A STUDY OF HOW BLIND PEOPLE IDENTIFY A PLACE BY USING ENVIRONMENTAL SOUNDS

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1. INTRODUCTION

It seems that environmental sounds give important information to visually impaired persons for orientation and mobility. When we plan soundscape design of urban spaces, we have to consider the importance of environmental sounds for visually impaired persons and know how visually impaired persons use sounds for orientation and mobility.

This study analyses how blind people identify a place by using environmental sounds.

2. METHODS

The subjects for this study were five visually impaired male trainees at the Fukuoka National Rehabilitation Center for the Blind receiving rehabilitation program that included orientation and mobility training. One subject was totally blind, and others who had low vision could not rely upon their sight for orientation.

The method of this survey is shown below. Environmental sounds recorded at the places where the subjects went for orientation and mobility training were presented via headphones and DAT. The duration of each sound was 2 minutes. The subjects were asked to identify places from each presented sound, and to indicate where the places were and why they identified the place there. The answer of the subjects were recorded.

Table 1 shows the list of presented environmental sounds.

Table 1. Lists of presented environmental sounds

Mark	Place	Mark	Place
P1	Large shopping street in Nishijin	P10	Large shopping street in Tenjin
P2	2nd floor of bus center at Hakata station	P11	Nishi Nippon Railway Tenjin Station
P3	Tenjin subway station	P12	Hakata subway station
P4	Shopping center at Hakata station	P13	Nishijin bus stop
P5	Underground shopping center in Tenjin	P14	Small shopping street in Nishijin
P6	Trunk road at Nishijin	P15	1st floor of bus center at Hakata station
P7	Bus center in Tenjin	P16	Information board for visually handicapped at Hakata station
P8	Nishijin subway station		
P9	JR Hakata Station		

3. ANALYSIS AND RESULTS

To analyse the answers of each subject, all the accounts concerning the sounds that were used identifying places were collected. Table 2 shows the examples of the collected accounts. The order of sentences in each column of the table corresponds to the order that each subject used.

As Table 2 indicates, subject A pointed out the sound of ticket vending machines and reverberation in both spaces at the early stage of his accounts. In his original answers, subject A identified both places as subway stations just after pointing out these two sounds. Then, in the case of Tenjin subway station, he identified the place as Tenjin subway station because of the frequency of ladies footsteps and the style of the BGM. In the case of Nishijin subway station, he identified this as a subway station except Hakata subway station because there is no public telephone near the ticket vending machines at Hakata subway station. This case suggests that the method that subject A used to identify a place by using environmental sounds is a "stepping method"; he roughly indicates the place by hearing a sound and this indication becomes more detailed as other sounds also related to that place. After several similar steps, he finally identifies the place.

On the other hand, though subject C pointed out the sound of ticket vending machines in both spaces, the order of the pointing out were very different. In his original answers, subject C pointed out all of the sounds listed in Table 2 first, then he identified each place saying "The place which all of these sounds could be heard is $\sim$." This case suggests that the method that subject C used to identify a place by using environmental sounds is a "setting method"; he identifies a place from a set of characteristic sounds.

The comparison of these two cases suggests that there are at least two different methods to identify a place by using environmental sounds. This suggestion is further investigated with a cluster analysis shown below.

To apply a cluster analysis to the collected accounts about sounds used for identifying places, all words of the sounds in the collected account were classified into words groups that had the same meaning. The classified groups named "the sound items" can be seen in Table 3.

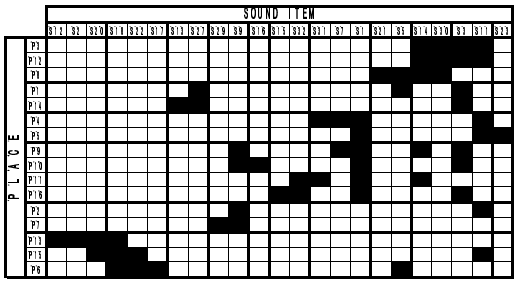
The collected accounts were arranged according to what sound item was pointed out at each place by each person. The arranged data of each subject were clustered by using cluster analysis about the sound items and places. Jaccard's similarity measure and unweighted pair group method average were adopted for clustering.

Table 2. Examples of the collected accounts

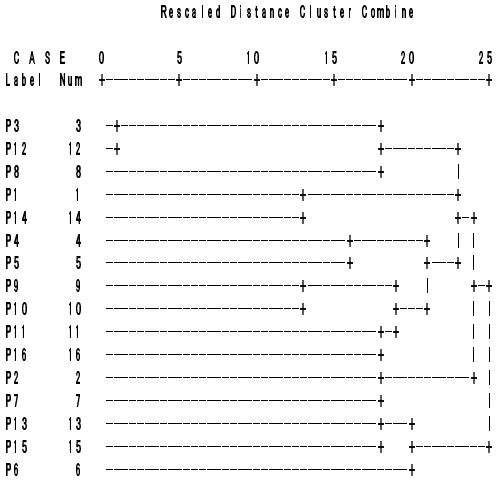
	Tenjin subway station	Nishijin subway station
Subject A	Sounds of ticket vending machines were heard. The reverberation of footsteps showed the place was underground. Ladies footsteps were more frequently heard. The style of the BGM was not Nishijin's.	Sounds of ticket vending machines were heard. Reverberation indicated the place was underground. Sounds of subway were heard. The voices of people using a public telephone were heard.
Subject C	Sounds of coins for buying ticket were frequently heard. A set of Lady's announcement and BGM were heard. Footsteps indicated that a lot of people were walking there. The reverberation indicated that the place was walled.	Voices of office workers were heard. The word "Airplane" was heard. Sound of ticket vending machines were loud.

Table 3. The sound items

S1: bustling, S2: no bustling, S3: footsteps, S4: no footsteps, S5: voices of known people,
S6: voices of vender, S7: contents of conversation or announcements, S8: existence of announcements,
S9: no announcements, S10: other voices, S11: BGM, S12: no BGM, S13: sound of *pachinko*,
S14: sound of ticket vending machines, S15: no sound of ticket vending machines, S16: audible traffic signal,
S17: no audible traffic signal, S18: sound of cars, S19: no sound of cars, S20: sound of trucks or buses,
S21: sound of trains, S22: sound of bicycles, S23: sound of shopping carts, S24: sound of water sprinkling,
S25: sound of cleaning, S26: sound of opening shutters, S27: sound of putting boxes (for opening of stores),
S28: sound of air-conditioners, S29: sound of construction works, S30: reverberation,
S31: no reverberation, S32: unknown sound

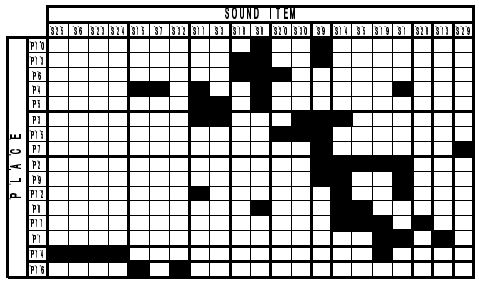


(a) List of sound items pointed out at each place



(b) Dendrogram of cluster analysis about places

Figure 1. The cluster analysis of subject A



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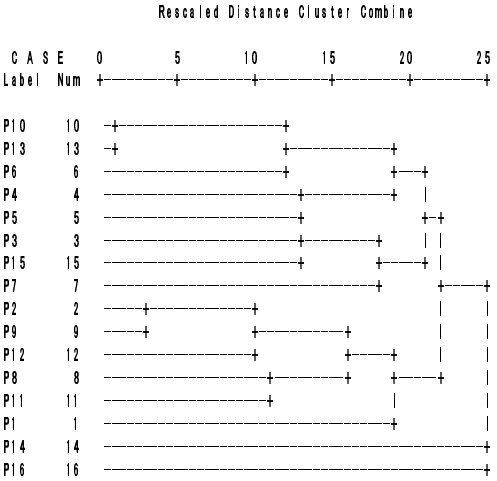

(b) Dendrogram of cluster analysis about places

Figure 2. The cluster analysis of subject C

Figure 1 shows sound items that were pointed out at each place by subject A [Figure 1-(a)] and a dendrogram of cluster analysis about places of subject A [Figure 1-(B)]. Figure 2 shows same as subject C.

4. DISCUSSION AND CONCLUSION

The relationship between the results of cluster analysis about places and the accounts of subjects are discussed below.

First, the case of subject A is discussed. A cluster consisting of Tenjin subway station (P3), Hakata subway station (P12) and Nishijin subway station (P8) shown in Figure 1-(b) is taken for an example.

The cluster is divided into a cluster consisting of Tenjin subway station and Hakata subway station and a cluster consisting of Nishijin subway station. Considering the list of sound items pointed out at each place [Figure 1-(a)], the structure of the cluster is explained as below; in the cluster consisting of Tenjin subway station, Hakata subway station and Nishijin subway station that were indicated as the places where sound of ticket vending machines (S14) and reverberation (S26) were heard, the cluster consisting of Tenjin subway station and Hakata subway station where footsteps (S3) and BGM (S11) were heard and the cluster consisting of Nishijin subway station where voice (S10) was heard are exist. This explanation of the structure completely corresponds the stepping method observed in the accounts of subject A shown in the preceding section.

The same correspondences between the explanation of the structure of cluster shown in Figure 1-(b) and the stepping method observed in the accounts of subject A are found out at all clusters shown in Figure 1-(b). This means that the structure of the method that subject A used to identify a place by using environmental sounds is completely explained by using the structure of the dendrogram obtained from cluster analysis of the accounts of subject A.

The same results are obtained from the case of subject B (it cannot be shown due to lack of space). Thus, the structures of the "stepping method" are completely explained using the structure of the dendrogram obtained from the cluster analysis of the accounts of the subjects.

Then, the case of subject C is discussed. A cluster consisting of Tenjin subway station (P3), 1st floor of bus center at Hakata station (P15) and bus center in Tenjin (P7) shown in Figure 2-(b) is taken for an example.

As Figure 2-(a) indicates, announcements (S8) were indicated at these three places. However, in the original answers of subject C, as has been pointed out, no sound was used for roughly identifying a place such as subjects A and B did. Moreover, all sounds were used to identify the place directly. Therefore, the announcements were only the sounds that were heard at these three places. In addition, the correspondence between the structure of the "setting method" observed in the accounts of subject C and the structure of the dendrogram shown in Figure 2-(b) could not be observed at all.

The same state is observed in other clusters as shown in Figure 2-(b).

The same results are obtained from the case of subject D (it cannot be shown due to lack of space). Thus, the structures of "setting method" are not explained by using the structure of the dendrogram obtained from the cluster analysis of the accounts of the subjects at all.

These results show that blind people apply two different methods to identify places by using environmental sounds. One method is a "Stepping method"; one can roughly indicate a certain place by hearing a sound, and this indication becomes more detailed as more other sounds relate to that place. After several similar steps, one finally identifies the place. The other method is a "Setting method"; one identifies a certain place from a set of characteristic sounds.