Abstract View

SPATIAL AND CHROMATIC FILTERS DERIVED FROM AN INFORMATION-THEORETIC ANALYSIS OF NATURAL SCENES

E. Doi[1,4]; T.-W. Lee[1]; T. Wachtler[3]; Inui[4]; T.J. Sejnowski[1,2*]

1. INC, UCSD, La Jolla, CA, USA
2. Salk Institute, La Jolla, CA, USA
3. Neurobio. & Biophys. Dept., Univ. Freiburg, Freiberg, Germany
4. Grad. Sch. of Informatics, Kyoto Univ., Kyoto, Japan

Neurons in the early stages of visual processing should represent the statistical properties of natural scenes efficiently. In previous studies, independent component analysis (ICA) was applied to images based on monochromatic or trichromatic cone arrays (Bell & Sejnowski, 1997; Lee et al., 1999). Here, we compare the results of this approach to physiological data based on the experimental conditions in Hanazawa et al., 2000. The resulting whitening filters could be categorized into the three classes of type I neurons found in the LGN (two classes for r-g, a third for y-b). In particular, both luminance and red-green information were coded together, as found in pLGN cells. Furthermore, the ICA filters can be categorized into simple-cell and double-opponent (DO)-cell types. The simple-cell type showed a spatial organization similar to the filters that emerge when ICA is applied to monochromatic natural images and their chromatic selectivity was identical to the luminosity function. The DO-cell type had spatially-oriented chromatically-opponent subfields, and had two subtypes based on their color selectivity (red-green and yellow-blue opponency). Characteristics of the simple-cell type and the DO-cell type suggest that they are responsible for form and color information, respectively. This was confirmed by reconstructing an image with single cell types. The separation of form and color channels is a statistically efficient way to encode natural scenes that arose during evolution, but these properties could also depend on visual experience during development in a local environment.

close