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PSYCHO-PHYSIOLOGICAL RESPONSES BY LISTENING TO SOME SOUNDS FROM OUR DAILY LIFE

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This study was made to clarify the relationship between mode of identification, mode of emotion and physiological response to noise. Twenty-six subjects, young females, listened to six different daily sounds for 150 s through head phones. The level of sound was 60–61 L_{Aeq}. The pulse wave and blood pressure were observed, and pulse wave interval, wave height and maximum and minimum blood pressures were measured. Measurements were taken twice once 30 s before listening and again during the final 30 s of listening. The ratio of the latter value to the former value was used as the index for the evaluation of change. Immediately after the listening session, identification of the sound source and emotional response were surveyed via a questionnaire and the sounds were judged as related to comfort or discomfort. In the case of incorrect identification, physiological functions were not seen to change significantly. However, in the case of correct identification, maximum and minimum blood pressures were significantly increased from the pre-listening values. The physiological functions of the discomfort group did not change significantly. In the comfort group, wave height was decreased and blood pressure was significantly elevated.

1. INTRODUCTION

There are many types of sounds in our daily life. When we listen to one type of sound, we identify the sound source correctly or incorrectly. Sound also brings us comfort or discomfort. At the same time, physiological functions change in polydimension.

This study was made to evaluate the relationship between mode of identification, mode of emotion, and physiological responses.

2. METHOD

The subjects were 26 Japanese females between the ages of 20 and 22. They were admitted into the experimental room and kept in bed rest posture during the experiment. The temperature in the experimental room was $23 \pm 1^{\circ}$C, the relative humidity about 60%, and the back ground noise level less than 30 dB(A).

They listened to six different sounds, an automobile engine, the warbling of a small bird, a wind chime, an alarm clock, the murmuring of a brook, and a sacred song sung by a male vocalist in Latin. The sounds of the automobile engine and the murmuring of a brook

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TABLE 1

Modes of identification

Sound source	Identification: correct	Identification: incorrect	Correct answer rate (%)
automobile engine	16	10	60·0
warbling of a small bird	26	0	100·0
wind chime	0	26	0·0
alarm clock	2	24	7·7
murmuring of a brook	26	0	100·0
sacred song	24	2	92·3

were kept at a constant level. The sound of the alarm clock was kept a constant level intermittently at one cycle per second. The sound levels of all other sources varied intermittently according to the course of time.

The listening sound levels were L_{Aeq} 60–61 dB. This level was an average of the most comfortable level for listening to music [1]. The women listened to the sound bi-aurally through head phones (Audiotechnica ATH-M7) for 150 s. The order of sounds was assigned randomly.

Immediately after listening, identification of the sound source and emotional response were surveyed via a questionnaire. The emotional response was estimated by self-rated 5-point scale of a comfort–discomfort measure.

Physiological functions were observed continuously by monitoring pulse wave and blood pressure. Two responses were measured from the pulse wave by plethysmograph (NEC-Sanei, Type 45261), wave height (WH) and wave interval. The coefficient of variation was calculated from the values of wave interval (CVWI). From the blood pressure curve by Finapress (Ohmeda, Type 2300), maximum (Max) and minimum (Min) pressures were measured. Measurements were taken twice once 30 s before listening and again in the final 30 s of listening. The ratio of the latter value to the former one was used as the index for evaluation of change.

3. RESULTS

The modes of identification of sound are shown in Table 1. The correct answer rate varied for the six sounds. Answers shifted between correct and incorrect on the identification, except for the automobile engine.

TABLE 2

Modification of physiological response according to identification ($\bar{\chi} \pm$ SE)

Identification	Measure	Evaluation index	Change from pre-listening
correct	CVWI	98·3 ± 5·21	ns
	WH	95·5 ± 2·55	ns
	Max	103·4 ± 0·93	$p < 0{\cdot}02$
	Min	104·1 ± 1·22	$p < 0{\cdot}02$
incorrect	CVWI	100·8 ± 2·58	ns
	WH	99·1 ± 5·23	ns
	Max	103·6 ± 1·83	ns
	Min	105·0 ± 2·50	ns

TABLE 3

Modes of emotional response

	Emotion				
Sound source	comfort	slight comfort	neither comf. nor discomf.	slight discomfort	discomfort
automobile engine	0	2	7	12	5
warbling of a small bird	10	7	3	5	1
wind chime	3	6	6	6	5
alarm clock	0	0	8	12	6
murmuring of a brook	4	11	5	4	2
sacred song	4	11	2	6	3

Four physiological indices are shown in Table 2 by the mode of identification. In the case of incorrect identification, the physiological functions of the women did not change significantly. However, when the subjects had identified the sound source correctly, Max and Min blood pressures were significantly increased from the pre-listening values.

The modes of the emotional response to each of the sounds are shown in Table 3. The emotional response to the automobile engine and alarm clock tended toward discomfort. The emotional response to the warbling of a small bird, the wind chime, the murmuring of a brook, and the sacred song were distributed over a wide range from comfort to discomfort.

The subjects who responded with "comfort" and "slight comfort" on the measurement scale were considered the comfort group, and the subjects who responded with "discomfort" and "slight discomfort" on the scale were considered the discomfort group. Subjects who responded "neither nor" were not included. The effects of the modes of emotion on physiological response are shown in Table 4. The physiological functions of the discomfort group did not change significantly. In the comfort group, however, the subjects' WH decreased significantly and their blood pressure was elevated significantly from the pre-listening values.

The physiological changes were compared for each group according to the connection between the mode of identification and emotion in Table 5. For the sound sources identified correctly in the comfort group, WH was decreased and Max and Min blood

TABLE 4

Modification of physiological response according to emotion ($\bar{\chi} \pm$ SE)

Emotion	Measure	Evaluation index	Change from pre-listening
comfort	CVWI	$106{\cdot}0 \pm 3{\cdot}37$	ns
	WH	$91{\cdot}5 \pm 0{\cdot}59$	$p < 0{\cdot}001$
	Max	$104{\cdot}9 \pm 1{\cdot}15$	$p < 0{\cdot}02$
	Min	$105{\cdot}7 \pm 1{\cdot}52$	$p < 0{\cdot}02$
discomfort	CVWI	$94{\cdot}5 \pm 4{\cdot}02$	ns
	WH	$100{\cdot}9 \pm 3{\cdot}75$	ns
	Max	$102{\cdot}4 \pm 1{\cdot}18$	ns
	Min	$103{\cdot}6 \pm 1{\cdot}77$	ns

TABLE 5

Group difference for physiological response by identification and emotion ($\bar{\chi} \pm$ SE)

Identification	Measure	Emotion	Evaluation index	Group difference
correct	CVWI	comfort	107·7 ± 4·99	$p < 0{\cdot}05$
		discomfort	93·2 ± 4·56	
	WH	comfort	92·0 ± 2·51†	ns
		discomfort	97·0 ± 3·01	
	Max	comfort	104·9 ± 1·19†	ns
		discomfort	102·4 ± 1·24	
	Min	comfort	104·5 ± 1·24†	ns
		discomfort	104·4 ± 2·74	
incorrect	CVWI	comfort	99·7 ± 6·37	ns
		discomfort	98·8 ± 5·43	
	WH	comfort	91·1 ± 4·31	$p < 0{\cdot}05$
		discomfort	101·9 ± 3·79	
	Max	comfort	107·1 ± 1·71†	ns
		discomfort	103·5 ± 1·51†	
	Min	comfort	109·8 ± 2·22†	ns
		discomfort	105·0 ± 2·19†	

† significant difference from the pre-listening value ($p < 0{\cdot}05$)

pressure were increased significantly from their pre-listening value. However, no physiological indices changed in the discomfort group. On the other hand, the difference between both the emotional groups was significant for the measure of CVWI. For the sound sources identified incorrectly in both the emotional groups, Max and Min blood pressures were increased significantly from the pre-listening values. The difference between the two emotional groups was also significant for WH.

4. DISCUSSION

In the studies mentioned earlier, it was observed that pulse wave changed at exposure to noise [2, 3]. However, in these cases, noise levels were high and attenuation was paid to pulse wave responses in the initial stage of exposure [4]. Since many types of sounds in our daily lives are of a lower level than that used in the above mentioned reports, the present study used noise levels actually found in daily life. Moreover, physiological responses at the initial stage of listening were not included, while those at the final stage of listening were measured.

When we listen to music, our emotional condition affects the mode of pulse-wave response [5]. As shown by the results of the present study, the modes of pulse-wave and blood pressure responses differed according to the modes of identification of the sound source and emotion by listening not only to music but to other sounds as well. As described previously in the case study on a noise-sensitive individual, his somatic responses were associated with the recognition of specific sounds [6]. In the present study, this was also observed in normal subjects. Accordingly, when we discuss the effects of sound on physiological functions or health, we must consider the interaction between the above mentioned physiological factors.

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