

## Visual Attention and Illusory Line Motion

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## VISUAL ATTENTION AND ILLUSORY LINE MOTION

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"To attend" is one of the covert behavior, but its effects are difficult to see. Illusory line motion task is one of the tools that shows the work of the visual attention with vivid motion-induction. However, it has not been confirmed whether this task truly reflects the work of visual attention. This point is the aim of present study. The results of some experiments, which 15 college students were participated in, showed that task itself contained several problems. Therefore, I concluded that it was necessary to be circumspect in using Illusory line motion task for investigating visual attention.

**Key words:** visual attention, illusory line motion, motion sensation, voluntary and involuntary shift.

### INTRODUCTION

Illusory line motion (ILM) was the visual motion illusion named by Hikosaka, Miyauchi, and Shimojo (1993a), resemble to polarized gamma motion (Kanizsa, 1951). A line, which was physically presented at once, had motion perception from one side where the attention was shifted by preceding cue. According to Hikosaka et al. (1993a), ILM caused by the attentional system. The attentional spotlight shifted to the cue location and this area was facilitated. The visual information near the attended area was reached at the motion detector faster, and the motion perception occurred.

Using ILM, Hikosaka et al. (1993a) examined the two main aspects of visual attention, involuntary and voluntary attention, and concluded that attentional system required 100 and 400 msec delay for its full effect, involuntary and voluntary, respectively. This time course was almost consistent with the other findings (Muller & Findlay, 1988; Nakayama & Mackeben, 1989). ILM might have a possibility to be a strong tool for studying visual attention, however, before using this technique, it should confirm whether ILM influenced actually by the attentional mechanism. To answer this question was the purpose of present paper.

### METHOD

*Subject:* Fifteen college students (seven male and eight female) were participated in the experiment, and they had normal or corrected-normal vision.

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*Stimulus and apparatus:* Fixation point was disk stimuli ( $0.28 \times 0.28$  deg.). The cue for the involuntary condition was the disk same as fixation point, and the cue for the voluntary condition was a triangle stimulus ( $0.45 \times 0.45$  deg.). These cues were presented at 3.2 degree above and 4.0 degree right/left horizontal from the fixation point. The line related to the task, was presented between the two possible cue positions. AV. tachistoscope (IWATSU ISEL; IS-701A) and the personal computer (NEC PC-9801 RX) was used for experiment.

*Procedure:* Each trial begin with subject's key pressing, and then fixation point was presented 500 msec. The fixation point remained on throughout the trial, and the subject was required to keep fixating it. In the involuntary condition, a disk was presented only on the right or left position, and it was the cue that captured attention. In the voluntary condition, however, the triangles were presented both the right and left position, and they could easily distinguish: the apex of these triangles were different, one had the upside apex (usual triangle) and the other had the downside apex (inverted triangle). The random cue lead time was followed by the line presentation. The task of the subject was to answer which direction motion was perceived over the line (Two-Alternative-Forced-Choice task). Figure 1 showed

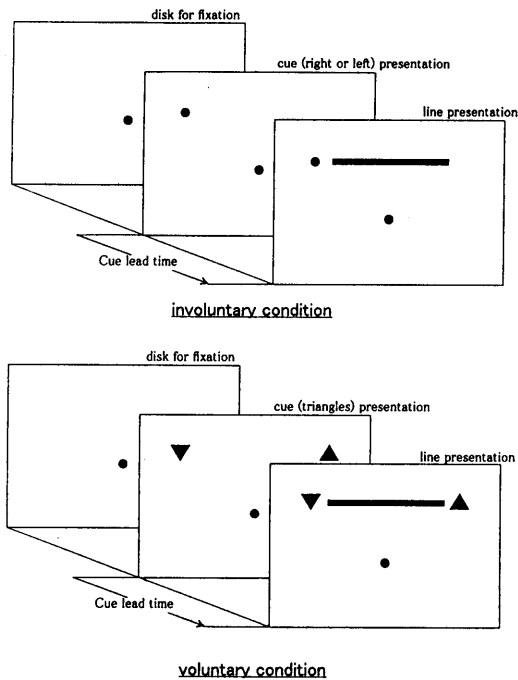


Fig. 1. Stimuli and procedure of the experiment. In the involuntary condition (upper case), figure shows when the cue presented at left position. In both condition, subject judged which side the line seemed to draw, in 2 Alternative Forced Choice.

the stimuli arrangement and the events on a single trial.

The cue lead times were 2, 100, 200, 300, 400, 500, 600, 700, 800, 1000, 2000, 4000 msec in the involuntary condition, 2, 20, 40, 60, 80, 100, 120, 140, 200, 400, 1000, 2000 msec in the voluntary condition. Each cue lead time was tested 10 trials.

The stimuli and the procedure were almost similar to that of Hikosaka et al. (1993a). The only different point between present study and Hikosaka et al. was the stimuli in the voluntary condition: Hikosaka et al. used the color stimuli, green and red, but in this experiment triangle and inverted triangle were used<sup>2</sup>.

## RESULT AND DISCUSSION

Figure 2 was shown the results of this experiments. The result of the involuntary condition gave good agreement with that of Hikosaka et al. (1993a). However, in the voluntary condition, although the probability of illusion was barely higher than the chance level, the result lacked consistency. This result did not coincide with that of Hikosaka, Miyauchi, and Shimojo (1993b). This disagreement was caused by some problem contained ILM task itself.

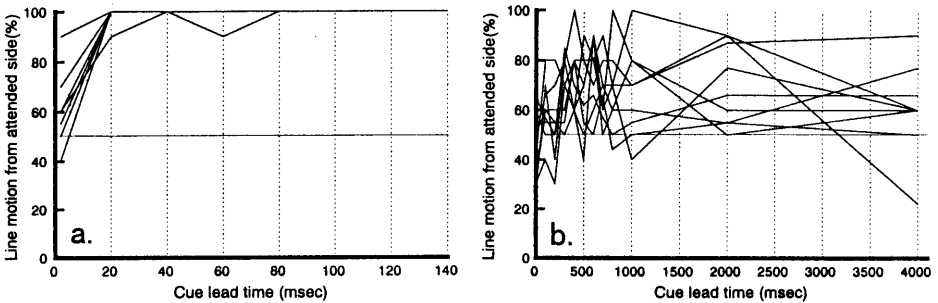


Fig. 2. Percentages of line motion from attended side. Each line shows each subject's personal data.  
 a) Involuntary condition. Most of the subjects perceived apparent motion over the cue lead time 20 msec.  
 b) Voluntary condition. The results showed barely higher than the chance level, but no consistency among subjects was indicated.

### *Differences in processing between involuntary and voluntary task in ILM*

As described above, according to Hikosaka et al. (1993a), attentional system required 100 and 400 msec for its full effect, involuntary and voluntary, respectively, but this conclusion

2. The each pixel of AV tachistoscope used in this study had 1-bit intensity levels, that is, it could not present color stimuli.

was unsound.

In the voluntary condition, subject had to identify which stimulus was the target at first, and then would shift attention to the target location. In the involuntary condition, however, identification was not necessary. I measured the period required for the identification, and the discrimination reaction time for the target became shorter the order, involuntary, voluntary -color-, voluntary -shape- (Fig. 3). This results indicated that the voluntary condition had longer discrimination time, and therefore, the direct comparison of the time 100 and 400 msec was questioned.

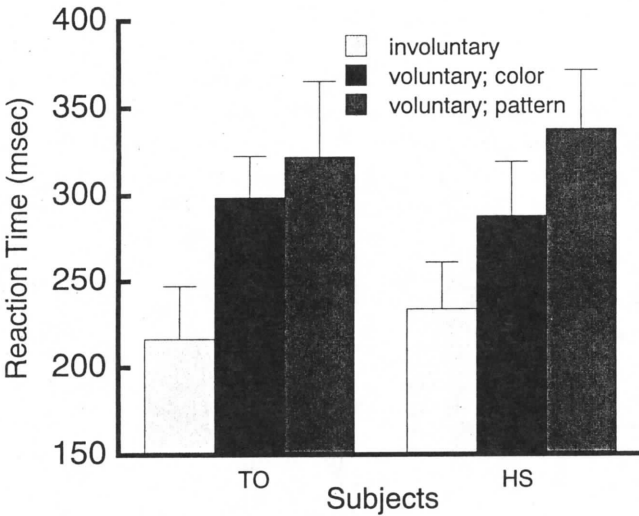


Fig. 3. Reaction time for the target discrimination (choice reaction time). Two subjects (TO; author himself and HS) participated in the experiment. The order of the condition was counter-balanced. The results indicated that voluntary condition had longer discrimination time than involuntary condition. (The vertical line shows the standard error.)

*Necessity of catch trials*

ILM paradigm have another critical problem that no catch trial contains. Most subject also reported that they could estimate the direction of the illusion, in the voluntary condition. To prevent the response biases, the catch trial was necessary for this paradigm. One possible procedure of such catch trials was to give the line physical motion from the opposite side of the attentive stimulus.

*Can visual attention divide into more than two locations?*

Many studies showed that visual attention could not divide into different region (Ericson & Yeh, 1985 ; Posner, Snyder, & Davidson, 1980). However, all subject reported that the line seemed to draw from both sides in the voluntary condition. This introspection indicated both the stimuli could direct visual attention. This phenomenon did not touch on the Hikosaka's study at all, but this was very robust one. If visual attention could not divide, ILM did not reflect the attentional effect, and this must be the fatal problem of ILM.

CONCLUSION

To shift attention was one of the human covert behavior, accordingly it was far from easy to make visibly the effect of visual attention. From this point, ILM was very strong tool, if it caused by the influence of visual attention. However, before using this paradigm for the investigation of visual attention, some problem as mentioned above must be solved.

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