False Pop-Out in an Odd Quadrant Visual Search Task

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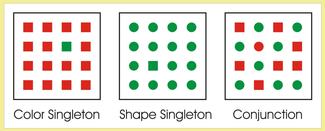
Introduction

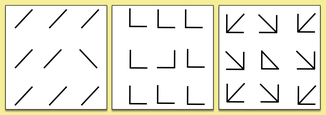
Traditional pop-out with basic features

- Basic feature discrimination produces pop-out.
- Conjunction search is inefficient, taking more time.



But groupings/conjunctions can still retain salient features

- Certain conjunctions can be as easily discriminated as black is from white.



Grouping/conjunctions can sometimes give way to incorrect discriminations: False Pop-Out (FPO)

Pop Out

A B A

VS

False Pop Out

/ \ /

> < >

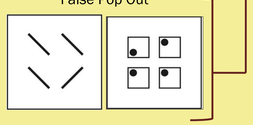
- A single item pops out from an array of items, but the item that pops out is not the odd one.
- These kinds of stimuli/ displays cause weird response distributions – one wrong quadrant holds most of the error.

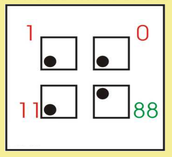
Pop Out

X O
X X

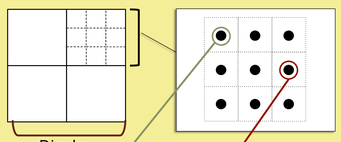
VS

False Pop Out



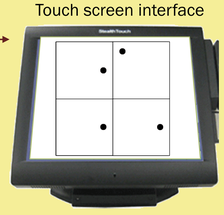


Design & Methods



- 17 participants instructed to touch the quadrant with the "odd" or "different" stimulus.
  - 2sec. display time (max)
  - ISI (fixation) = 750msec
  - No feedback given.
  - Participant comments collected.

Touch screen interface

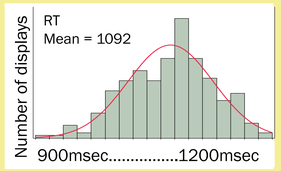


- 4 blocks:
  - All displays 1x per block

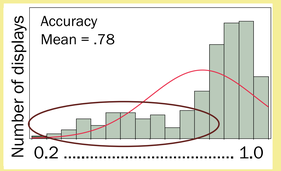
- Total of 9 X 8 = 72 dot pairs
  - 72 X 4 quadrants = 288 displays

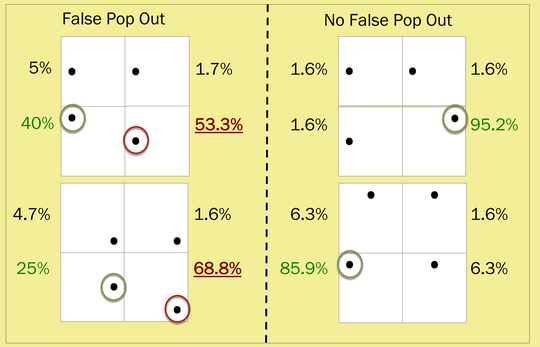
Results

Display Data



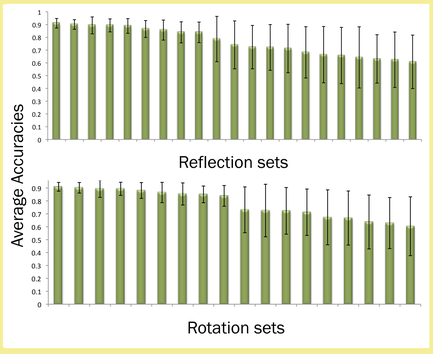
Frequency distributions of RTs (above) and accuracies (below) for all displays. Displays with the lowest accuracies (circled below) should contain FPO.





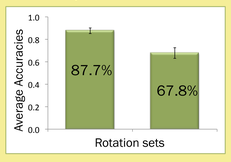
- More dramatic error distributions with no feedback: an error quadrant would sometimes receive more responses than the correct quadrant.
- To avoid dealing with 288 different displays, displays were grouped into rotation and reflection sets, where many/most configural relationships were invariant.

Reflections and Rotations



$p < .001$

$p < .001$



- Two separate patterns of performance can be seen in both reflection and rotation sets, with the same percentage point difference in accuracies.
- Need to understand *why* this happened – what makes some displays harder?

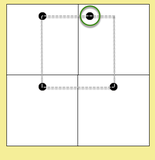
Participant feedback

- "I tried to visualize a box with 3 dots that were aligned in a L shape"
- "I tried to make a square of the dots, and the one that didn't fit was odd."

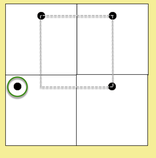
The "Square"

- The odd dot always fell either on the border of, or inside/outside of the "square" implied by three dots forming an isosceles right triangle.

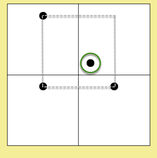
Border



Outside



Inside

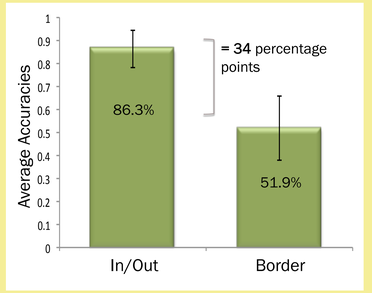


Further Analyses

Prediction with the square

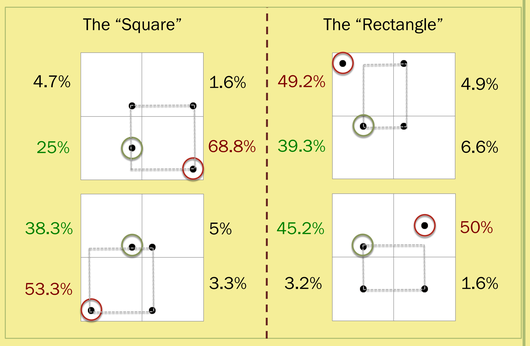
- If all displays in a reflection/rotation set were in/out, it was one of the easy sets (see set accuracies on the left).
- If any displays in a reflection/rotation set were border displays, it was one of the hard sets.
- The visual system looks for order and symmetry, so perhaps a 'best-fitting' square is found: if the odd dot falls on the border of this square, it is not clearly symmetry breaking, so the display becomes harder.

$R^2 = .70$



The "Square" vs the "Rectangle"

- The square helps predict which displays are more difficult, but does not explain why the error "clumps" onto one *wrong* quadrant. That's a job for...the "rectangle"!
- When the square cannot be used to resolve the display, the rectangle can, and the "clump" of error falls on the dot that 'busticates' the rectangle.



Conclusions

- The data support the idea that groupings/conjunctions of features can be more salient than the basic features themselves.
- False Pop-Out in this paradigm is attributable to the grouping of elements in a display across quadrants.
  - When a stimulus 'busticates' (i.e., falls clearly inside or outside of) the formation of an implied "square", the display is resolved correctly.
  - If the odd stimulus is seen as 'busticating' the competing "rectangle", False Pop-Out occurs.
- We speculate that future research will reveal that the general principle underlying False Pop-Out is one of symmetry breaking or pattern breaking in a stimulus.

References

- Pomerantz, J. R. & Portillo, M. C. (in press). Grouping and Emergent Features in Vision: Toward a Theory of Basic Gestalts. Journal of Experimental Psychology: Human Perception and Performance.
- Pomerantz, J. R., & Portillo, M. C. (2004). False Pop-Out. Paper presented at the Annual Meeting of the Psychonomic Society.
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- Wolfe, J. M., & Horowitz, T. S. (2004). What attributes guide the deployment of visual attention and how do they do it? Nature Reviews: Neuroscience, 5, 1-7.