

Introduction

How are distractors processed when people keep track of multiple targets moving among identical objects?

Multifocal theory of attention: Distractors are not processed during tracking because they do not receive foci of attention (Cavanagh & Alvarez, 2005).

Probabilistic assignment model: Distractors receive the same level of processing as targets. Location and velocity information are used to predict the future locations of all objects (Vul, et al., 2009).

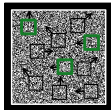
Previous research has not examined whether the features of distractors are processed during tracking.

Purpose

We examined whether distractor motion is processed during multiple object tracking.

General Methods

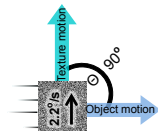
Multiple Object Tracking Task



Targets were cued with green boxes. Ten 1° squares moved for 6.7 sec. Squares moved linearly in random directions, only changing direction when they hit the bounds of the tracking area. Squares were only visible by their motion during the tracking interval.

Tracking accuracy was measured as the mean proportion of targets correctly selected.

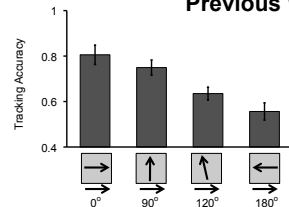
Texture Motion



Texture inside the squares moved relative to the object's direction of motion.

Θ = direction of the texture motion relative to the object motion

Previous Work



Tracking accuracy decreased as the direction of the texture motion deviated further from the object direction (St.Clair, Huff & Seiffert, 2010), suggesting motion is used during tracking.

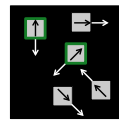
If distractor motion is used during tracking, we expect to find an effect of distractor texture motion on tracking accuracy.

Experiment 1

Does distractor motion affect tracking accuracy?

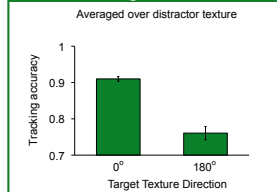
Methods

The direction of texture motion was manipulated independently for targets and distractors. Textures moved at 2x the object speed in the same direction as the object (0°) or the opposite direction of the object (180°). Objects speed was 1°/sec.



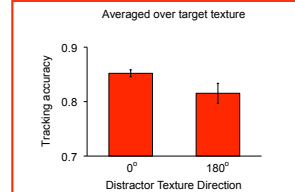
Target Texture Direction	Distractor Texture Direction	
	0°	180°
0°	0° / 0°	0° / 180°
180°	180° / 0°	180° / 180°

Is there a target texture effect?



YES. Tracking accuracy was higher when distractors had 0° texture than when targets had 180° texture, $t(14) = 7.93, p < .05$.

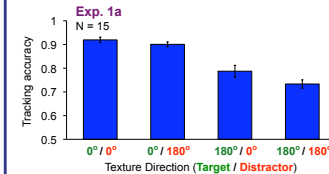
Is there a distractor texture effect?



YES. Tracking accuracy was higher when distractors had 180° texture than when distractors had 0° texture, $t(14) = 2.25, p < .05$. The texture effect was smaller for distractors than targets, $F(1,14) = 13.14, p < .05$.

Yes. Tracking is impaired when distractors have conflicting texture motion.

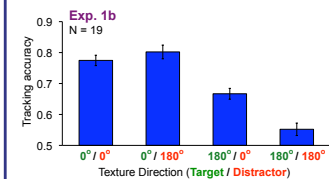
Does the distractor texture effect differ between target texture conditions?



Tracking accuracy was only affected by distractor texture when targets had 180° texture $t(14) = 2.19, p < .05$.

Tracking accuracy was not affected by distractor texture when targets had 0° texture $t(14) = 1.04, ns$. The null result may have been caused by ceiling performance when targets had 0° texture.

In Exp. 1b, the task was made more difficult by increasing object speed to 2.5°/sec.



Results were the same as Exp. 1a.

Tracking accuracy was only affected by distractor texture when targets had 180° texture $t(18) = 7.09, p < .05$.

Tracking accuracy was not affected by distractor texture when targets had 0° texture, $t(18) = 1.52, ns$.

Yes. Texture motion may have been used to distinguish targets from distractors.

Experiment 2

Does distractor motion affect tracking accuracy when targets and distractors always have different texture motion?

Methods

Squares moved at 2.5°/sec. Texture motion could always be used to distinguish targets from distractors. Six conditions were presented in random order.

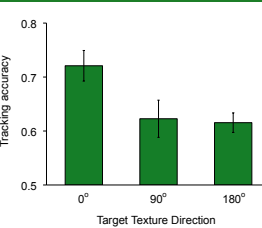
Texture Conditions

Targets	Distractors
0° 90° 180°	270° 270° 270°
270° 270° 270°	0° 90° 180°

Target texture changed across conditions but distractor texture did not.

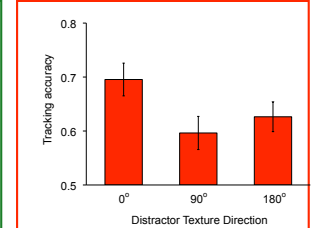
Distractor texture changed across conditions but target texture did not.

Is there a target texture effect?



Yes. Tracking was affected by target texture direction, $F(2,20) = 9.15, p < .05$. Tracking accuracy was higher when targets had 0° texture than when targets had 90° texture, $t(10) = 3.12, p < .05$, or 180° texture, $t(10) = 4.46, p < .05$.

Is there a distractor texture effect?



Yes. Tracking was affected by distractor texture direction, $F(2,20) = 14.30, p < .05$. Tracking accuracy was higher when distractors had 0° texture than when distractors had 90° texture, $t(10) = 7.12, p < .05$, or 180° texture, $t(10) = 3.54, p < .05$.

Yes. Conflicting texture motion impairs tracking even when texture motion can always be used to distinguish targets from distractors.

Discussion

Tracking is impaired when the texture motion on distractors conflicts with the object motion, suggesting distractor motion is used during tracking.

Previous research has shown targets are enhanced relative to distractors during tracking using a probe detection task (Drew, et al., 2009; Flombaum, et al., Pylshyn, 2006). Previous work did not reveal the extent to which distractor features are processed during tracking.

Our work provides the first demonstration that distractor features, such as motion, are processed during multiple object tracking.

References

- Cavanagh, P., & Alvarez, G. A. (2005). *Trends in Cognitive Sciences*, 9(7), 349-354.
 Drew, T., McCollough, A. W., Horowitz, T. S., & Vogel, E. K. (2009). *Psychonomic Bulletin & Review*, 16(2), 411-417.
 Flombaum, J. I., Scholl, B. J., & Pylshyn, Z. W. (2008). *Cognition*, 107(3), 904-931.
 Pylshyn, Z. W. (2006). *Visual Cognition*, 14(2), 175-198.
 St.Clair, R., Huff, M., & Seiffert, A. E. (2010). *Journal of Vision*, 10(4), 1-13.
 Vul, E., Frank, M. C., Tenenbaum, J. B., & Alvarez, G. A. (2009). *NIPS* (pp. 1955-1963).