



Surface Segregation and the Time-Course of Feature-Binding

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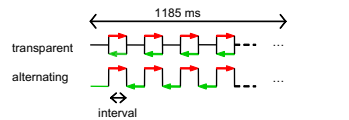
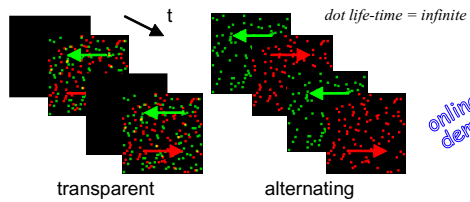
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Background

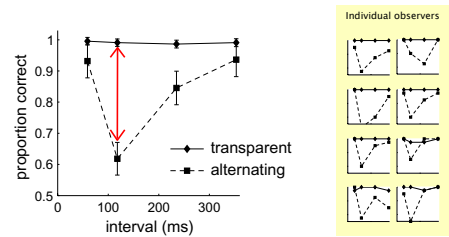
Color and motion are registered in distinct brain regions. **Functional separation could impose a constraint on how fast these attributes are combined into a unified percept** (e.g., *color and motion can be processed with different latencies*¹). It is also suggested that **temporal synchrony can facilitate binding**.

We measured the temporal resolution of color-motion binding by presenting two alternating random dot patterns (red moving left vs. green moving right). Observers were asked to pair color and direction of motion.

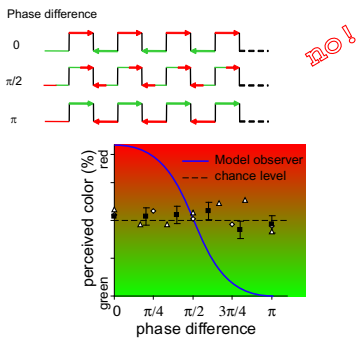
How fast is binding?



"What direction are the red dots moving?"



Neural latency difference?



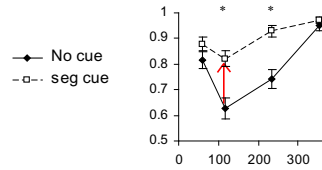
Presenting motion before or after color (to compensate differences in latencies) does not improve pairing performance.

Experiment 1

Experiment 2

Experiment 3

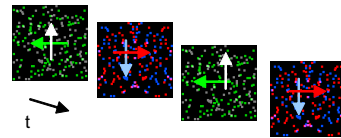
Transparency facilitates binding



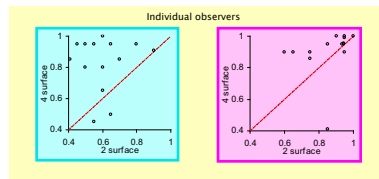
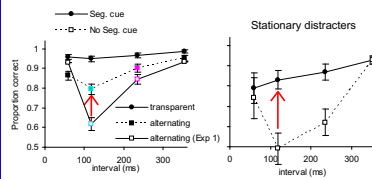
Transparency was introduced in the alternating condition by having 5% of the dots on each surface remain on the screen during the whole trial.

To prevent those dots to be used for binding, they were gray.

Implicit segregation facilitates binding



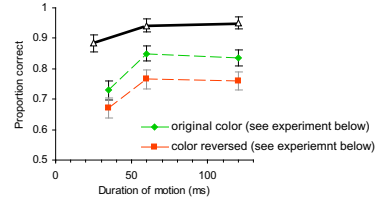
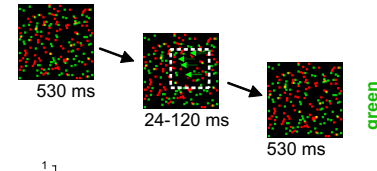
Adding irrelevant transparency cues can facilitate binding by providing additional segregation/grouping constraints. Pairing improves despite increased stimulus complexity. However, transparency by itself (superimposing a fixed surface over alternating stimuli) has little effect. Therefore, **binding is affected by surface segregation rather than transparency itself**.



Experiment 4

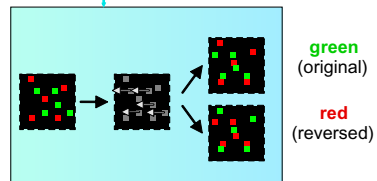
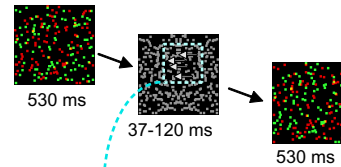
online demo

Segregation is pre-attentive ...

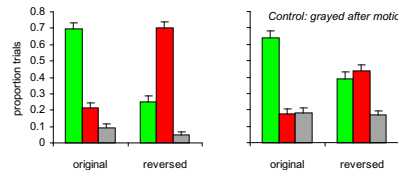


Observers were asked to report the direction and color of the moving dots (empty triangles). The location of the target was not known before each trial. **Top-down attention presumably requires more than 24 ms to shift to the target surface.**

and precedes feature-binding



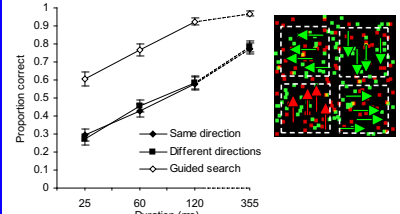
"What color are the moving dots?"



The data suggest that the perceived color of the brief motion display depends on the color of the dots before motion onset, during motion, and **mostly after the motion offset**.

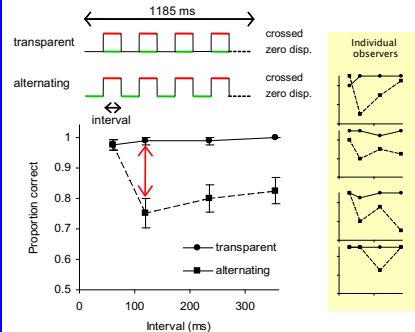
Experiment 5

Visual Search



Observers were asked to report which quadrant contains the odd color. In the guided search task observers were asked to report the color of the odd motion direction. Performance increased with time, consistent with a serial search strategy.

Depth transparency and color-disparity binding



Results of Experiment 1 can not be explained based on first order (color, disparity) and second order (motion) temporal markers⁴.

- 1- Motion- and depth- transparency provide surface segregation cues that facilitate binding.
- 2 - Temporal cues can be used for binding (only for long intervals).
- 3 - attributes are integrated over time. Segregation resets integration.
- 4 - Perceptual asynchrony in binding can be post-dictive^{2,3}.
- 5 - attention is needed to register surface attributes.

Experiment 6

Experiment 7

Summary Ref.

1 Moutoussis K, Zeki S (1997) Proc R Soc Lond B 264, 393-9
 2 Sheth BR, Nijhawan R, Shimojo S (2000) Nat Neurosci 5, 489-95
 3 Eagleman DM, Sejnowski TJ (2000) Science 287, 2036-8
 4 Nishida S, Johnston A (2002) Curr Biol 12, 359-68