Trade-off in the effect of attention for visual short term memory

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Introduction
Failures of perception such as change blindness (Rensink et al. 1997) provide insights into the nature of visual consciousness. Visual short term memory is an important constituent of visual awareness in its temporal manifestations. Memory of an object to which subjects are exposed tends to be maintained by employing voluntary attention to the memory itself (recall) during the time of retention and results in a better performance in a later recognition task (Griffin and Nobre 2003, Makovski et al. 2008). With an increase in the retention time, there is more failure in recognition. What is the nature of this failure? Is it memory deletion or having false memory? Here we explore this issue by making the subjects orient attention to visual stimuli.

Experiment

Materials and methods
A different subject paradigm was designed to investigate the effect of attention orientation when attention was oriented to visual memory (buttress representation) on objects in visual short term memory (VSTM). Attention was controlled by a predictive symbolic cue which indicates a possible target identity, the outcome of which (valid or invalid) is randomly generated by the computer.

### Results

- **Hit rate of attended objects (VALID response in the valid trial)** decreased significantly when retention intervals were increased (one way ANOVA, p<0.001; between rates with no retention period and 1500 ms retention, Tukey test, p<0.05; between no retention period and 3000 ms retention, Tukey test, p<0.001) whereas the rate of invalid objects (INVALID response in the invalid trial) and of novel objects (NOVEL response in the novel trial) was maintained (p>0.1) (Figure 2 (a)).
- **Comparison of trial types on 0 ms retention interval** by Tukey post hoc test revealed significant differences between the valid and novel trials (p<0.001) and between the invalid and novel trials (p<0.05) (Figure 2 (a)).
- With an increase in failure in recognition for valid objects after longer retention intervals, wrong answers of invalid and novel objects were increased (p<0.001 and p<0.05, respectively)(Figure 2 (b)). Paired t-tests were performed on two types of wrong answers for each retention interval. Only with the interval of 1500 ms, the rate of INVALID response was significantly higher than that of NOVEL response (p<0.05), indicating that the failure in recognition of a valid object may result in having false memory (i.e. of an unattended object) rather than memory deletion at that retention interval. There is also 10%possibility that the data in the valid trial includes false alarms from other trial types. To exclude the mutual effects of trial types, the mere rates of response types were analyzed (Figure 4).
- Although the number of trials was designed asymmetricaly to control for the validity of cues (Table 2), the results shows significantly different tendencies (Figure 4). The rate of VALID response decreased (one way ANOVA, p<0.001; the rate of both INVALID and NOVEL response increased (both p<0.001) when the retention intervals were 1500 ms, the rate of INVALID response was significantly higher than that of both VALID and NOVEL responses (Tukey post hoc test, both p<0.05).

### Conclusions

- When the retention intervals increased, success in the recognition of valid (attend) stimuli decreased while that of unattended or novel stimuli did not.
- This failure in recognition of valid stimuli is possibly due to having false memory.

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References