Is Opacity A Basic Feature? It's Not Transparent.

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Adapted from Moraglia (1989a). Display organization and the detection of horizontal line segments. *Perception and Psychophysics, 45, 265-272.*

Adapted from Ramachandran, V.S. (1988). Perception of shape from shading, *Nature, 331, 163-165.*

You spotted the oddballs above right away, didn't you? At left is a target whose **ORIENTATION** markedly contrasts with that of its neighbors. At right, **SHADING,** reveals the presence of a bump among holes. Both are on a short list of **BASIC FEATURES** that, among other things, support efficient visual search. Do either transparency or opacity, surface properties like shading, yield efficient visual search and thereby warrant consideration as a basic feature?

TRANSPARENT   OPAQUE

General Method & some notes about the data:
Os were asked to fixate and respond quickly and accurately. Stimuli remained on screen until a response was made. Graphs represent correct target present trials. All error rates < 10% unless otherwise noted.

Exp. 1: Does an opaque object stick out among transparent objects and/or vice versa in a static display?

N = 10

A screen shot of the stimuli.
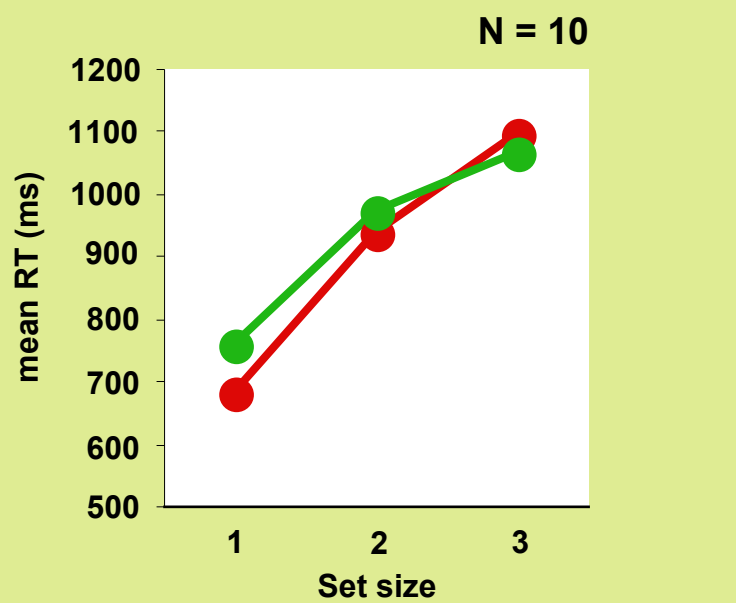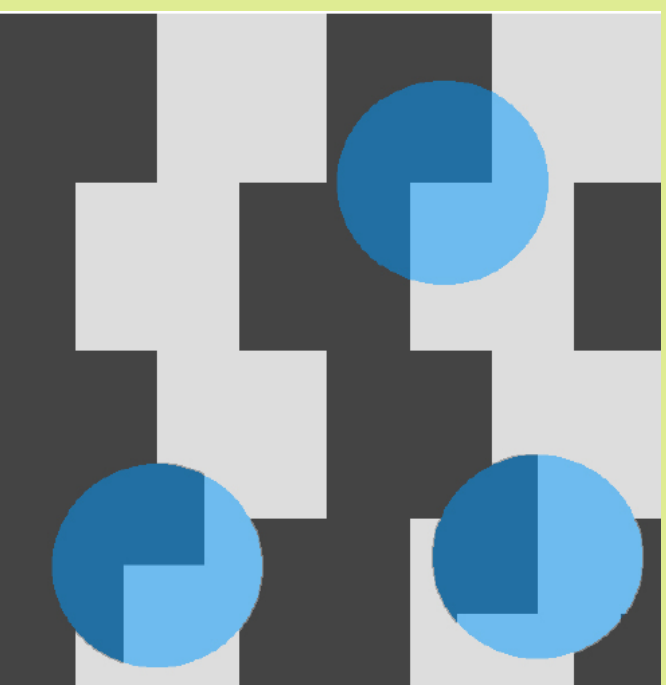
Op vs. Trans (slope = 154 ms/item)
Trans vs. Op (slope = 209 ms/item)

Results:
No, search was inefficient, though less so for opaque targets. Why? Perhaps motion will help...

Exp. 2: Does a moving opaque object stick out among similarly moving transparent objects and/or vice versa?

N = 11
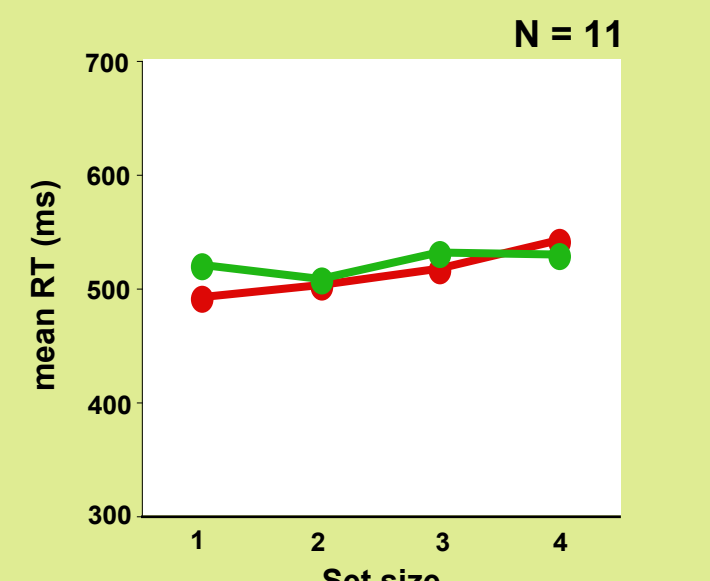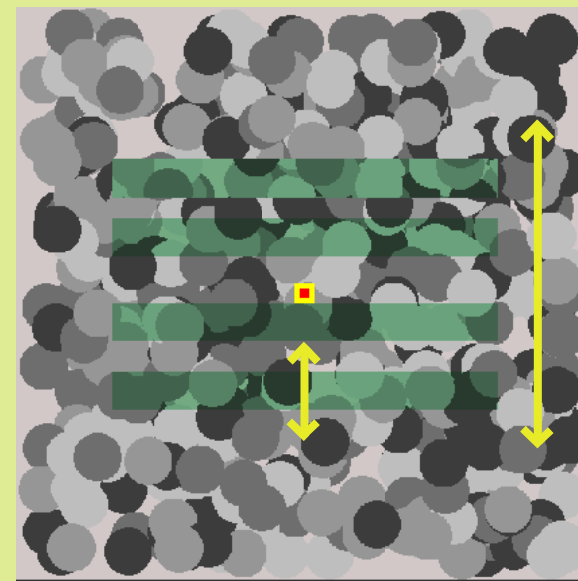
Stimuli:
Transparent bars were created by moving a virtual green filter over the background texture. Opaque bars were "cut " from a filtered portion of the same texture and then moved over the background.
All bars moved sinusoidally. Each individual bar moved with a higher frequency "wobble".
Set sizes:1, 2,3, or 4 bars.

Op vs. Trans (slope = 5 ms/item)
Trans vs. Op (slope = 17 ms/item)

Results:
Yes! Search for a moving opaque bar was quite efficient. Transparency search bordered on inefficiency.

### Would background motion disrupt search efficiency?
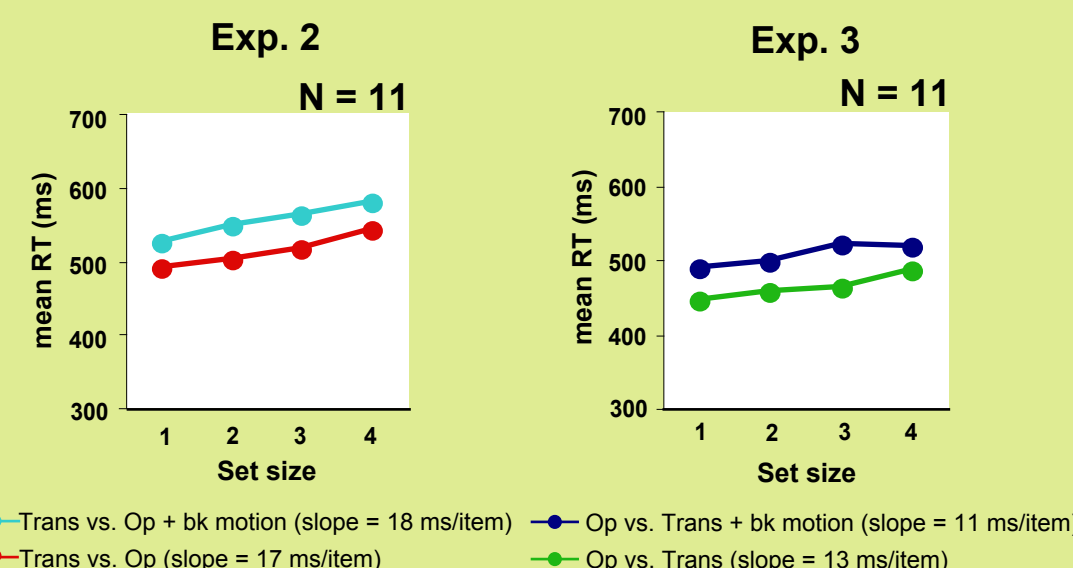
Stimuli:
The background was given a two-dimensional, periodic motion consisting of a 2 Hz oscillation along the vertical (amplitude = 30 pixels) and 3 Hz oscillation along the horizontal (amplitude = 20 pixels).

Results:
No, search efficiency was preserved.

Exp. 2   N = 11
Exp. 3   N = 11

Trans vs. Op + bk motion (slope = 18 ms/item)
Trans vs. Op (slope = 17 ms/item)
Op vs. Trans + bk motion (slope = 11 ms/item)
Op vs. Trans (slope = 13 ms/item)

Were Os using the low-level motion cues inside the bars?

Exp. 3: Same motion, invalid transparency

Stimuli:
Stimuli were sampled from an alternate background that consisted of the same dot locations, but uncorrelated colors and luminances.
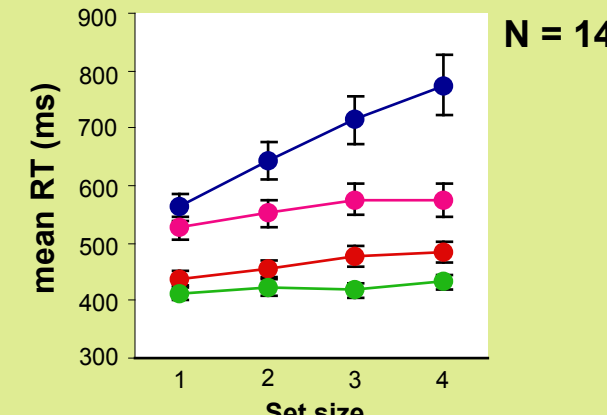
N = 11
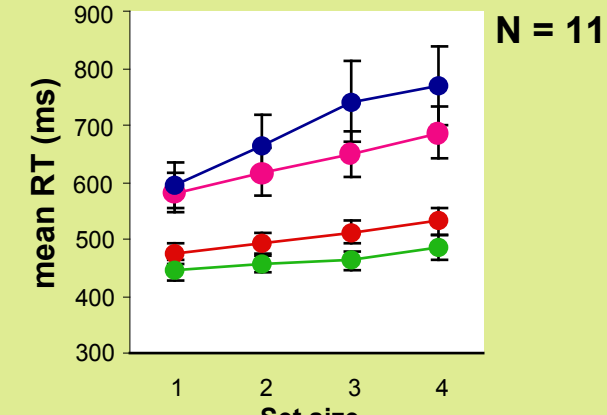
Trans vs. Op (slope = 18 ms/item)
Op vs. Trans (slope = 13 ms/item)
Bogus Trans vs. Bogus Op (slope = 35 ms/item)
Bogus Op vs. Bogus Trans (slope = 60 ms/item)

Exp. 4: Only motion, no background

Stimuli:
The background was hidden except that portion viewable through the moving transparent bars.

N = 14

Trans vs. Op (slope = 16 ms/item)
Op vs. Trans (slope = 5 ms/item)
Trans vs. Op no background (slope = 17 ms/item)
Op vs. Trans no background (slope = 71 ms/item, errors = 12%)

Results: Efficient search for opacity is not based on motion within the bars.

Exp. 5: What happens if we use a frame to create T-junctions in the transparent case?
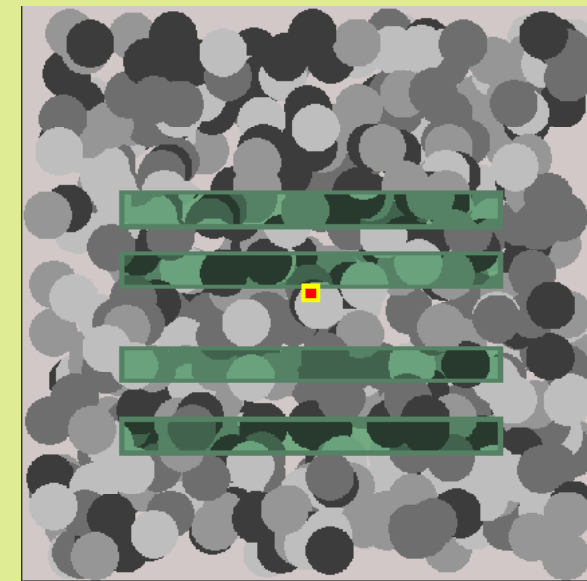
Stimuli:
Add frames around bars.

Some T-junctions that suggest occlusion of the background.

N = 15

Trans vs. Op (slope = 16 ms/item)
Op vs. Trans (slope = 9 ms/item)
Trans vs. Op + frame (slope = 20 ms/item)
Op vs. Trans + frame (slope = 12 ms/item)
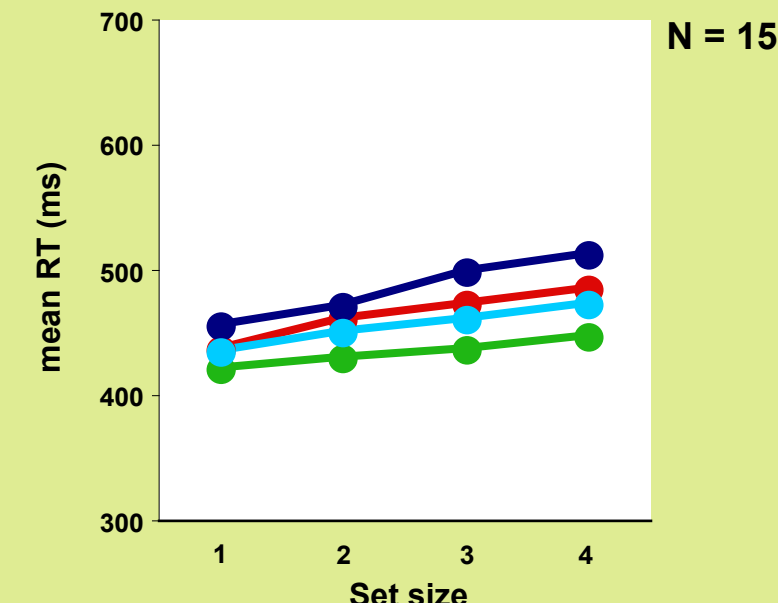
Results:
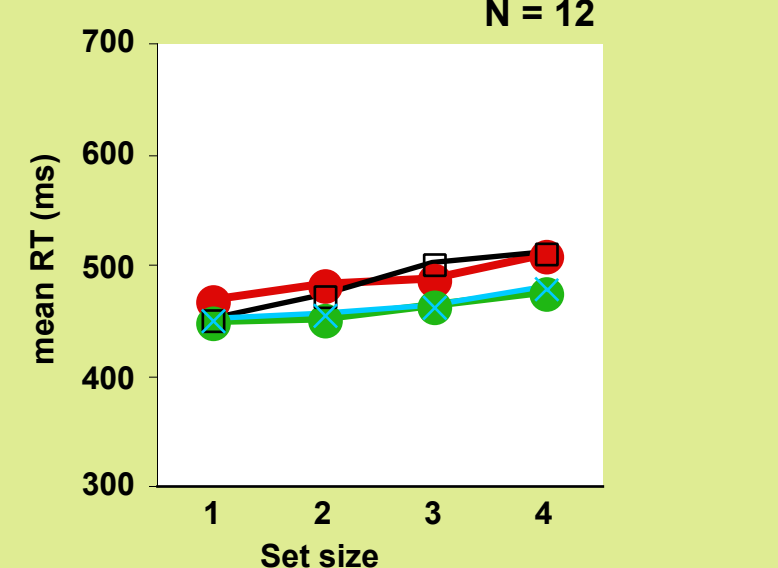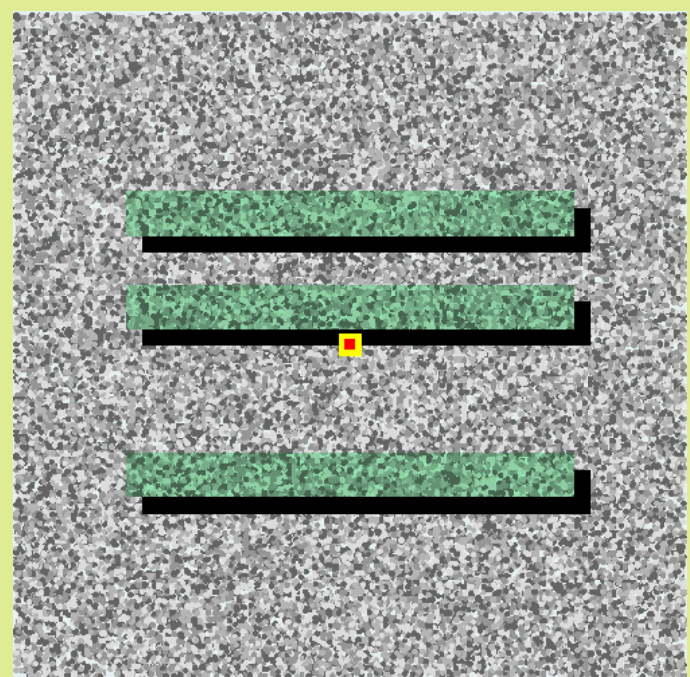The frame made no difference.

Exp. 6: Maybe observers completed contours under the frame?

N = 11
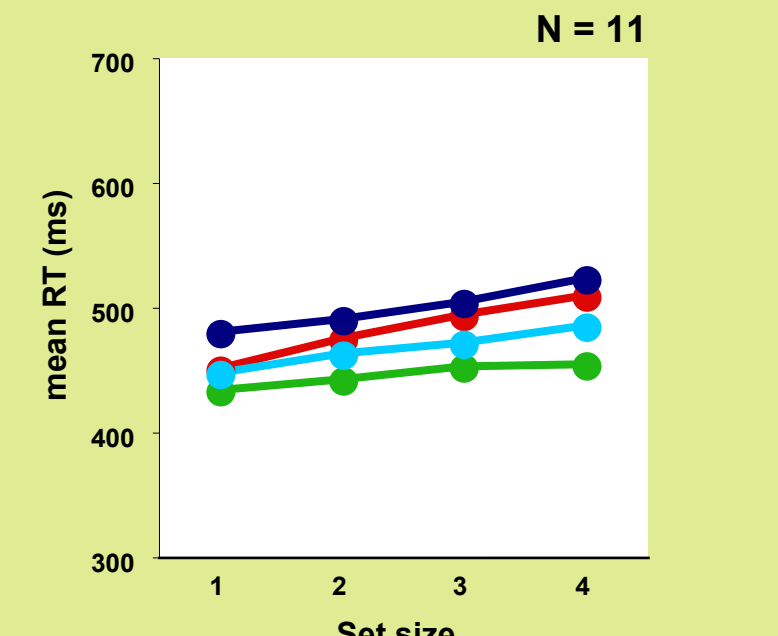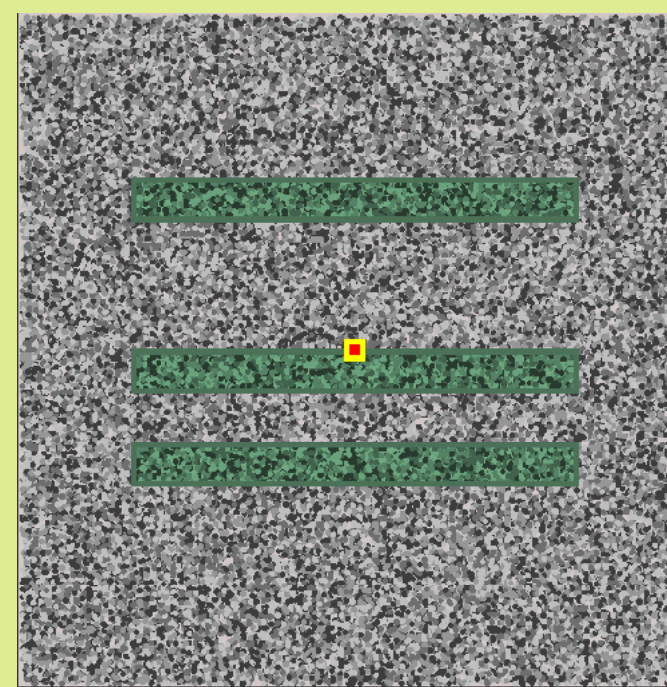
Stimuli:
Texture of tiny dots (equal to frame width) to eliminate dot contours straddling the object boundary.

Trans vs. Op (slope = 20 ms/item)
Op vs. Trans (slope = 7 ms/item)
Trans vs. Op + frame (slope = 14 ms/item)
Op vs. Trans + frame (slope = 12 ms/item)

Results:
No, search efficiency wasn't disrupted.

Exp. 7: How will an occluded shadow affect search efficiency?

An occluded shadow implies an occluding object. If both transparent and opaque objects have occluded shadows, does search for opacity become inefficient?

N = 12

Trans vs. Op (slope = 13 ms/item)
Op vs. Trans (slope = 9 ms/item)
Trans vs. Op + shadow (slope = 21 ms/item)
Op vs. Trans + shadow (slope = 9 ms/item)

Results:
Search for opacity was unaffected, suggesting that the shadow cue did not make the transparent bar opaque.

Exp. 8: What if you look at the background through a bar-shaped hole in the filter?

N = 14
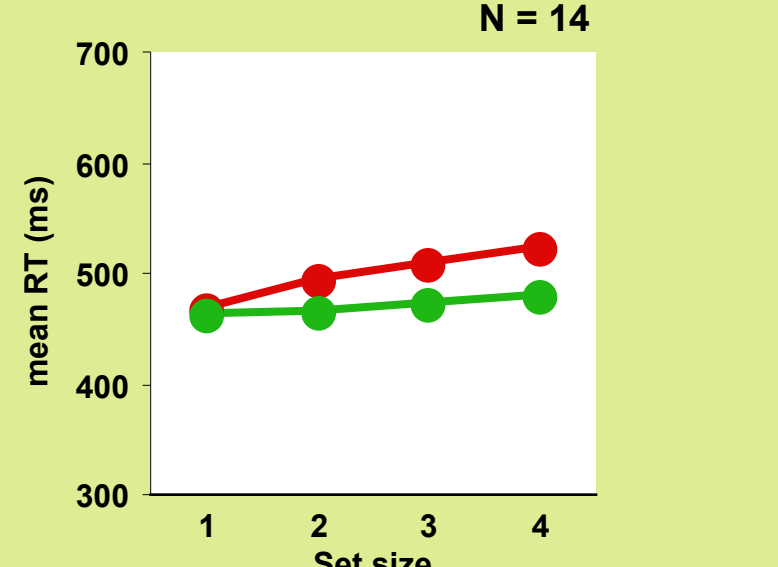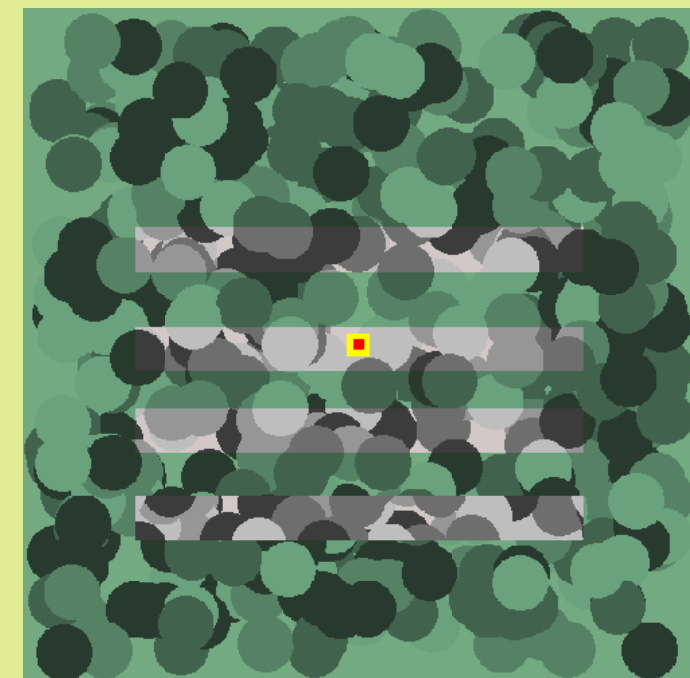
Stimuli:
The entire background of dots was passed through the green filter. "Transparent" stimuli consisted of moving windows that permitted a view of the unfiltered background. Opaque stimuli consisted of a piece of unfiltered background moving in front of the filtered texture.

Window vs. Op (slope = 18 ms/item)
Op vs. Window (slope = 6 ms/item)

Results:
Search efficiency was comparable to that found in Exp. 2.

Conclusions

1.) Opaque objects can be found efficiently among otherwise identical transparent objects.

2) Transparent objects are NOT found efficiently among opaque objects.

3) This asymmetry between search for the presence and absence of opacity is consistent with "basic feature" status for opacity.

4.) "Opacity" cannot be described as an artifact of motion of textures within objects (Exp. 3 & 4)), T-junctions at object edges (Exp. 5), or completion of background contours within transparent objects (Exp. 6).

comments
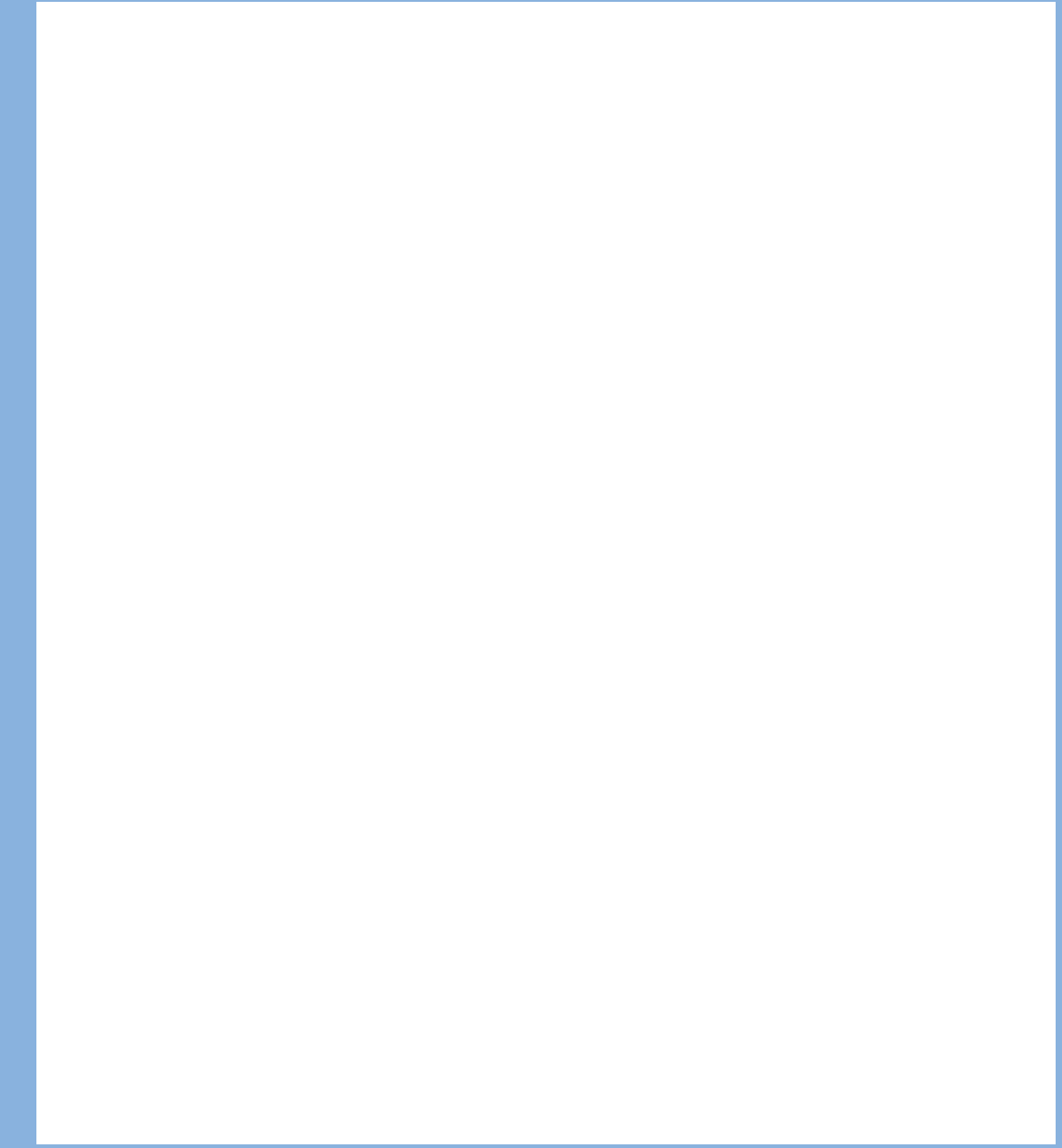
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