

MEMORY OF THE LOUDNESS OF SOUNDS AND ITS RELATION TO OVERALL IMPRESSION

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ABSTRACT

Overall impression of long-term sound will be judged on the basis of memory. The results of our former studies comparing overall impression with instantaneous impression suggest that the prominent portions of the sound contribute to the overall impression more greatly than less prominent portions. Long-term environmental sound consists of various kinds of sound. In order to examine what kind of constituent sounds may contribute to the determination of the overall impression, a new approach was tried asking subjects to recall the sound with their loudness and time sequences. The results suggest that prominent sounds are not always loud sounds and that subjects can recall the loudness fairly precisely.

1. INTRODUCTION

Most of the sounds in our environment are varying with time and consist of various sound sources. We may have two kinds impression to such environmental sounds. One is the instantaneous impression corresponding to the temporal change of the sound at each moment. The other is the

overall impression after listening to the sound for some period. The period may differ from a few minutes to a few hours, a day, a month or a year. The overall impression of long-term sound will be judged on the basis of memory. Memory of long-term sound may be influenced by various factors as well as the instantaneous impression of the sound. In our former studies [1-3], it was found that the overall impression is not always the same as the average of instantaneous loudness, but usually overall impression is overestimated compared with the average of instantaneous judgments. This suggests that the prominent portions may have greater contribution to the overall impression than less prominent portions. The present study is conducted in order to make clear which portions of the sound are prominent and easily memorized and how they contribute to the overall impression asking subjects to recall the sound sources and express their temporal sequences and loudness after instantaneous judgment of loudness.

2. EXPERIMENT

(1) Stimulus

Environmental sound recorded in the suburban area in Eichstaett in Germany was used as a stimulus. The duration was 20 min. It included road traffic noise, noise from motor bike, train noise, bird twittering, etc. The L_{Aeq} value was 76.3 dB. The sound level pattern is shown in Fig.1.

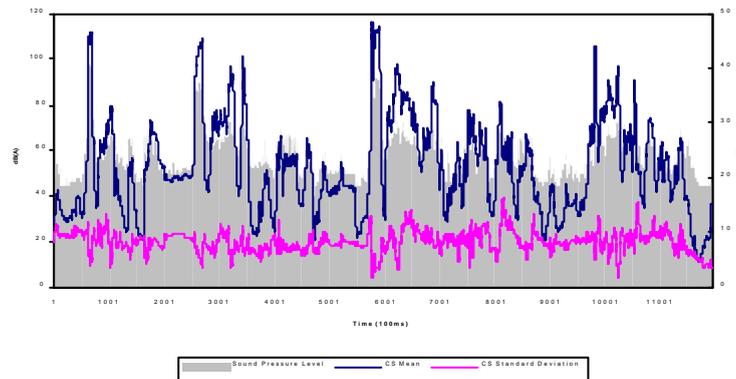


Fig.1

(2) Procedure

The experiment consisted of the following three parts, each of which was conducted in different days.

Step A: Subjects listened to the sound without doing anything. After listening to the whole sound, subjects were asked to judge the overall impression of loudness using 50-point category scale and recall the name of the sound sources after the overall judgments.

Step B: Subjects were asked to judge the loudness continuously by matching the length of a line on a screen to the instantaneous impression of loudness. They were also asked to judge the overall loudness by 50-point category scale after the instantaneous judgments.

Step C: Subjects were instructed to memorize the sound while listening to the sound. After listening to the whole sound, they were asked to recall each sound source and write down the names of the sound sources with the order of recalling in the time-loudness axes.

(3) Equipment

The sound was reproduced with a DAT recorder (Pioneer D-05) and presented to subjects' ears through headphones (Stax SDR-X Pro) in a sound proof room.

(4) Subject

Five Japanese females and three Japanese males with normal hearing ability aged between 22 and 40 participated in the experiment. However, a part of the data of two subjects was missing and the data of six subjects were analyzed.

3. RESULTS

(1) Relation between instantaneous judgment and instantaneous sound level

There is a time lag (reaction time) between the presentation of sounds and the subjects' responses to them. The coefficient of correlation between physical values ($L_{Aeq,100ms}$) and subjects' responses sampled every 100 ms was calculated by sliding the interval between them. The time lag when the highest correlation was obtained was regarded as the reaction time. Taking the reaction time into account, the instantaneous judgments sampled every 100 ms are averaged. High correlation was found between them as shown in Fig.1. This suggests that the instantaneous impression is mainly determined by instantaneous physical values.

(2) Relation between instantaneous loudness and overall loudness

The results are shown in Fig.2. There was little difference between overall loudness judged in Steps A (34.7) and B (32.0). On the other hand, the average of instantaneous judgments in Step B was 21.9, which was much smaller than overall loudness. It was confirmed that the overall loudness is not the simple average of the instantaneous loudness as found in our former studies [1-3].

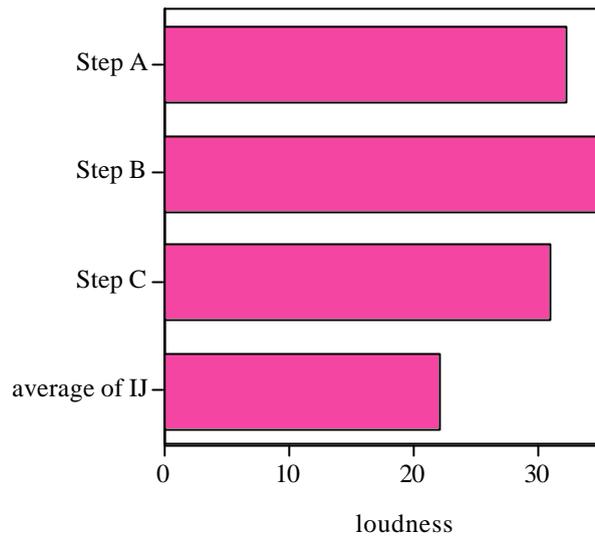


Fig.2

(3) Factors which determine the overall impression

Each subject recalled about 15-20 sounds on the average in Step C. Though the number and the kind of the recalled sound sources are different among subjects, the recalled sound sources may be regarded as the prominent sounds to the subject. The loudness was expressed on the vertical line of the response sheets. The average of loudness judgment of recalled sounds was calculated for each subject and the judgments of six subjects were averaged. This average is close to the overall judgment in Step A and Step B as shown in Fig.2. It is noticed that the recalled sound sources were not always loud sounds, but many subjects recalled the sound of bird twittering. This result suggests that impressive sounds may contribute to determining the overall judgment regardless of their sound levels.

(4) Order of recall

Subjects were asked to write the order of recalling in Step C. Three patterns of recalling were found. (1) Subjects recalled in the order of loudness, i.e. from loud sounds to soft sounds. (2) Subjects first recalled the sounds presented at the beginning or at the end. (3) Subject recalled by grouping the sound sources. That is, for example, train noises were audible four times in 20 min and these four train noises were recalled first. These patterns of recalling meet the law of memory and further analysis is needed in order to find the weight of each sound in determining overall impression.

(5) Correct recall

Since it is difficult for subjects to recall the time precisely when each sound source appeared, the 20 min was divided into five portions. If the sound is plotted in the correct portion or adjacent

portions, it was admitted as correct answer. The result is shown in Fig.3. The train noise was fairly loud and seemed to be impressive. However, there were few subjects who recalled correctly all the four train noises. It is not easy to recall the sound sources, but it seems more difficult to recall the correct timing of the occurrence of each sound source.

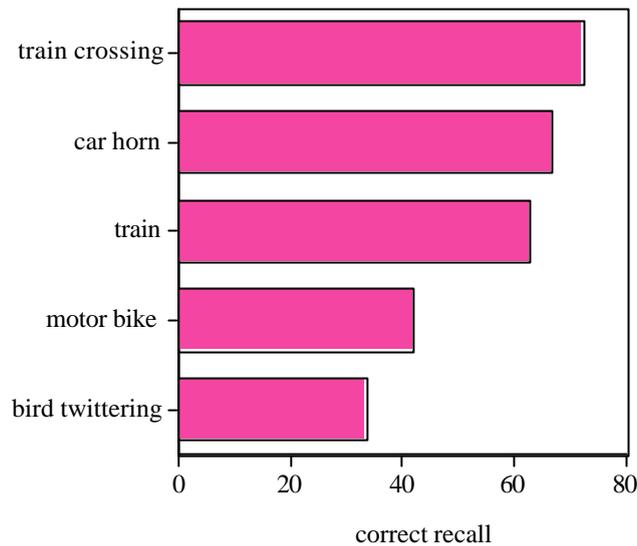


Fig.3

(6) Relation between sound level and loudness of recalled sounds

The maximum levels of train noise, road traffic noise, train crossing, car horns, and bird twittering were correlated to the loudness judged in Step C. The result is shown in Fig.4. High correlation was found between them. It was suggested that recalled loudness shows good correlation with physical values if the sounds were recalled just after listening.

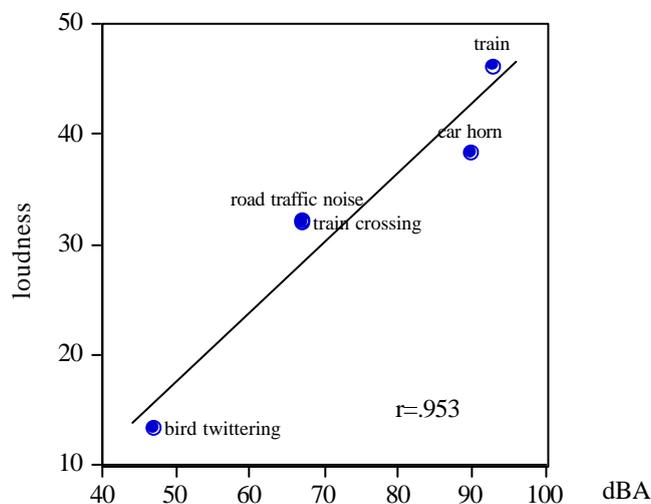


Fig.4

4. FINAL REMARKS

It was confirmed in the experiment that the overall judgment of loudness is not the same as the simple average of instantaneous judgments as found in our former studies. This suggests that the weight of the contribution of each constituent sound to the overall impression may differ. The prominent sounds may contribute more greatly to determining the overall impression than less prominent sounds. It is true that loud sounds tend to be prominent. However, in this experiment it was found that even soft sounds sometimes are prominent and impressive, and that which sound is easily recalled may depend on the serial order of presentation as indicated in the law of memory. It is noticed that high correlation was found between sound level and recalled loudness. This suggests that subjects memorize the impression of loudness as well as the sound sources. Further investigation is needed by controlling various factors systematically and by taking the law of memory into consideration.

5. REFERENCES

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