Effective visual cue for guiding peoples' attention to important information based on subjective and behavioral measures.

Yuko Masakura, Masayoshi Nagai, and Takatsune Kumada

Institute for Human Science and Biomedical Engineering, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba Central 6, 1-1-1 Higashi, Tsukuba, 305-8566, Japan.
E-mail: yuko.masakura@aist.go.jp

This study examined attentional attractiveness and impressions on visual cues for helping people to focus their attention to important information on a display. Two experiments were performed using behavioral (reaction times for visual search) and subjective (Semantic Differential method) measures. In the first experiment, we found two types of cues effectively reduced reaction times for detecting a target, showing these cues attracted observers' attention. In the second experiment, we found that three factors ('evaluation', 'potency & activity', and 'novelty') affected impressions on visual cues. From the comparison of the results in Experiment 1 and Experiment 2, we discuss the relationship between the attentional attractiveness of visual cues and the impressions on them.

Key words*: Impression, Reaction time, Semantic Differential Method*

Introduction

Recently, IT devices provide rich information with very rapid rate, making harder to access to relevant information while ignoring other information. In order to guide peoples' attention appropriately to relevant information, visual cues are used on such displays. We have started a project to propose a database of effective cues for all observers.

Psychological researches with a visual search task have shown that various types of cues affect on identification and detection of targets (e.g., Nothdurft, 2002). Practically, various types of cues were used in presentation tool like Microsoft's PowerPoint. To our best knowledge, however, the cues are implemented in the software, without any evidence that the cues effectively guide peoples' attention and don't give negative impressions. If cues were not properly selected, such cues might make important information harder to be understood and give negative impressions such as unpleasantness.

The purpose of this study was to find effective cues for guiding peoples' attention to important information on displays without giving them negative impressions. For this purpose, we adopted two approaches: Behavioral measures for the attentional attractiveness of the cues and subjective ('kansei') measures for the impression on the cues. First, we used a visual search task to find effective cues reducing reaction times for a target when the target was presented at the cued region (Experiments 1a & 1b). In the second approach, we examined observers' impressions on the cues using the Semantic Differential method (Experiment 2). Although the first experiment may suggest which cues are effective on guiding peoples' attention, it is possible that such cues may give them negative impressions and thus may not be appropriate for the application to a display in which important information is presented. Therefore, it is important to examine the subjective impressions on the cues as well as attentional attractiveness of them.

Experiments 1a & 1b

First, we used a visual search task to find effective cues which reduced reaction time (RT) for detecting a target.

Method

Different 15 observers took part in each experiment (15 males in Experiment 1a, 12 males and 3 females in

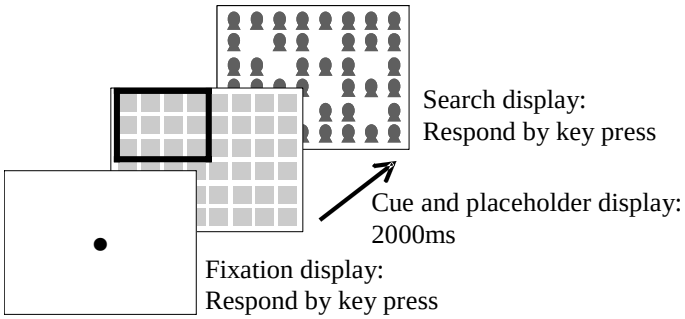

Figure 1. Sequence of stimulus presentation in Experiment 1.

Experiment 1b). 40 pictures of individual face were presented in the matrix of 8×6 on the screen. On each picture, a receiver was hold by either right or left hand. Three cue type conditions were used in each experiment (Figures 2 & 3). In the no cue condition, a square frame surrounding all stimuli was presented. In the flashing, zooming, static, and moving cue conditions, a square frame cueing quadrant was presented. The probability of presenting a cue in each quadrant was equal (25%). The probability of presenting a target face in each quadrant was also equal (25%). Thus, the probability that the target face was presented in the cued area was 25% (valid trial) of all trials, and the one not so was 75% (invalid trial). We did not inform the probability of the cue validity to the observer. Observers were asked to search a known face (his/her friend's face) among unfamiliar faces and press the key corresponding to the side of hand with a receiver.

Results & Discussion

Figures 4 and 5 show the RTs in each experiment (the error bars indicate the standard errors). Based on the RTs in each experiment except for the no cue condition, we conducted two-ways [Cue type condition (2) x Cue validity (2)] repeated measures ANOVAs and Turkey's HSD tests. It was revealed that the RTs were significantly shorter in valid trials than in invalid trials in Experiment 1a [$F(1, 14) = 12.93$, $p < .01$, Figure 4]. In Experiment 1b, however, no significant difference between the cue validities was revealed (Figure 5). Moreover, no significant difference between the cue type conditions was found (Figure 5).

These results indicated the flashing cue and zooming cue to the area were effective on the information processing of target search, but the static cue and moving cue were not effective.

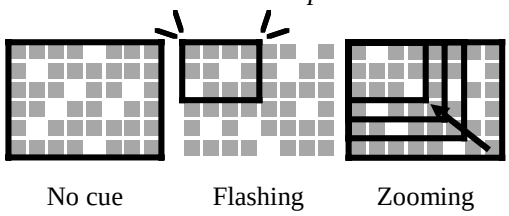

Figure 2. Visual cue conditions used in Experiment 1a. In the no cue condition, a square frame surrounding all stimuli was presented for 2000ms. In the flashing cue condition, a square frame cueing quadrant was presented four times for 250ms at 250ms intervals. In the zooming cue condition, a square frame surrounding all stimuli got smaller every 500ms, and cued quadrant in last 500ms.

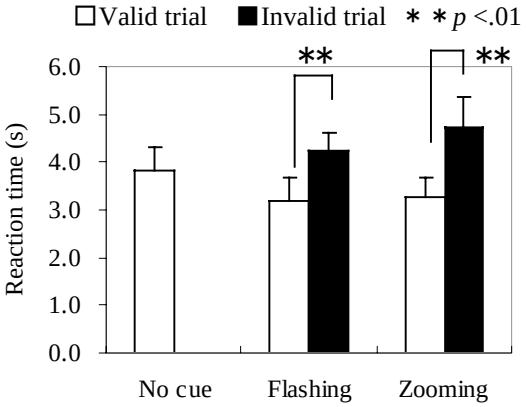

Figure 4. Mean reaction times for the cue conditions on valid and invalid trials in Experiment 1a. The error bars indicate the standard errors.

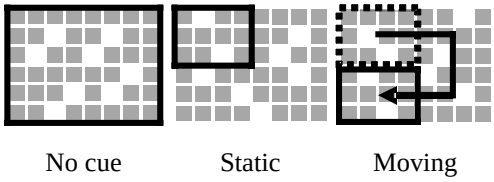

Figure 3. Visual cue conditions used in Experiment 1b. In the no cue condition, a square frame surrounding all stimuli was presented for 2000ms. In the static cue condition, a square frame cueing quadrant was presented for 2000ms. In the moving cue condition, a square frame was presented in each quadrant for 500ms in clockwise order.

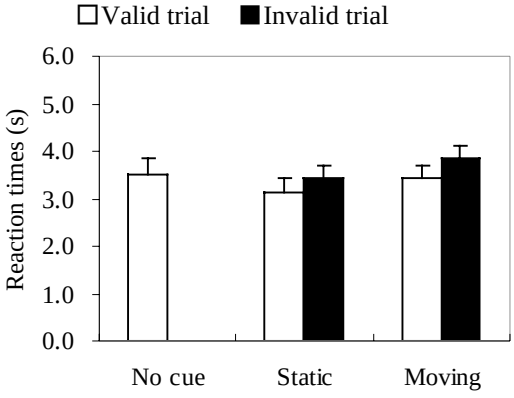

Figure 5. Mean reaction times for the cue conditions on valid and invalid trials in Experiment 1b. The error bars indicate the standard errors.

Experiment 2

In the second approach, we examined observers' impressions on the cues using the Semantic Differential method.

Method

64 observers took part in Experiment 2 (46 males and 18 females). We used 20 different pictures with sentences which described the content of those pictures to be understood. There were 10 cue type conditions: moving, and changing of shape and color (see Figure 7 legends). Each cue was overlaid with two of the pictures. The cue was presented on a critical object described by the sentence. Time sequence of cue presentation was shown in Figure 6. Observers were asked to understand a picture and a sentence on the screen. After the stimulus presentation, observers rated the impression on the cue by using 19 adjective pairs in Japanese (Table 1).

Results & Discussion

Rating data of all the observers were subjected to a principal factor analysis with varimax rotation. We found three factors whose eigenvalues were larger than 1; Table 1 shows the factor loadings of each adjective. The first factor (contribution: 22.9 %) was comprised of the adjectives such as beautiful, pleasantness, and likable, corresponding to the evaluation factor in Osgood, Suci, and Tannenbaum (1957). This factor was named as 'evaluation'. The second factor (contribution: 19.9 %) was comprised of the adjectives such as active, strong, and sharp, corresponding to the potency and activity factors in Osgood et al.. This factor was named as 'potency & activity'. The third factor (contribution: 14.4 %) was comprised of the adjectives such as unusual and new, and named as 'novelty'. Their cumulative contribution was 57.3%.

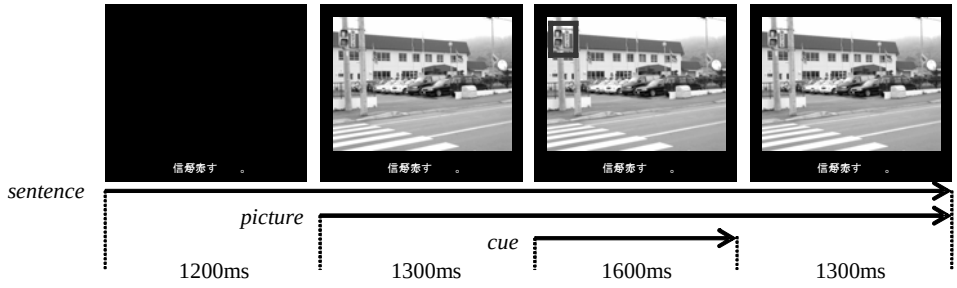

Figure 6. Sequence of stimulus presentation in Experiment 2.

Table 1. Factor loadings of the adjective scales after varimax rotation.

Adjective pairs		Factor 1 evaluation	Factor 2 potency & activity	Factor 3 novelty
beautifle	ugly	0.82	0.12	-0.03
pleasant	unpleasant	0.80	0.16	-0.10
likable	dislikable	0.79	0.27	-0.04
clean	dirty	0.77	0.13	-0.06
natural	unnatural	0.62	-0.01	-0.42
simple	complex	0.58	-0.29	-0.31
stable	unstable	0.55	0.08	-0.42
calm	exitable	0.54	-0.39	-0.32
delicate	rugged	0.54	-0.02	-0.01
active	passive	0.00	0.80	0.20
clear	unckear	0.25	0.76	-0.08
strong	week	0.03	0.75	0.06
attractive	unattractive	0.23	0.70	0.16
ornate	plain	-0.17	0.63	0.44
dinamic	static	-0.18	0.59	0.36
sharp	blunt	0.10	0.57	0.00
unusual	usual	-0.14	0.17	0.83
unknown	known	-0.17	0.04	0.75
new	old	-0.02	0.25	0.72

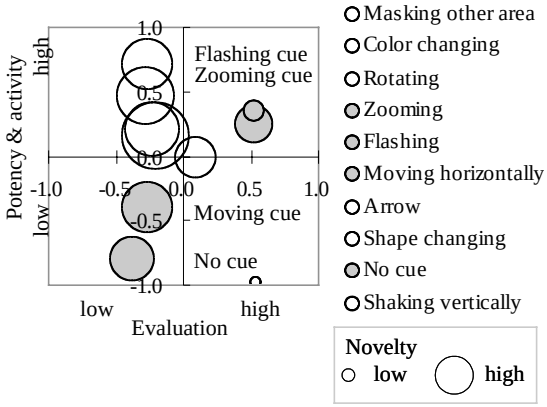

Figure 7. Plotting the cues on the factor space of the impression about the visual cue. Horizontal axis indicates the 'evaluation' factor score, the vertical axis indicates the 'potency & activity' factor score, and disc size indicates the 'novelty' factor score. Gray plots indicate the score of the cues corresponding to the cues used in Experiment 1.

It was shown that the impressions were formed by three factors of ‘evaluation’, ‘potency & activity’, and ‘novelty’. The ‘evaluation’ factor seems to more directly relate to the impression formation about the cue. Therefore, we should consider the ‘evaluation’ factor to avoid negative impressions like feeing of dislike when the cues were applied to the information display.

The ’evaluation’ and ‘potency & activity’ factors seem to relate to the attentional attractiveness. This can be seen in the semantic space about the cue (Figure 7), in which the mean factor scores from 64 observers were plotted for each cue type condition. Gray circles in Figure 7 were plotted by the cues used in Experiment 1. From these plots, we could point out some relationship between the impressions on the cues in this experiment and the attentional attractiveness of the cues in Experiment 1. For the cues that were effective on target search, the ‘evaluation’ factor scores were positive and high and the ‘potency & activity’ factor scores were positive. For the cues that were not effective on target search, both the ‘evaluation’ and ‘potency & activity’ factor scores were negative and low. These indicated the correlation between the effects of reducing RTs on target search and the impressions on the cues.

The ‘novelty’ factor doesn’t seem to relate to the attentional attractiveness. Future examination is required to clarify how the ‘novelty’ factor relates to the attentional attractiveness.

General Discussion

In Experiment 1, we demonstrated that a flashing cue and zooming cue were effective on target search. Applying these cues to displays in which important information was presented expects to guide peoples’ attention to important information. In Experiment 2, we demonstrated that the impressions on cues were formed by three factors of ‘evaluation’, ‘potency & activity’, and ‘novelty’. From the results of ‘evaluation’ factor score, we found the cues for guiding peoples’ attention to important information on displays without giving them negative impressions. The results of Experiment 1 and Experiment 2 suggested that there was relationship between the RTs for visual search and the impressions on the cues.

Now, we have a plan to examine the attentional attractiveness of wider range of cues and impressions on them with the same procedures as this study. These researches would reveal the relationship between the behavioral and subjective measures in more detail. By clarifying the relationship between two measures, we also have a plan to construct a model. The model was intended that subjectively rated scores for some adjectives predict RTs. This enables us to examine various types of cues efficiently by only measuring of subjective impressions on them. Finally, we would propose the database of the cues for effectively and appropriately guiding peoples’ attention to the important information on displays.

References

Nothdurft, H. (2002). Attention shifts to salient targets. *Vision Research*, **42**, 1287–1306.

Osgood, C. E. Suci, G. J. and Tannenbaum, P. H. (1957). *The Measurement of Meaning*. (Urbana, IL: University of Illinois Press).

Acknowledgement

This work was supported by “Assistive technologies to ensure safe and comfortable lifestyles of persons with disabilities”, Special Coordination Funds for Promoting Science and Technology, 2004, from Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.