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FASTER IS NOT NECESSARILY BETTER IN VISUAL SEARCH

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The Question

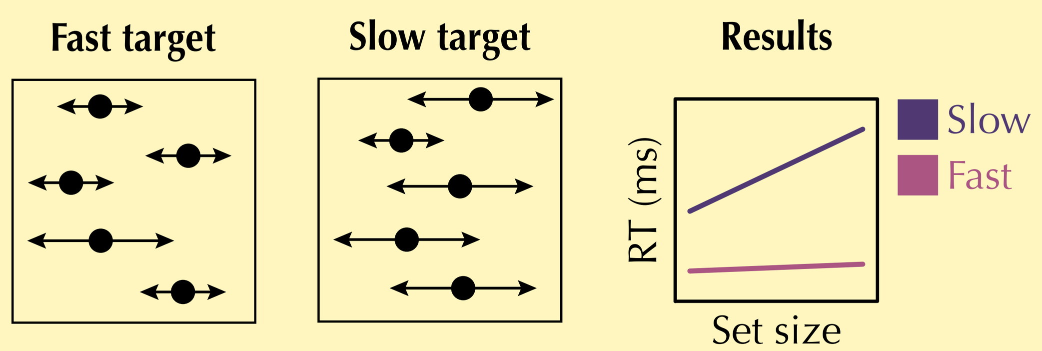
How does the visual system detect differences in speed of motion?

Is detection based on:

1. signed velocity differences (e.g., efficient detection of fast motion, but not slow motion)?
2. absolute velocity differences (all speeds are equal)?

An Answer

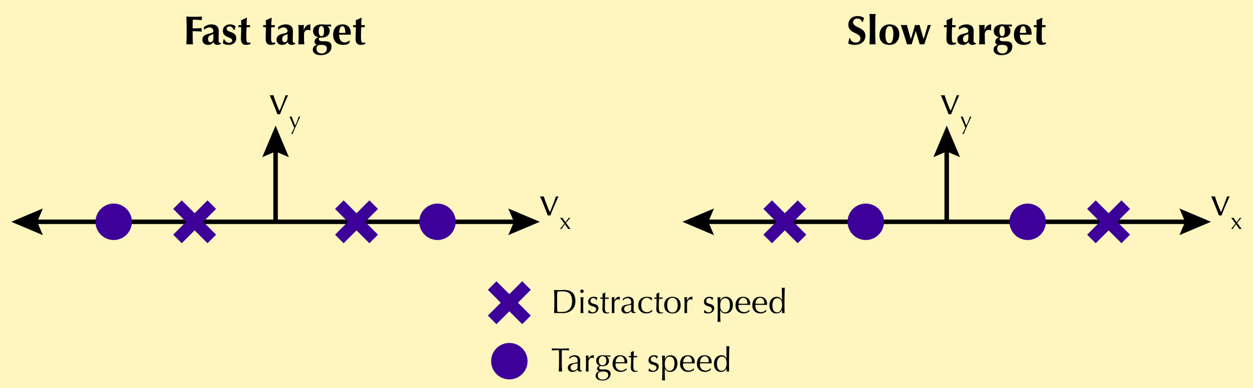
Ivry & Cohen (1992): observers searched among oscillating dots for a fast-moving target among slower-moving distractors, or vice versa.



From this search asymmetry, Ivry & Cohen inferred an asymmetry in the visual system: preferential detection of fast motion.

But...

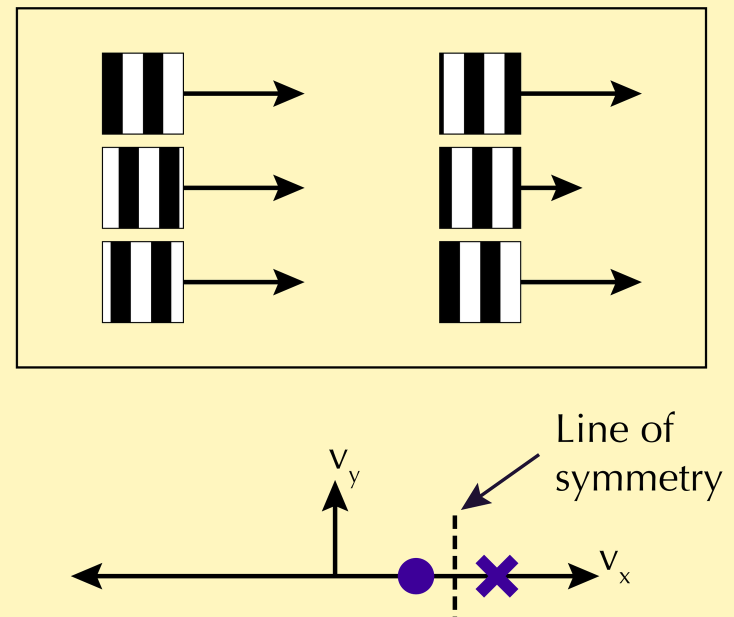
Rosenholtz (1999, 2001) plotted Ivry & Cohen's stimuli in 2-D velocity space, revealing a potential asymmetry in the design.



There is no symmetric transformation between the stimuli in the fast-target condition and the stimuli in the slow-target condition.

Symmetric vs. Asymmetric Designs

We designed stimuli with which we could construct search displays that were either symmetric or asymmetric in velocity space. Instead of moving dots, we employed drifting square-wave gratings. Each stimulus could either oscillate or move continuously in a single direction within a window.



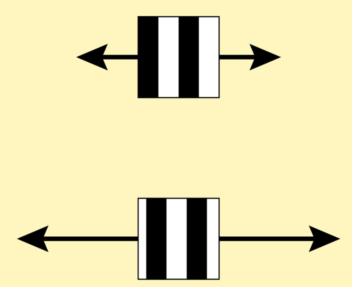
General Method

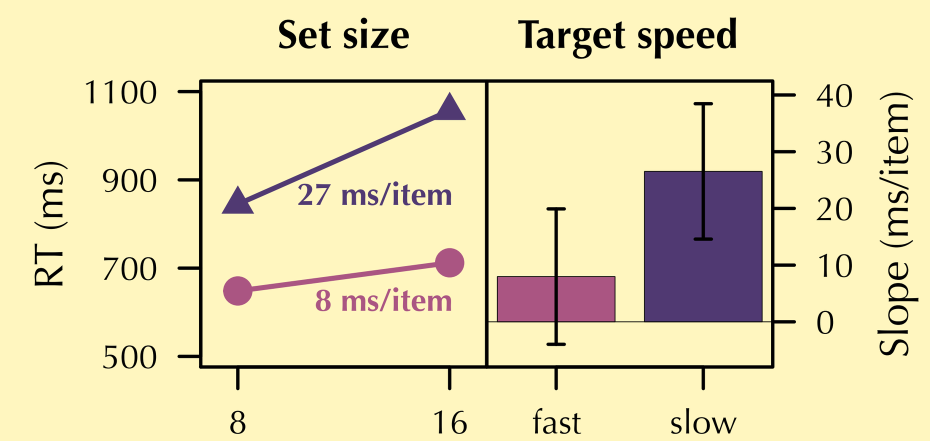
Observers searched for either a fast target among slow distractors, or a slow target among fast distractors. Gratings moved at 1.25 (slow) or 2.50 (fast) degrees per second. Each grating was presented within a fixed square window measuring 1 degree on each side. There were 8 or 16 stimuli, arranged in a circle, on each trial. One target was present on 50% of the trials, and no targets were present on the remaining trials. Target speed was blocked.

Experiments

1

Oscillating motion: Replicated Ivry & Cohen's (1992) design with our stimuli.

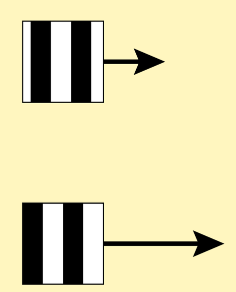


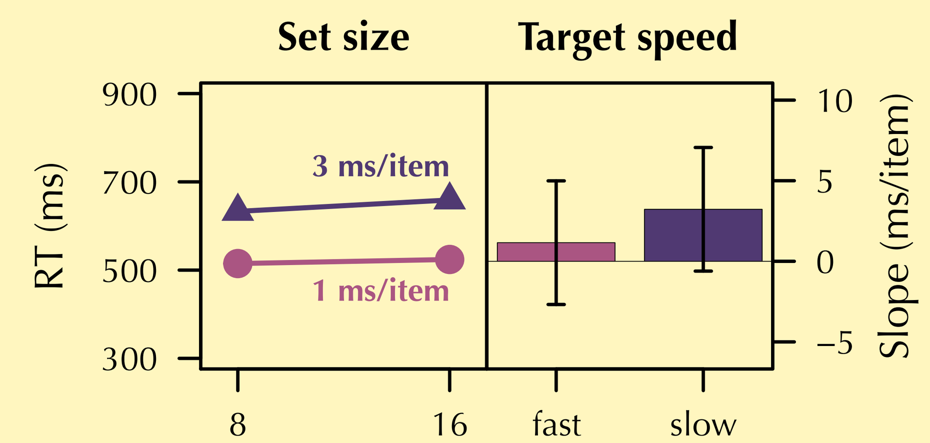


ASYMMETRIC DESIGN → ASYMMETRIC RESULTS

2

Unidirectional motion: Compared search for fast and slow targets using a symmetric design.

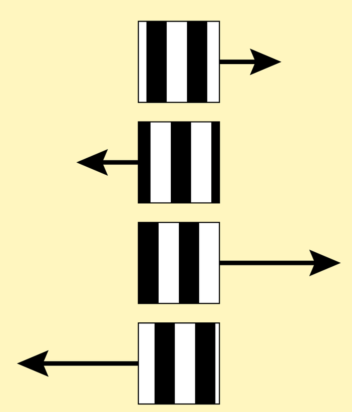


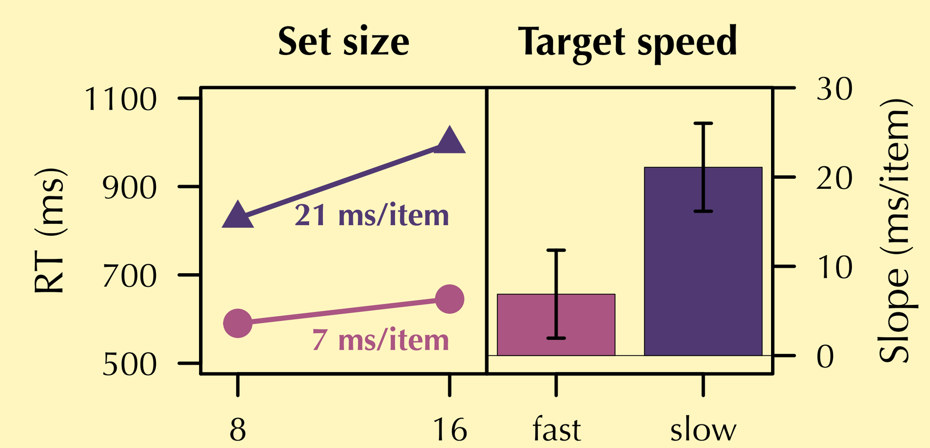


SYMMETRIC DESIGN → SYMMETRIC RESULTS

3

Bidirectional motion: each stimulus moved in a single direction, but both directions were present in every search display.





ASYMMETRIC DESIGN → ASYMMETRIC RESULTS

Conclusions

The visual system appears to detect absolute velocity differences, rather than signed differences.

Symmetric designs lead to symmetric search results.

Our findings contradict Ivry & Cohen's (1992) conclusions, and support Rosenholtz's (1999, 2001) saliency model.

What's Next?

Could the symmetric results be a ceiling effect? We will test this by increasing the similarity between fast and slow stimuli.

Previous studies reveal a search asymmetry between moving and static stimuli (Dick, Ullman, & Sagi, 1987), but this too may be an asymmetric design. What happens with a symmetric version?

References

Dick, M., Ullman, S., & Sagi, D. (1987). Parallel and serial processes in motion detection. *Science, 237*, 400–402.

Ivry, R. B., & Cohen, A. (1992). Asymmetry in visual search for targets defined by differences in movement speed. *Journal of Experimental Psychology: Human Perception and Performance, 18(4)*, 1045–1057.

Rosenholtz, R. (1999). A simple saliency model predicts a number of motion popout phenomena. *Vision Research, 39*, 3157–3163.

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