Texture difference cues in figure-ground separation
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Motivation

Parsing an image into figure and ground, a critical element of visual processing, can be driven by many textural cues, including the distribution of luminance, orientation, and higher-order image statistics.

Recently (2023), we showed that for differences in orientation, thresholds depended on whether the oriented component was present in the figure or the ground. Since, for the stimuli used in that study, the figure-ground distinction was only possible after orientation is analyzed, this asymmetry implies functional recursion.

Here, we ask whether this asymmetry extends to higher-order image statistics, which are known (2015) to be primarily processed in V2.

Results and Conclusions

Plots show thresholds for figure-ground organization, with figure and ground each defined by a combination of image statistics (domain shown above the plots). Each domain shows the effect of the two statistics independently. The center of each domain corresponds to a random texture.

In the upper row of plots, the image statistics are combined in the same sign; in the lower row, they are combined with the opposite sign. In each case, the abscissa indicates the texture contrast in the figure; the ordinate indicates texture contrast in the ground. Symmetry across the diagonal, if present, indicates that threshold does not depend on whether the texture contrast is in the figure or the ground.

When alpha is combined with the other statistics (β, γ, or θ), the thresholds show a pronounced figure-ground asymmetry.

Because figure and ground are only defined by their image statistics, this asymmetry implies that figure-ground separation utilizes functional recursion from visual areas that process higher-order image statistics, such as V2, to V1.

Methods

Sampling the Texture Planes

Examples

Different combinations of image statistics can yield the same texture plane. These combinations are shown in the figure, with samples from the lower right corner of the plots being shown in the upper left corner of the plots.

Sampling of each texture plane was achieved by randomly sampling the four-plane textures of four different image statistics, with the texture plane being defined by the four-plane statistics.

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Results - Combinations of Image Statistics

Plots show thresholds for identifying figure-ground organization, with figure and ground each defined by a single image statistic shown next to each plot. Each strip shows the effect of varying a statistic over its range, from -1 to +1. First-order statistic: fraction of white vs. black checks. Second-order statistic: correlations between pairs of adjacent checks (here, horizontal, third, and fourth order statistic: parity of checks in regions containing 5 and 6 checks, respectively. In all cases, a correlation of 0 corresponds to a random texture.

References


Support: NIH EY07977
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