



The grouping of contours into an L-Vertex depends on contrast polarity: Evidence for the incorporation of image statistics into mechanisms of perceptual grouping



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Background

L & T vertices

L vertices are produced when two contours coterminate, i.e., end together at the same point. An L vertex provides strong evidence for the termination of a surface. Thus the two squares are interpreted as separate surfaces rather than as a single surface.

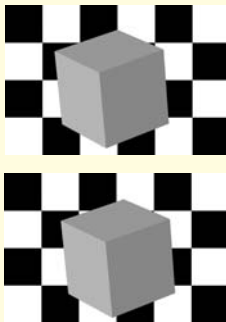


Matched **T vertices**, in contrast, promote smooth continuation of two surfaces into a single surface as in the figure below.



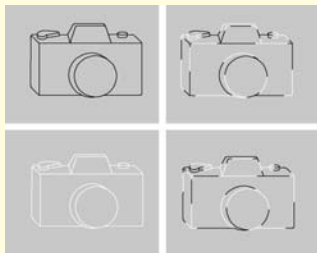
Contrast Polarity

Whereas an extended edge boundary of an object will often undergo a change in contrast polarity with respect to the background, as illustrated with the cubes against the checkerboard, being sometimes lighter and sometimes darker than the background, it will be rare for a change in contrast polarity to occur right at the termination point of an L-vertex. We have produced one with the topmost L of the top cube.



The neural connectivity that subserves perceptual grouping of shape is generally believed to be activity dependent, determined by the **statistics of images**.

Consistent with image statistics, the grouping of segments into a single smooth contour is unaffected by variations in contrast polarity of the segments, as demonstrated by Subramaniam (1998) with stimuli such as those shown below. The objects with segments of alternating polarity were no more difficult to identify than those of uniform contrast polarity.

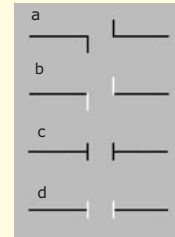


Problem

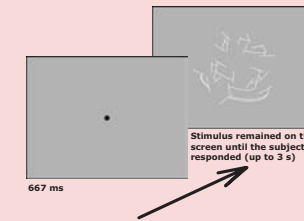
Will an L-vertex lose its effectiveness at signalling the termination of a surface when its segments are of different contrast polarity?

L-Vertices: When the segments of an L are of the same contrast polarity (the common condition) as in a, the legs should group into an L, providing evidence for the end of a surface. If the Ls straddled gaps in the contour of an object, they should interfere with the bridging of the gap and object identification should suffer. If the segments of an L are of different polarity (a rarity) then bridging should be more successful, as in b.

T junctions: Because changes of contrast between the top and stem of a T junction are common, little effect would be expected from a change in the direction of contrast for such junctions so c and d should be near equivalent with successful bridging.



Task: Object Naming



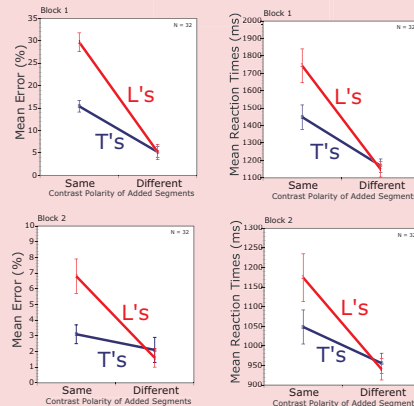
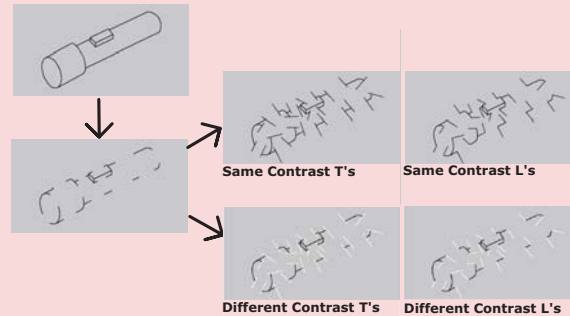
Results and Conclusions

The statistics of images predicts the effects of variations in contrast polarity of junctions on perceptual grouping.

1. Grouping of the segments of an L-vertex is contrast dependent: When the segments were of different contrast polarity, the L was not effective in suppressing smooth continuation across a gap.

2. Performance with L-vertices of different contrast polarity approached that of T-junctions, which were largely independent of contrast polarity.

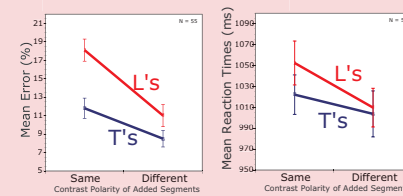
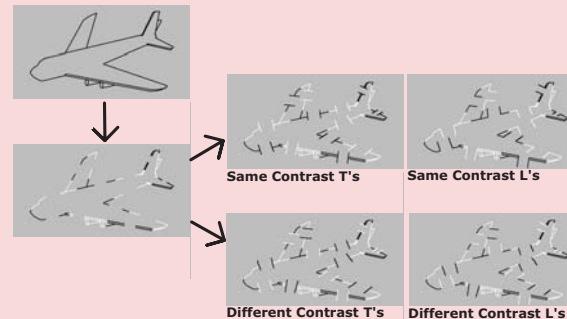
Experiment 1



Greater interference for L's with segments of the same contrast.

Experiment 2

Could this effect be simply the result of a 'global' color separation? No.



The interference observed for same contrast L's in Experiment 1 is not an effect of global color separation.

A neural prediction:

Pasupathy & Connor (1999) have shown that about 12% of the cells in macaque V4 can be strongly driven by L-vertices.

Our results would suggest that these cells should show reduced firing when the legs of an L-vertex are of opposite contrast polarity.

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Acknowledgments

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