

## Effects of cue reliability on eye movements in visual search task

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In the usual visual search tasks, participants were required to find the target as soon as they can. If we introduce a cue to inform a location of the target, participants would use this cue when they are appropriately “motivated”. If we change the degree of reliability to inform correct locations, we can easily imagine that decreasing the degree, decreasing the participants’ rate of referring to the cue.

Traditional animal operant research have also considered very similar problems in the area of “observing response” and “selective attention”. Animal subjects emitted observing responses according to their connection to conditioned reinforcement, and showed high response rates to specific features in the stimulus as if they had attend it selectively.

These research were very interesting, but one of the big problems was using conventional operant responses such as lever pressing and key pecking although we want to know observing and attending. There were a couple of studies to utilize eye-movement responses in operant literatures, but they showed only that observing responses could be controlled by some reinforcement schedules. (Berger, 1968; Schroeder and Holland, 1968; Schroeder and Holland, 1969; Frazier and Bitetto, 1969; Rosenberger, 1973 )

Our purposes of this study were:

- 1) We used the eye-tracking recorder to record visual search task directly.
- 2) We also analyzed eye-tracking records to

consider the relationship between the cue reliability and eye-movement responses controlled by the cue.

### Method

#### Participants

Six university students (two males and four females) participated in this experiment. All participants have normal eyesight. Because of the instability of eye tracking data, two females were omitted from further analyses. Average age was 20.75 years old.

#### Apparatus

Participants’ heads were always fixed by a chin rest at 54 cm from the CRT. Using the corneal-reflection eye tracker (Nac Image Technology Co., EMR-8 model ST-560), we recorded x-y coordinates of the gazing points on the CRT screen. Stimuli presented on the CRT were controlled by Visual Basic 6.0 installed in the standard PC, and the experimental situation was always recorded by the video recorder (Fig. 1).

#### Stimuli

All stimuli were presented on the CRT display. One alphabetical lowercase letter (target) and seven uppercase letters (distracters) were presented at even intervals on a circumference on a computer screen. These stimuli were randomly selected on every trial. In some conditions, a small red circle was presented as a cue

just after pushing a starting button on the center of the display.

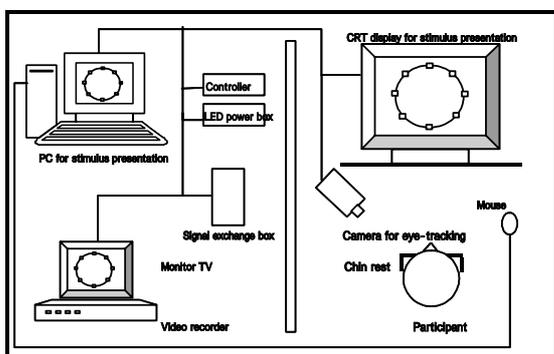


Fig. 1 Diagram of experimental arrangements

Total score was appeared on the upper left corner, and down counter showing the remaining time in the ongoing trial was showed on the upper right corner.

### Procedure

Participants wore an eye-movement detector and were required to point the target with a mouse cursor as quickly as possible. Inside the circumference, there was a cue that pointed the direction of the target with certain reliability. The reliability was changed across the following conditions.

1. **No Cue condition:** Cues were not presented during experiments.
2. **Cue conditions:** Cues were presented according to one of four reliabilities,

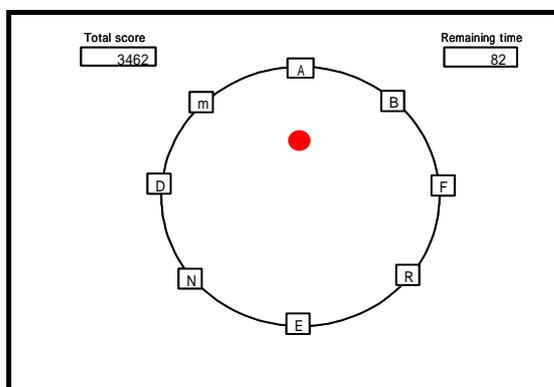


Fig. 2 Screen display in the cue conditions

12.5%(=1/8, using as BL), 33.3%, 50%, 66.6%.

Each condition contained 112 trials.

For evaluating direct effects by cue stimuli, participants experienced No Cue condition at first, then they were exposed Cue conditions. Two participants were exposed the conditions in the ascending order of the reliabilities as follows: No Cue condition BL 33.3% BL 33.3%

BL 50% BL 50% BL 66.7%

BL 66.7%. Remaining two participants were exposed in the descending order. No Cue condition BL 66.7% BL

66.7% BL 50% BL 50% BL

33.3% BL 33.3%.

After the experiments, participants were paid according to their total score.

### Analyses of data

We used the latter half (56 trials) of trials during experiments for comparisons between conditions. We excluded special trials from data analyses if they contained the first gazing responses (corresponding "eye-marks") which were disappeared from the predetermined visual area over 300ms.

The first gazing response was defined as the response whose corresponding eye-mark stayed over 100ms within 75 pixels (ca. 3 cm) in radius from the center of one of eight selected stimuli appeared just after the start button disappeared.

### Results

Figure 3 shows the mean reaction time from pressing the start button located in the center of CRT screen until finding the target stimulus. The mean reaction time in the cue condition (12.5%) was almost same as the time in the no cue condition.

Figure 4 presents the mean reaction time in each cue condition. Except the 33% cue

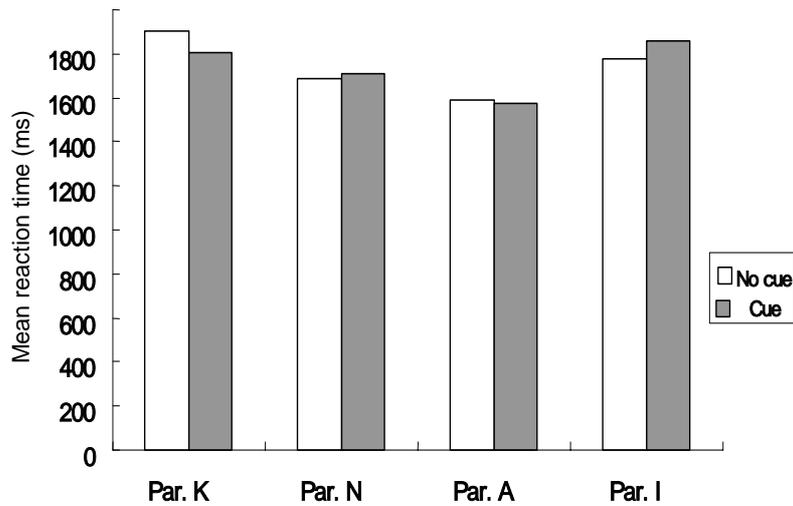


Fig. 3 Differences in reaction time without and with cue

condition for participant N, the reaction time in the 12.5% baseline cue condition was longer than the time in the other cue conditions. This fact suggested that the cues might provide facilitated effects for finding the target stimuli. On the other hand, we couldn't observe any consistent

functional relationships between the degrees of reliability and the mean reaction time.

Figure 5 shows the correlation between cue reliabilities and percentages of the first gazing responses to cued locations. Two participants experienced the ascending

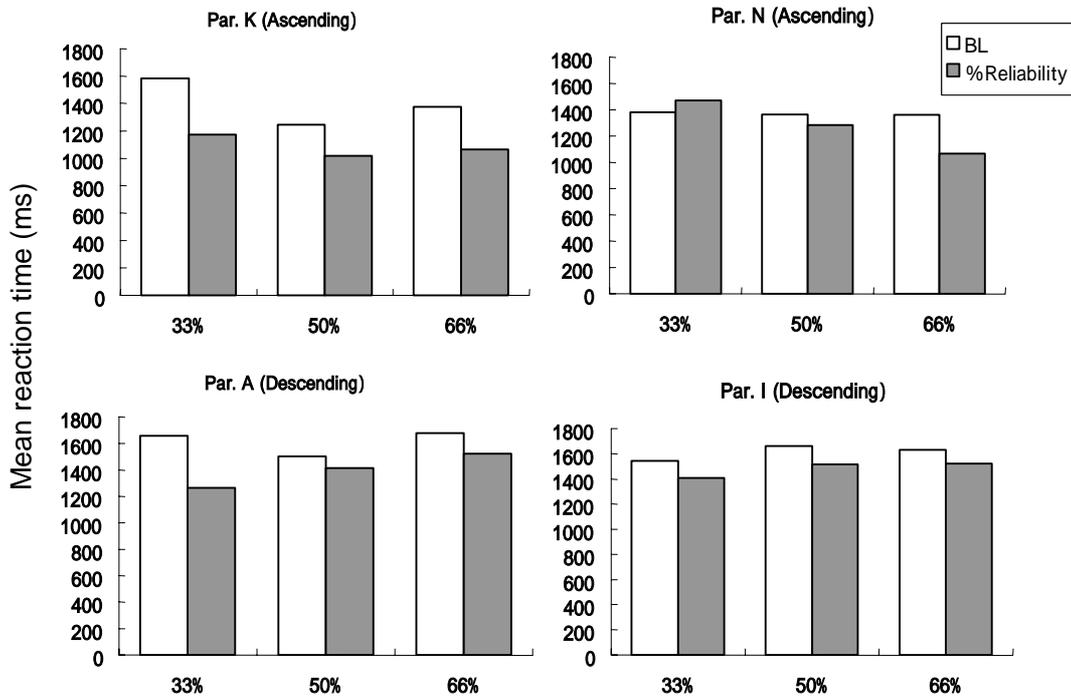


Fig.4 Reaction time as a function of the degree of reliability in Cue condition

order of cue reliabilities indicated a clear increasing function of cue reliability and one participant experienced the descending order indicated weak increasing function. However one participants experienced the descending order showed no functional relationships.

### Discussion

Some evidences that increasing cue reliability made stronger control on eye movements in visual search task were found in participants exposed to the ascending order of cue reliability, but not (or weak) in participants who were experienced in the descending order.

One of the reasons for the historical effect of cue reliability might be attribute to weak sensitivity of an individual to informational value of the stimulus, especially under uncertainty. All participants started from the no cue condition, and then experienced the random cue condition (12.5%) as a baseline. It means that they were exposed to the 'extinction' for more than two hundreds trials. If their sensitivity to informational value might be deteriorated by this extinction, participants in the descending order group could not have the chance to recover from the deterioration during their early stage. We still need to conduct more precise controls and analyses of eye movement to clarify these learning effects.

### References

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(This research was presented at the International Congress of Psychology, Beijing, 2004.)