Perceptual segregation of center and surround does not yield independent processing
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Introduction

We have previously reported that center-surround stimuli produce a symmetric masking effect (our round means center but not vice versa) when maskers are introduced between the center and surround.

Methods

Stimuli and Apparatus

• Viewsonic Professional PS75 17-inch monitor connected to Dell Dimensions XPS R450

• Custom graphics software

• Spatial Resolution: 2 pixels/mm

• Mean luminance: 19.3 cd/m²

• Stimuli were 40-min patches of 4-cpd gratings with annular, in-phase 4-cpd gratings surrounding 40-min width. A gap of 4 minutes (mean luminance) was introduced between center and surround.

• Four stimuli were intermingled in each session. Both center (c) and surround (s) contained a discrimination cue (right or left of vertical for orientation judgments; lower or higher frequency for spatial frequency judgments).

• Orientation: R, Rs, L, Ls, H, Hs, C

• Spatial Frequency: L, Ls, H, Rs, C

• Task

• Make two discriminations on each trial, responding sequentially to the center and surround using a signal detection rating scale (1-6) certainty as to whether stimulus A or B had been presented.

• Order of responding was balanced across a observer.

• Procedures

• Starting with a very easy orientation discrimination, track performance as the orientation differences decreases.

• Blocks of 100 trials repeated over days until each stimulus had been judged 600-1200 times, for a total of 2400-4800 trials per observer.

• On any trial, one stimulus appeared for 500 ms, followed by two 5000 ms (min) responses per block. The second response was measured immediately after 1st response was made.

• Cumulative ratings over 6 days, ten linear Gaussian independence model.

Results

The frequency with which each combination of responses was tallied in four 6x6 matrices. We attempted to fit a linear Gaussian model to each observer's data. While our algorithm returned some pictures that almost looked reasonable, goodness of fit values were in the thousands, indicating that the data were not adequately fit by an underlying linear Gaussian model. The pattern of frequencies used suggested observers were using a multi-attribute response strategy, placing the pattern that would be expected if the two stimulus components were independent (responses canceled out the appropriate quadrant of each response table), and the double decision pattern observed when there is no gap. That pattern appears to be based on first classifying the stimulus as "correlated" (RR, LL) or anticorrelated (LR, RL), and then responding either on the positive or negative diagonal. Results from the no gap and the gap conditions are shown for comparison purposes.

Although the fitted ellipses look reasonable and appear to indicate a medium of independence, goodness of fit tests reject that interpretation (χ² = 12,475,046; χ² = 1,997,087). Inspection of the raw data is more informative. Independent processing is indicated by a mass of frequencies in the appropriate quadrant. Non-independent processing is here indicated by an over-use of the diagonal.

Discussion

Results obtained with a gap did NOT show independence of processing of center and surround components, despite single-attribute discrimination results suggesting this outcome. Similar to results obtained without a gap, the whole idea of an underlying bivariate response model was rejected. It seems that at least some observers are using a two-partion ion strategy.

Without a gap, observers seem to first classify the stimulus as same sign (LL,RR) or different sign (LH,HL). If they are correct, same sign-decisions lie close to or on the diagonal, and observers tend to get the "right" answer (upper left for the first table), and different-sign decisions lie in the upper right or lower left quadrants. Observers are less certain of the different-sign decisions, as they do not all lie on the negative diagonal. When the gap is added, there is less of a tendency to use the diagonal, but it is still quite evidence in the correlated conditions. All of these results differ markedly from those obtained with overlaid sec-

Reference


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