Towards a model for sensitivity to local image statistics
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Segmenting an image into its components is a crucial step in visual processing. Modeling the underlying computations is challenging, owing to the high dimensionality of the problem. We have therefore taken a reductionist approach, focusing on black-and-white images defined by their local spatial correlations. In this space, image statistics can be independently probed and fully analyzed, enabling a predictively model of psychophysical sensitivities in 10 dimensions.

Here, we show that key aspects of these findings extend to images with three luminance levels – a space with 66 dimensions. We suggest a model framework that can account for the observed behavior. This framework is also consistent with Chubb et al.’s studies of “scramble” textures with multiple gray levels.

Results: Isodiscrimination Contours

For other kinds of horizontal and vertical pairwise contrasters (AB2 and AC2), sensitivities vary widely. Interactions are weak, leading to circular (above) or a trihedral (below) isodiscrimination contours that are aligned with the axes.

A Model Framework

Each channel first transforms the grayscale image into a texture image via a stochastic threshold, in which the probability of assignment to black or white depends non-linearly on the grayscale value of the original stimulus. The three-dimensionality of the psychophysical representation means that the individual channels are compared across regions, yielding 10-element parameter vectors (\(\mu_{30}, \mu_{20}, \ldots, \mu_{03}\)). A quadratic distance is applied to each of these vectors, and the weighted sum yields the predicted perceptual distance.

Conclusions

The two main findings that emerged from studies of binary textures also apply to textures with gray levels: similar thresholds for positive and negative variations of image statistics, and quadratic cue combination.

These behaviors are captured by a model that unifies two previous sets of studies: Chubb et al.’s studies of textures with multiple gray levels and parameter correlations, and our studies of spatially-correlated textures with black and white elements.