

Simultaneous and Sequential Presentations for Object Selection and Memory Recall



1. Abstract

Previous Multiple Object Tracking (MOT) results show that the mechanism responsible for selecting and tracking objects does not encode properties of these objects (Pylyshyn, 2004). In contrast, Visual Short Term Memory's (VSTM) main function is to store information about visual percepts. However, in spite of their apparent functional disassociation, these mechanisms must interact at a fundamental level because selection and tracking involve updating some information in real time. In this experiment we show that the process of selecting objects operates with different spatio-temporal constraints than the process of memory encoding in VSTM. This suggests that VSTM does not determine object selection processes.

2. Background

Hung et al. found that simultaneous presentations of digits led to better memory recall performance than brief sequential presentations. In contrast with the Hung et al. finding, we found that brief sequential presentations with the same total exposure lead to better performance in MOT than simultaneous presentations (see chart below), suggesting that the process of selection is not subject to the same temporal constraints as the process of encoding digits into VSTM. But what would happen if the digits were presented in an MOT task? Would the same dissociation be found? That is what we tested in this experiment.



3. Method

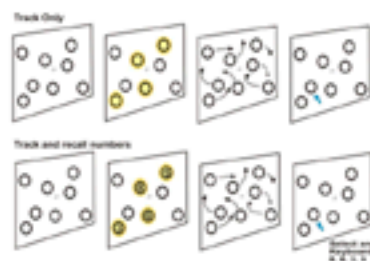
Participants

31 Rutgers University psychology undergraduates participated in this experiment for course credit.

Design

In a typical MOT task, all objects look identical; generally they are equidimensional circles of the same size but a subset are flagged as targets by being flashed on and off. Here, we used the MOT paradigm but the cuing of the targets was done by flashing numerals in the target objects (the numerals were randomly chosen between 1 and 9 and appeared for 18 ms). There were four different cue presentation conditions:

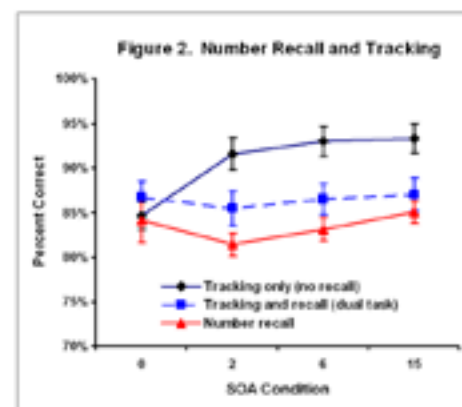
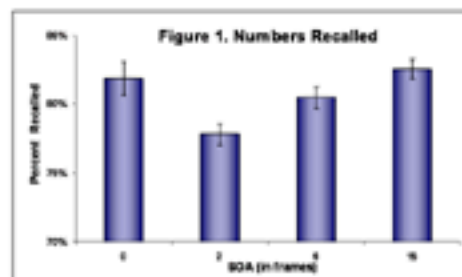
- (1) *Simultaneous cues*, presented in a single 25 ms off-flash of 4 targets;
- (2) *Sequential cues*, presented once on each target with an SOA of 17 ms (2 frames);
- (3) *Sequential cues*, presented once on each target with an SOA of 51 ms (6 frames); and
- (4) *Sequential cues*, presented once on each target with an SOA of 126 ms (15 frames).



In this experiment, we asked subjects to remember the numerals presented inside four of eight identical objects and to track the objects in which the numerals appeared. We analyzed number recall and also object tracking performance at different SOAs. We tested three conditions in which subjects: (1) were required to recall the numerals without tracking; (2) were required to first recall the numerals and then identify the targets (dual recall and tracking condition); and (3) were only required to track the objects without recalling the identity of numerals.

4. Results

We replicated Hung's et al. findings (Figure 1), showing that number recall was significantly better in the simultaneous condition than in the very brief sequential condition. However, this discontinuity in the capacity to recall numerals does not appear in the tracking task, where the simultaneous condition was significantly worse than any sequential condition. Interestingly, cuing targets with numerals improves tracking for the simultaneous condition. The contrast between numeral recall and object tracking condition show that VSTM does not operate in the same way in selecting objects for tracking as it does in number recall.



5. Discussion

Our main finding is that individuation and selection of targets in MOT does not exhibit the discontinuity between simultaneous and sequential presentation that is found in number recall tasks, where recall is better when items are presented simultaneously. This result supports the hypothesis that the selection of objects in MOT is subject to different constraints than those that apply in memory recall tasks. In particular, in selection for MOT, simultaneous presentations produced worse tracking, suggesting that although serial allocation of attention may sometimes be needed for selecting some objects (Pylyshyn & Annan, 2006), it is not required in general for individuation and selection of target objects. These results have implications for the automaticity of selection processes, the independence of selection processes from VSTM, and the properties of VSTM for numerals, object selection, and its relation to subitizing, which has also been reported in the animal literature.

6. Conclusion

VSTM plays a crucial role in limiting the amount of visual information available. The most intuitive way to understand visual selection processes is by appealing to constraints in VSTM that limit the amount of visual items that can be stored at a time. This experiment challenges this intuitive idea, and shows that VSTM influences, but does not determine, the selection of objects in MOT.

7. References

- Montemayor, C., & Pylyshyn, Z. W. (2006). Are items encoded into VSTM when they are selected for tracking in MOT? Explorations with simultaneous and sequential cue presentations. *Journal of Vision*, 6(6) 774.
- Pylyshyn, Z. W. (2004). Some puzzling findings in multiple object tracking: I. Tracking without keeping track of object identities. *Visual Cognition*, 11(7), 801-822.
- Pylyshyn, Z. W., & Annan, V. J. (2006). Dynamics of target selection in multiple object tracking (MOT). *Spatial Vision*, 19(6), 485-504.