Effect of combining active observation with audio-visual stimuli on pleasantness

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We examined whether participant's active control of the audio-visual stimulus would enhance pleasantness in observing the visual stimuli (a colored circle). In the experiment, we combined different colors with sound conditions that would give participants pleasant or unpleasant impression by themselves. We prepared the active and passive conditions for observation. In the active condition, participants viewed the visual stimuli presented on a display with controlling the movement of the visual stimuli by the use of a computer mouse. The stimulus movement was accompanied congruously with tones at the top end and bottom end of the movable range on the display. In the passive condition, participants observed the visual stimuli which moved automatically without mouse control. In each trial of those conditions, participants rated the impressions of the stimuli in terms of semantic differential technique. We examined whether participant's active control of the visual stimuli would be effective in enhancing pleasantness in observing the stimuli, and whether there are any interactions between the active control and color conditions, or sound conditions. Our results suggested that active observation has the enhancing effect for the impressions in the dimension of the evaluation of pleasantness when visual stimuli are presented with auditory stimuli.

Key words *pleasantness, audio-visual stimuli, colors, tone, active and passive observation*

Introduction

We would form various and abundant impressions from colors of the visual stimulus, and from tones of auditory stimulus. We are researching how the combining color of the visual stimulus and various aspects (e.g., tune, tone, and pitch) of the auditory stimulus affect the processing of our impression formation in the basic of the audio-visual interaction (Iwamiya, 2000; Spence & Driver, 2004). In our previous study (Toyono & Ichikawa, 2005), we found that temporal congruency between turning-on-and-off of the colored circle and music tunes may enhance the impressions in the dimensions of lightness and activity, while we could not find such an enhancement for the impressions in the dimension of pleasantness. We are looking for effective factors to enhance the pleasantness in observing the combinations of moving colored stimuli and sounds with temporal congruency between visual and auditory stimuli. In this study, we conducted experiments to investigate whether the active control of the audio and visual stimuli could enhance the impressions in the dimension of evaluation which would include the pleasantness.

Methods

Equipment and stimuli

In the main experiment, we combined the colored circle as a visual stimulus and pleasant or unpleasant tones as an auditory stimulus. In order to determine the colors and tones used in the main experiment, we conducted two preliminary experiments.

The first preliminary test was conducted to determine the color conditions used in the main experiment. We examined the luminance for the three phosphors (RGB) to present typical four hues (red, green, blue, and yellow), which are similar to the typical color tips. We used a personal computer (Apple Macintosh G4) to present visual stimuli on a 21" CRT display (Eizo T962, 75 Hz).

The viewing distance was about 50 cm. For each of the four hues, we presented a square on the CRT display whose luminance for each of three phosphors was one of the 12 settings. A background of stimuli on CRT display was gray (61.13cd/m^2). In viewing each of color tips (v2, v8, v12, and v18 from the Practical Coordinate System, Nihonshikiken), three observers (Two females and one male. Their ages ranged from 22 to 33 years old) rated the similarity of the color in the square to that in the color tip. The combination of the luminance for each phosphor to present the most similar hue to the color tip was used in the main experiment.

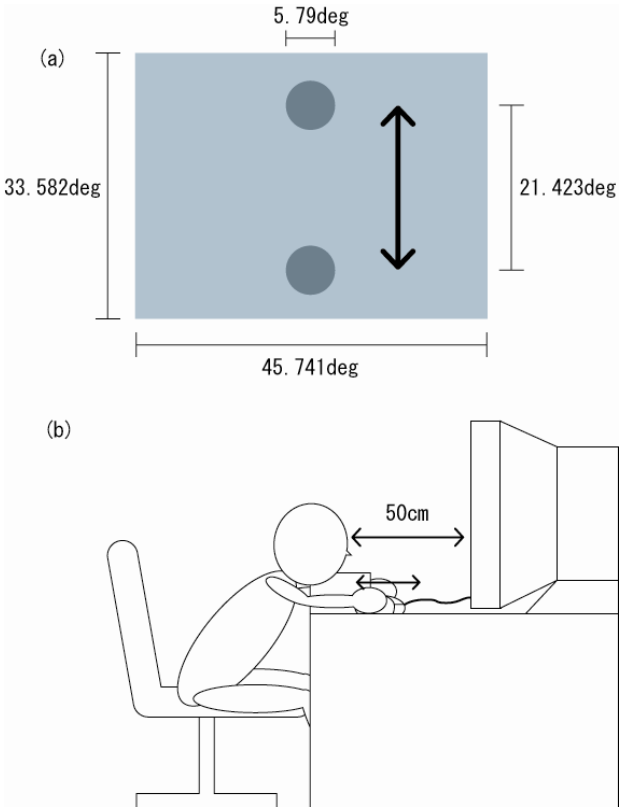

Figure 1: Diagram of the display configuration and equipment used in the main experiment. (a) Moving color circle as a visual stimulus presented on the CRT display. Two circles show the top end and bottom end of the movable range of the visual stimulus. (b) Setting of the equipment. In the active condition, in order to move the visual stimulus in the vertical dimension on the CRT display, observers moved the computer mouse backward and forward by the use of their right hand on the desk. In the passive condition, the setting was the same as in the active condition except that observers did not use the mouse.

The second preliminary test was conducted to determine the tone conditions used in the main experiment. We examined the pleasant and unpleasant tones. The same three observers as in the first preliminary experiment rated their impression for tones in terms of four adjective pairs which were supposed to be related to dimension of evaluation; boring-attractive, dislike-like, stressful-relaxing, and unpleasant-pleasant. We prepared ten tone conditions whose frequency ranged from 48 to 114 Hz presented by the use of a headphone (SONY, Digital Preference MDR-CD270). The most pleasant (72 Hz) and unpleasant sound (114 Hz) in the average from the three observers were used in the main experiment.

Figure 1 showed details of the display configuration and equipment used in the main experiment. In the main experiment, we presented a colored circle as a visual stimulus [Fig.1(a)]. The equipments used to present the auditory and visual stimuli were the same as those used in the preliminary experiments.

We prepared two viewing conditions; active and passive conditions. The active condition always preceded to the passive condition.

In the active condition, the observer sat on a chair in front of a desk (80 cm in height), with the head fixed on a chin rest, and grasped the computer-mouse (Apple Pro Mouse M5769) with the right hand, where they could move it backward and forward on the desk. The vertical position of the visual stimulus was yoked to the mouse position which was controlled by the observer. The movable range of the stimulus extended 21.4 arc degrees on the CRT display [Fig.1(a)]. At both of the top end and bottom end of the movable range of the visual stimulus, tone was presented by the use of the headphone.

In the passive condition, the visual stimulus automatically moved in terms of the sinusoidal function. The frequency of the sinusoidal function was determined in terms of the average of the velocity of the active movement in the active condition, which ranged from 0.43 to 0.70 Hz (average was 0.56 Hz) for the ten observers. The amplitude of the sinusoidal function was the same as the movable range of the active condition (21.4 arc degree).

Procedure

There were five conditions for the visual stimulus (red, green blue, yellow, and absent), three conditions for

auditory stimulus (pleasant, unpleasant, and absent), and two viewing condition (active, and passive). Therefore, there were 30 conditions for an observer. Each of the conditions was presented once in a random order. In each trial, observers reported their impressions by the use of semantic differential method (Osgood, Suci & Tannenbaum, 1957) in terms of ten pairs of adjectives, which were supposed to related to one of the three main dimensions in the human impression formation; evaluation, activity, and potency (Table 1).

Observers

The observers for the main experiment were 20-23 years old (Five females and five males). They were undergraduate or graduate students of Yamaguchi University, and were naïve to the purposes of the experiment. All of them had normal or corrected to normal visual acuity. All of them were right handed.

Table 1: Factor loadings of the Factor analysis for the results in the main experiment. Numbers below the Roman numerals are the eigenvalue and contribution for each of the three factors (Evaluation, Activity, and Potency). Bold and Italic numbers show the factor loadings whose absolute values were lager than 0.6 and 0.4, respectively.

	Adjectives	Factors			Communality
		1	2	3	
		Evaluation	Activity	Potency	
Ⅰ	painful-joyful	**0.894**	0.063	0.050	0.806
4.090	dislike-like	**0.858**	0.328	0.078	0.850
40.899	boring-attractive	**0.800**	-0.265	-0.068	0.715
	uncontrollable-controllabl	**0.752**	0.008	0.145	0.586
Ⅱ	quiet-active	-0.047	**0.837**	0.116	0.717
1.920					
19.190					
Ⅲ	heavy-light	0.160	-0.066	**0.907**	0.853
1.454					
14.538					
Ⅰ・Ⅱ	unpleasant-pleasant	**0.802**	*0.435*	0.106	0.844
	unnatural-natural	**0.648**	*0.466*	0.036	0.638
	stressful-relaxing	*0.507*	**0.651**	0.081	0.687
Ⅱ・Ⅲ	strong-weak	-0.033	*0.450*	**0.751**	0.768

Results and discussions

We conducted a factor analysis (Principal factor solution, Varimax method) for the results of the ratings by the ten observers in terms of ten adjective pairs. We extracted the basic three factors (Osgood et al., 1957); evaluation, activity, and potency (Table 1). These three factors explained 74.63% of the variations of the data. Fig.2 (a), (b), and (c) show the averages of the factor scores for each of the 30 conditions. Ordinates in those figures indicate the extents of the evaluation, activity, and potency.

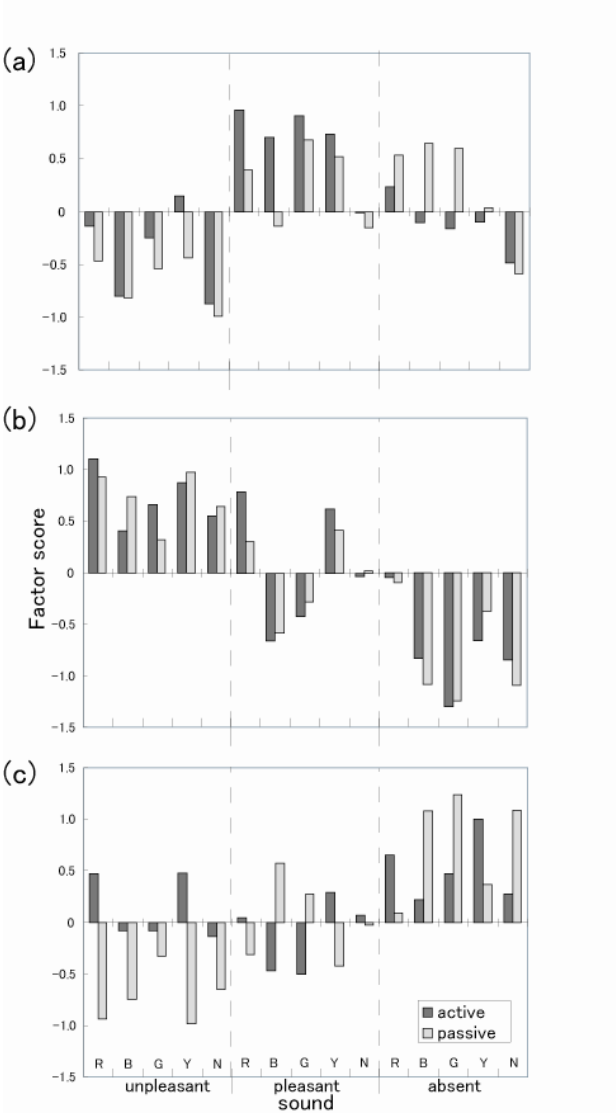

Figure 2: Averages of the factor scores from ten observers. (a) Factor score of the evaluation. Positive values indicate that the impression was rather joyful and like. (b) Factor score of the activity. Positive values indicate that the impression was rather active. (c) Factor score of the potency. Positive values indicate that the impression was rather light.

We conducted a three-way repeated measures analysis of variance for the average of the factor scores

from the ten observers. Factors were the viewing conditions (2), visual stimulus conditions (5) and auditory stimulus conditions (3). We found significant main effects of sound and color on the impressions for the evaluation factor [Fig. 2 (a)]. That is, the main effect of the visual stimulus condition [F (4, 36) =9.231, p < .001] and auditory stimulus condition [F (2, 18) =8.709, p < .005] were significant. In addition, there was a significant interaction of viewing condition and auditory stimulus condition [F (2, 18) = 6.518, p < .01] Post hoc *HSD* tests for the interaction showed that, in the active condition, there were significant differences between the pleasant condition and the other two conditions, and that, in the passive condition, there were significant differences between the unpleasant condition and the other two conditions (p < .05). There was no significant simple main effect of the observing condition in each of the auditory stimulus conditions. We should notice that, in the tone absent condition, the factor scores for each color in the active condition were smaller than those in the passive condition [Fig 2(a)]. In contrast, if either of the pleasant or unpleasant tone was presented, the factor scores for each color in the active condition were the larger than those in the passive condition. These results suggest that the observers' active control of the temporally congruent audio and visual stimuli would enhance the impressions in the dimension of evaluation.

For the activity factor, the main effects of the visual stimulus condition [F (4, 36) =9.996, p < .001] and auditory stimulus condition [F (2, 18) = 44.247, p < .001] were significant [Fig.2 (b)]. In addition, there was a significant interaction of the visual and auditory stimuli conditions [F (8, 72) =2.486, p < .05]. Post hoc *HSD* test for the interaction found significant differences in terms of color of the visual stimulus only in the pleasant and tone absent conditions (p < .05). There were several significant main effects of the auditory stimulus conditions for each visual stimulus conditions (p < .05). For the potency factor, the main effects of the viewing condition [F (1, 9) =25.152, p < .001], visual stimulus condition [F (4, 36) =4.645, p < .001], and auditory stimulus condition [F (2, 18) = 7.585, p < .001] were significant [Fig.2(c)]. We found no significant interaction for this factor. These results imply that the observers' active control of the audio and visual stimuli hardly affects the impressions in the dimensions of activity and potency.

General discussion

Fig. 2 (a) shows that the active control of the visual and auditory stimuli enhanced the pleasantness of the tone. In the active condition, impression from the unpleasant tone could be reduced when it was compared to the impression in the passive observation. However, without tones, the pleasantness in the active observation was less than that in the passive observation. Fig. 2 (b) and (c) shows that the active observation did not affect the impressions related to the factors of activity and potency. These results indicate that active observation has the enhancing effect for the impressions related to the dimension of the evaluation which should include the pleasantness, in particular with auditory stimulus. We are proposing that the temporal congruity in the audio and visual stimulation would be one of the necessary conditions to enhance the impressions in the dimension of evaluation in active observation.

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