All on the surface?

In a much-cited passage in Optiks, Newton wrote: ‘The colours of natural bodies derive from the kind of light rays that those bodies reflect to the maximum degree’. Few other statements have been more influential on both our naive and scientific thinking about colours. Newton distilled the fundamental observation that conscious colours correlate well with a photometric property of the reflecting material. Far from being an explanation of color perception, however, this observation highlights a fundamental problem: simple matching of our eyes to surface material reflectance are contaminated by another spectrum—that of the illumination impinging on the surface itself. These two spectra are inextricably mixed, but to build a perceptual representation of reflectance our perceptual system must be able to separate them. How is this possible? In two recent articles, Schirillo argues that, fundamentally, to form a representation of reflectance is a scene’s geometry, rather than its light spectra. The essential feature of Schirillo’s experiments was the manipulation of the number of surfaces surrounding a constant target surface. By choosing the reflectances of surround surfaces appropriately, it was possible to increase their number (from one to 20) while keeping their average intensity constant. Thus, in these conditions, the photometric information is the same, but despite this, the color of the target changes as a function of the change in the spatial distribution of the surround. Re-using a term first employed by Gestalt psychologists, Schirillo calls his manipulation of some geometry ‘articulation’. By increasing the number of surfaces in a scene, the improved surround articulation might allow the recovery of surface reflectance, separating it from illumination. Thus, the very process that Newton’s intuition identified as the basis of color perception suggests that it is not only the ‘kind of light rays’ reflected that determine the color of a surface, but also the nature of the surrounding surfaces.

References

A novel view of recognition

The problem of how we recognize objects independently of viewpoint, size, distance, and the number of surfaces that has been much studied in visual neuroscience. However, until recently, computational approaches to this problem have been comparatively sparse and have operated on the basis of training a network on a limited set of relatively simple inputs (e.g. Ref. 1). Such models are ‘view-based’ in the sense that they perform object recognition on the basis of a comparison of a new input with previously stored views of objects that most closely match the novel input. Now, Riesenhuber and Poggio have developed a model that operates on the basis of a non-linear maximum operation (or ‘MAx’), which more closely reflects what the brain must do when faced with multiple stimuli in the visual input. The idea of MAX is that it pools features by giving greater weight to the most active (best matching) input, rather than performing a linear summation, with all inputs given equal weight. Such a mechanism is consistent with neurophysiological data from the temporal cortical visual pathway, which is thought to have a key role in object recognition. Running simulations with the model, the authors found that it did indeed achieve recognition of complex multi-element objects, fulfilling the fundamental requirements of feature selectivity and invariance to viewpoint. Significantly, the model is also hierarchical in that it incorporates a hierarchy of increasingly complex features, and at each successive stage, the invariance among features increases. This is a natural extension of the structural model of the visual processing, from the simple cells of striate cortex to the object-selective properties of inferotemporal cortex. This model may represent the most complete and predictive implementation of visual object recognition, and promises further advances in the quest to solve the task of object constancy in perception.

References

Activation from neuron to brain

Cognitive neuroscientists are frequently baffled when well-established neurophysiological and psychophysical findings are not corroborated by human functional neuroimaging. A recent paper by Sassenet and colleagues supports an important caveat for interpreting the relationship between activations in animal brains and the population response measured with brain imaging. They show that traditional models of activity within areas such as MT, the authors show that activation across the population depends on many factors, including baseline firing rate, response modulation and tuning width. Such factors can be used to model ‘iso-activity contours’. These demonstrate that, despite vigorous responses within a subset of neurons tuned for a particular stimulus, the population as a whole can fail to show increased activation, particularly in regions where neurons are tuned to multiple stimulus dimensions. The authors suggest that brain activation levels may be particularly susceptible to factors which change the baseline rate, such as attention, and those which affect neural tuning, such as learning. Furthermore, they recommend the use of high-resolution imaging techniques and parametric stimulus designs to enhance the likelihood of observing significant modulation in neuroimaging. They also suggest that these issues could be clarified by simultaneous physiological recording and fMRI, employing a technique that is currently under development in several laboratories. This important paper addresses an issue that affects the entire functional imaging community, and, along with future fMRI developments, will help the limits of these more powerful techniques to be exposed to the full.

References


d

Thanks to our Monitor contributors

We would like to take this opportunity to express our sincere thanks to the authors who have contributed to the Monitor section during 1999. They are:

D. Alais, Paris, France
N. Bruce, Trieste, Italy
T.J. Bussey, Bethesda, USA
J. Culham, London, Canada
D.I. Donaldson, St. Louis, USA
N. George, Paris, France
A. Gruvenaal, Pavia, USA
S.J. Jackson, Bangor, UK
E. Kaan, Utrecht, The Netherlands
T. Nichols, Madison, USA
G. Rieu, Pavia, Italy
M. Rushworth, Oxford, UK
J.M. Sabatini, Bethesda, USA
R. Snowden, Cardiff, UK
L. Wagner, Antwerp, USA

If you would like to contribute to Monitor, please contact the Editor at trendscurrents.com. Regular contributors receive a free personal subscription to the journal.