Journal of Vision
www.journalofvision.org

doi: 10.1167/9.8.785
Journal of Vision **August 5, 2009** vol. 9 no. 8 **article 785**

Evidence for autocorrelation and symmetry detection in primary visual cortex

David Berry [1] **and**

Horace Barlow[2]

Author Affiliations

Abstract

The detectability of patterns in random dot arrays was measured as a function of dot density and compared with the statistical limit set by different methods of detecting the pattern. For filtering, cross-correlation, convolution, or template matching, the limit is expected to be inversely proportional to the square root of dot density. But for auto-correlation, which can detect symmetries of various types, the limit is unaffected by dot density under many conditions. Confirming previous results, we found that the coherence-threshold is often constant for Glass patterns, but the range of constancy depends on details of the display procedure. Coherence-thresholds were found to increase when the average number of dots expected at each location rose towards or exceeded a value of one; we therefore think it results from the non-linear effects of occlusion that occur when a later-programmed dot falls in the same location as an earlier one. To test this, these non-linear effects were prevented by arranging the luminance of each location to be directly proportional to the number of times that location was covered by a dot. Millions of dots can be used for these images, and they retain the streakiness of Glass patterns, while discrete dots disappear. The constant coherence threshold for detecting this streakiness is maintained over a huge range of dot densities, extending right down to the range where discrete dots become visible and up to patterns that are essentially full-tone images with no discrete dots. At threshold, all these patterns have similar auto-correlation functions, as we can see from the way both low dot-number Glass-patterns and these mega-dot, multi-tone, Glass-like images are formed. This startling fact raises the question whether primary visual cortex computes auto-correlations as well as, or even instead of, the local, Fourier-type, wavelet analysis of the currently popular paradigm.

Footnotes

This work was made possible by a grant from the Gatsby Foundation.

Received June 11, 2009.