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DEVELOPING FEELINGS OF EXCITEMENT FOR THE SOUND PRODUCED BY CAR ENGINES

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Some drivers are attracted to cars, and they derive the feeling of excitement and experience "fun, joy, and enthusiasm to drive." The sound made by a car is one of the factors that create the feeling of excitement. In particular, the sound made by a car engine is symbolic of a car and increases the feeling of excitement To develop the feeling of excitement created by the sound of the engine, we need to examine some evaluation indicators using sensory, physical, and biological reactions of the excitement. In this study, we focus on the sensory indicator. We investigate the sensory evaluation indicator using a semantic differential (SD) method and factor analysis for two groups of participants: experienced and inexperienced drivers. The results showed that for participants who were experienced drivers, factors such as the force/stimulant factor (force, agitation, lock, sporty, stimulation, and cool), height/darkness factor (light, high, and dark), and emotional factor (pain and anxiety) were extracted. In the case of participants who were inexperienced drivers, the factors extracted were the height/darkness factor (light, high, dark, positive, rising phase, and stretch), sporty factor (sporty, rock, and wild), and emotional factor (satisfaction, cost, and softness). Using the SD method and factor analysis, we defined the sensory evaluation indicator. The fact that these factors vary based on the participants indicates the need to change the sensory evaluation indicator for each group.

Keywords: Feeling of excitement, sound of the engine, SD method

1. Introduction

In recent years, automobiles have gained importance not only as means for transportation but also as means for entertainments such as driving; for example, drivers are now seeking to experience the feeling of "excitement" such as "joyful driving pleasure." People fully realize their latent abilities and perform better under exciting conditions. In particular, the engine sound is important as being symbolic of the car, and efforts have been laid to improve its impression. However, the feeling of excitement is an ambiguous expression. To extract the feeling of excitement and its corresponding sensory indicators, adjective pairs are required. In this study, we investigate the sensory evaluation indicator using brainstorming, an semantic differential (SD) method, and a factor analysis [3, 4].

2. Adjective pair for sound evaluation

2.1 The choice of the adjective pair by the brainstorming

As the first stage, eight people that included five employees of a car company , chose an adjective pair by brainstorming. The following points were considered for the brainstorming.

- Individual ambiguous interpretations were avoided.
- Similar adjective pairs were gathered and then varied for the overall structure.
- The basic measures (evaluation, competence, activity) and the five senses (visual, auditory, tactile, smell, taste) of the SD method were accepted.
- Opposite words were used.

As a result, we selected 29 adjective pairs. Table 1 lists the adopted adjective pairs.

Table 1: Adopted adjective pairs

Excited, Clear, Dull, Light, Stuffiness of obstruction, Lenient, Powerful, Soft, Rocky, Good Rising, Slow, Excited, High, Anxious, Impressive, Dark, Familiar, Positive, Inexpensive, Unsatisfactory, Cool, Stimulating, Expectable, Electronic, Responsive, No pain, Sporty, Resound, Wild, Preference

However, it is difficult to interpret the results because too many adjective pairs are present (large number of dimensionss). Moreover, in the experiment, a large number of adjective pairs can burden the participants. Therefore, an auditory impression experiment using the SD method was adopted. Empirical data was analysed by factor analysis and presented in three dimensions. We extracted the adjective pairs included in the three dimensions and defined them as the final adjective pairs.

3. Stimulus sound

The sound of a four-cylinder four-cycle engine (sampling frequency of 6000 Hz) was adopted as the stimulant. Figure 1 shows a spectrogram of the engine sound. The engine was operated in the third gear with full acceleration at 1000–6000 rpm. Two types of engine sounds were produced with variations in the rate of change of frequency with respect to time by using modifications on the sampling frequency. The auditory impression experiment was performed using three engine sounds (as stimulation sound). The sound pressure level of the stimulant was calibrated by using a dummy head in70 dBA by considering the actual vehicle interior noise.

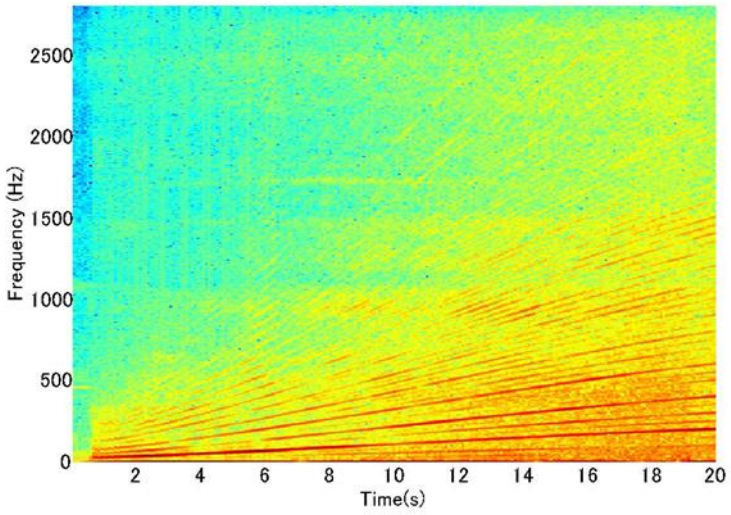

Figure 1: spectrogram of the engine sound

4. Experimental method

A total of 42 volunteers (20–23 years old; 30 men, 12 women) with normal hearing abilities participated in the experiment. Among them, 22 participants were experienced drivers and the rest were

inexperienced drivers. They were seated in an anechoic room with a comfortable thermal environment. Figure 2 shows the experimental environment in the anechoic room. The participants were joined for all three trials. In each trial, the participants listened to a stimulus sound three times, and evaluated each adjective pair under the exposure of engine sound. Participants rated the stimuli on a scale of seven grades (+3, +2, +1, 0, −1, −2, −3). The stimulus sound was presented to both ears via a headphone amplifier (HC6S, RANE) and open headphones (HD 650, SENNHEISER, Co.), as shown in Fig. 3. The characteristics of the headphones used are given below:

- Headphone amplifier: HC6S (RANE)
  - S / N ratio: 96 dB
  - Frequency response: 20 Hz–20 kHz
- Open-type headphone: HD 650 (SENNHEISER, Co.)
  - Frequency response: 10 Hz–39500 Hz
  - Impedance: 300 Ω

Figure 2: Anechoic room.

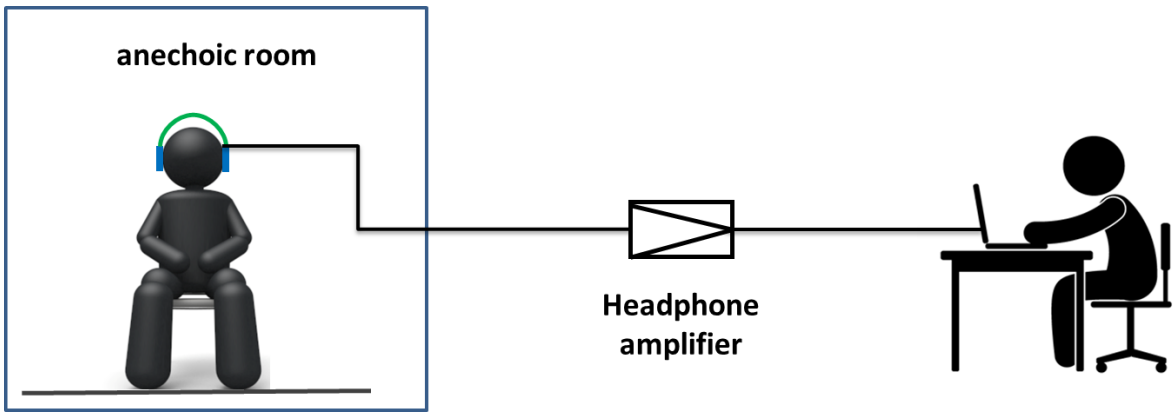

Figure 3: Experimental system

5. Experimental Results and Discussion.

Principal factor analysis was employed as the factor extraction method; varimax rotation, which is orthogonal rotation, was adopted as the rotation method. Tables 4 and 5 show the results of the factor analysis. Figures 3 and 4 show each result of factor loading for experienced and inexperienced drivers. In this analysis, if factor loading is greater than 0.4, the adjective pair affects its factor. The

established factor was named after the combination of constituting adjective pair. In Tables 3 and 4, the total number of adjective pairs in the first, second, and third factors was 12 for experienced drivers and 13 for inexperienced drivers. Table 2 lists the factors for experienced drivers. These factors consist of the force/stimulant factor (force, agitation, lock, sporty, stimulation, and cool), height/darkness factor (light, high, and dark), and emotional factor (pain and anxiety). Table 3 lists the factors for inexperienced drivers. These factors consist of the height/darkness factor (light, high, dark, positive, rising phase, and stretch), sporty factor (sporty, rock, and wild), and emotional factor (satisfaction, cost, and softness). By comparing the two groups, it is apparent that the construction of the factors is different for each group. This result indicates the difference in the impression made by the engine sound on the experienced and inexperienced drivers. Therefore, it is suggested that the sensory evaluation indicator should be changed for each group. The adjective pair “exciting” is not included in any factor. It is considered that the adjective pair “exciting” is equidistant to each factor.

6. Conclusion

In this study, the sensory evaluation indicator (adjective pairs) was investigated by using the SD method and factor analysis for both experienced and inexperienced drivers. The number of adjective pairs for experienced drivers was 12, and the number of adjective pairs for inexperienced drivers was 13. By comparing the two groups, it was determined that the construction of the factors was different for each group. This result indicates the difference in the impression made by the engine sound on experienced and inexperienced drivers. As future work, we shall investigate the relationship between sensory reactions and biological reactions.

Table 2: Results of factor analysis for experienced drivers

Adjective pair
Powerful - Quiet
To get excited - Calm down
Rocky - Not lock
Sporty feeling - No sporty feeling
No irritation - Irritating
Cannot expect - Can expect
Cool - Parenthesis is bad
Light - Heavy
High - Low
Dark - Bright
No pain - Painful
Anxious - To be relieved

Table 3: Results of factor analysis for inexperienced drivers

Adjective pair
Dark - Bright
High - Low
Positive - No negative
Good rise - Poor standing up
Good reaction - Poor reaction
Familiar - Fresh
Expansive - Unbending
Sporty feeling - No sporty feeling
Rocky - Not lock
Wild - Urban
Unhappy - Satisfying
Inexpensive - Expensive
Softer - Hard

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