Surface features facilitate target recovery after a momentary disappearance during multiple object tracking

Philip C. Ko* & Adriane E. Seiffert

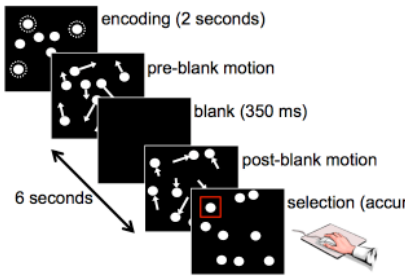
Department of Psychology, Vanderbilt University

*p.ko@vanderbilt.edu

INTRODUCTION

We can perceive multiple objects as the same persisting entities across changes in space and, time as shown by multiple object tracking (**MOT**; Pylyshyn & Storm, 1988). Recent studies have shown that tracked targets can be recovered when they vanish during a temporary blank (Alvarez et al., 2005). **Target recovery** after the blank depends on a process that relates pre- and post-blank information.

GENERAL METHOD FOR THE TARGET RECOVERY (TR) TASK

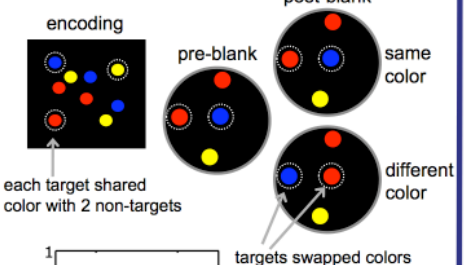


- Participants tracked 3 out of 9 dots.
- The dots moved in a random walk and repulsed each other.
- Blank began at either 1, 2, 3, 4, or 5 seconds after the motion started.
- The dots **paused** or **moved** during the blank.

Is there a role for appearance in Target Recovery (TR)?

EXPERIMENT 1

Q: Does consistent appearance facilitate TR?



- Accuracy was superior when dots paused rather than moved (Keane & Pylyshyn, 2006).
- Consistent appearance across the blank facilitates target recovery, even when location is also consistent across the blank.

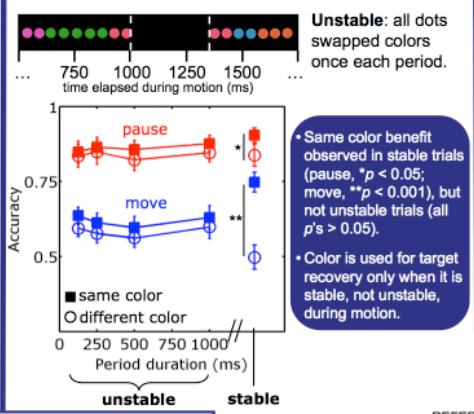
EXPERIMENT 2

Q: Does unstable color impair TR?

The method was similar to Exp 1, but all of the dot colors were **unique** and all dots swapped colors instead of just targets.

Stable: colors were unchanging during motion.

Unstable: all dots swapped colors once each period.



- Same color benefit observed in stable trials (pause, $*p < 0.05$; move, $**p < 0.001$), but not unstable trials (all p's > 0.05).
- Color is used for target recovery only when it is stable, not unstable, during motion.

CONCLUSION

Consistent appearance helps target recovery (EXP 1), but only when the colors are stable during motion (EXP 2).

This work was supported by P30-EY008126

Common or distinct processes?

Is appearance used in MOT? Evidence of color processing in MOT would support the view that MOT and TR are mediated by the same process. In Exp 3 and 4, we included trials without a blank to see how unstable colors affected MOT.

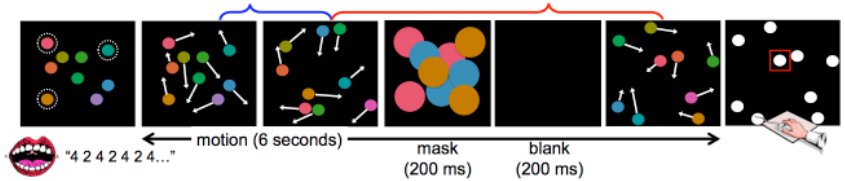
METHOD

stable or **unstable** color during motion

Appearance processing in MOT assessed by varying color consistency during motion in blank absent trials.

same or **different** color across blank

Appearance processing in TR assessed by varying color consistency across the blank in blank present trials.



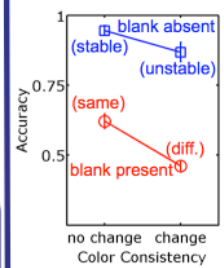
Articulatory suppression was performed concurrently to rule out verbal encoding strategy.

Mask was used to disrupt iconic memory. Mask began at either 1,2,3,4 or 5 seconds after the motion started.

Are MOT and Target Recovery (TR) mediated by a common process?

EXPERIMENT 3

Q: Is color consistency important when tracking without the blank?



- Color consistency is important when the blank is absent, $t(10) = 3.6$, $p < 0.01$, and the blank is present, $t(10) = 5.4$, $p < 0.001$.
- These results support the theory that MOT and target recovery are mediated by a common process.

Earlier research had shown that participants are relatively poor at encoding appearance during MOT (Bahrami, 2003).

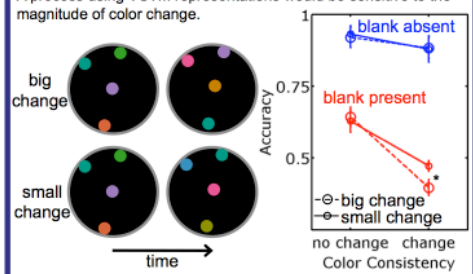
Different methods have shown that appearance helps to distinguish targets from non-targets (Makovski & Jiang, 2009).

The current results also show that appearance is processed in MOT, which supports the theory that MOT and TR are mediated by a common process.

EXPERIMENT 4

Q: How is color used in MOT and TR tasks?

Visual short-term memory (VSTM) facilitates detection of changes within, but not between, categories (Olsson & Poom, 2005). We manipulated category by varying the magnitude of color changes. A process using VSTM representations would be sensitive to the magnitude of color change.



- When the blank is absent, accuracy in change trials does not depend on magnitude of change, $t < 1$. When the blank is present, accuracy in change trials is better with small changes compared to big changes, $t(14) = 2.6$, $*p < 0.05$.
- This suggests that color may be stored in VSTM for TR, but color may be stored with better resolution for MOT.

CONCLUSION

Surface features are used in both MOT and TR, suggesting a common process behind both tasks (EXP 3). However, surface features in MOT and TR are represented differently (EXP 4).

REFERENCES

Alvarez et al. (2005) *J Exp Psychol Perform Percept, 31*(4), 643-67.
Bahrami B (2003) *Vis Cogn, 10*(8), 949-963.
Keane BP, Pylyshyn ZW (2006) *Cognitive Psychol* 52, 346-368.
Makovski T, Jiang Y (2009) *Vis Cogn, 17(1,2)*, 180-194.
Olsson H, Poom L (2005) *Proc Natl Acad Sci USA, 102*(24), 8776-8780.
Pylyshyn ZW, Storm RW (1988) *Spatial Vision, 3*, 1-19.