participants were requested just to listen to the sound without doing anything. After the lecture of psychology about one hour, part 2 was conducted. The contents of lecture were irrelevant to the memory experiment. A response sheet was distributed and the participants were asked to answer the following questions.

(1) to judge the overall loudness of the sound using seven-point category scale from "1: very soft" to "7: very loud".
(2) to recall each sound source and write down the names of the sound sources they recall
(3) to judge the loudness of each recalled sound source using seven-point category scale

The response sheet was collected and another response

sheet was distributed. In part 3 the 12 sounds were represented again with pause between them. During the pause the participants were asked to identify the sound source and judge the loudness of that sound using 7 point category scale. After they finished the judgment of one sound, another sound was presented.

2.3 Equipment

The sound was reproduced with a DAT recorder (Sony DTC-ZE700) and presented to the participants through an amplifier and loudspeakers in a lecture hall where there is little difference in sound level among the positions of the participants.

2.4 Participants

69 females and 18 males (in total 87) aged between 18 and 23 (average 18.9) participated in the experiment.

3 Results and discussion

The recalled percentages of each sound source are shown in Fig.1. The recalled percentages varied among sound sources. There seems a weak tendency that loud sounds may easily be recalled. The relation between the recalled loudness and L_{Aeq} is shown in Fig.2. Similar correlation was found between them as in our former studies where the sounds were presented at the original levels. The difference of recalled loudness between the loudness of sounds at the original sound level in our former experiment and the loudness judged in this experiment was calculated and correlated with the difference in sound level. The result is shown in Fig.3. Fairly good relation can be seen. It was tried to calculate the coefficient of correlation between the loudness obtained in the present experiment and the original sound level in L_{Aeq}. The coefficient of correlation was 0.57. These findings suggest that the participants could memorize the loudness of the sounds they listened to and not judged based on their daily life experiences. The percentages of correct identification are shown in Fig.4. It was found that most of the sound sources were identified. The relation between loudness judged after listening to the sound and L_{Aeq} is shown in Fig.5. When the loudness was judged in a short period after listening to the sound, fairly high correlation can be seen.

4 Final remarks

L_{Aeq} is a good index of the loudness of environmental sounds [e.g. 9]. In this experiment, the memory of loudness was examined in relation to L_{Aeq}. The results of this study suggest that the loudness of sounds can be memorized and recalled even though the sound levels of memorized sound are different from those experienced in our daily life situations. This means that the participants judged the loudness of sounds they litened to. Since it seems possible to measure the recalled loudness in laboratory situations, it would be important in further studies to find crucial factors that affect to memoraized sound environment. These factors may contribute to realize a comfotale sound environment.

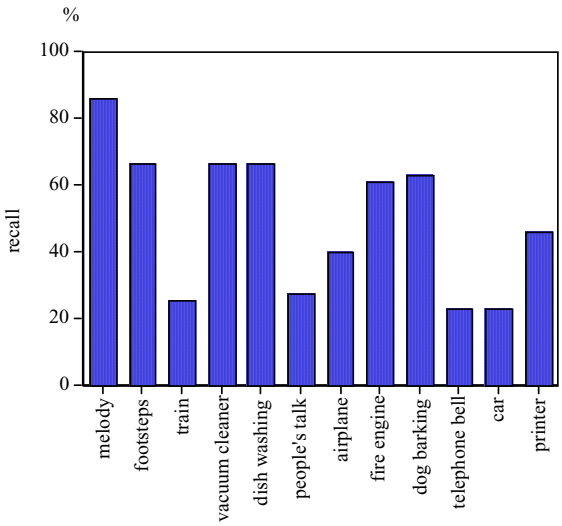

Fig.1

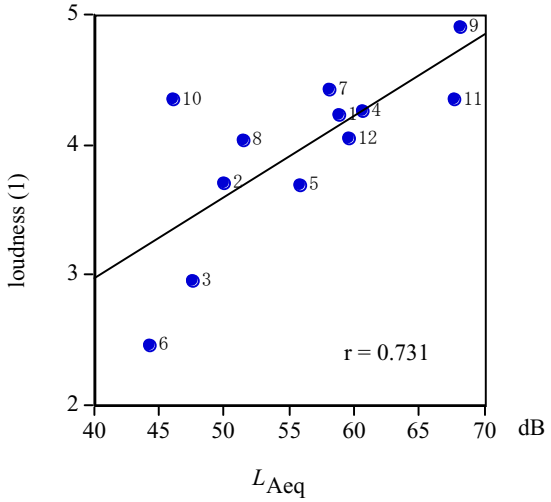

Fig.2

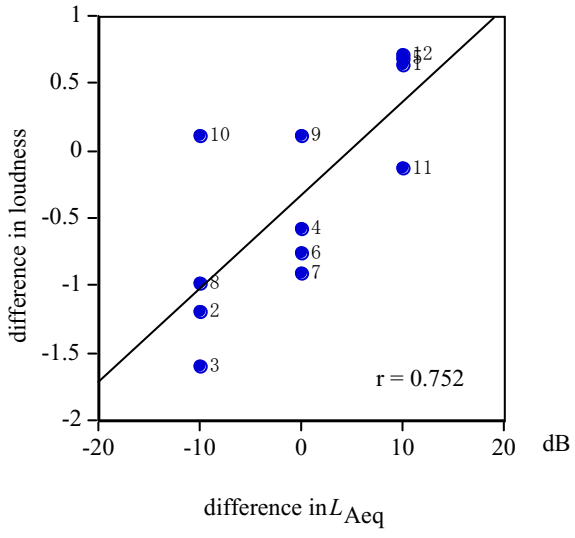

Fig.3

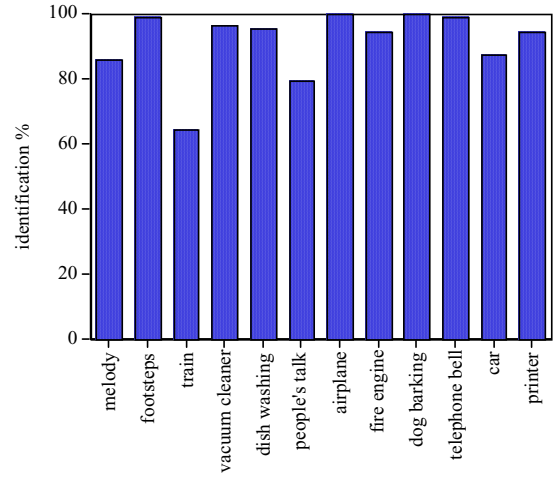

Fig.4

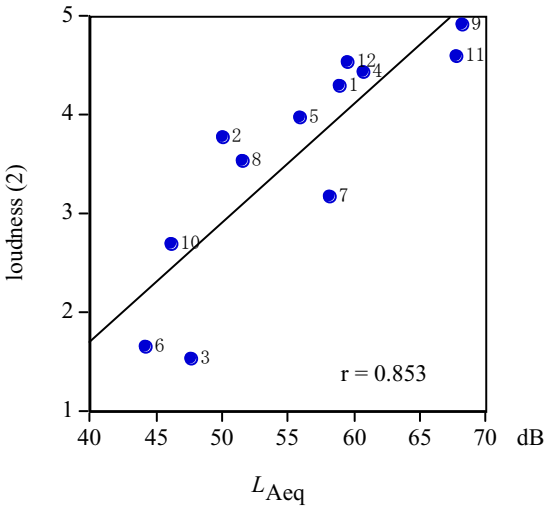

Fig.5

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