Seeing things

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Visual Processing: Computational, Psychophysical and Cognitive Research.

By Roger Watt. Lawrence Erlbaum: 1988. Pp.152. £14.95, \$26.95.

Visual Cognition: Computational, Experimental and Neuropsychological Perspectives. By Glyn W. Humphreys and Vicki Bruce. Lawrence Erlbaum: 1989. Pp.330. Hbk £19.95, \$37.95; pbk £9.95, \$16.95.

PSYCHOLOGISTS are better at discovering problems than at solving them. No sooner is a good clean theory put forward than someone rushes to the laboratory to obtain results that not only disprove it but also suggest a host of new problems demanding a totally different theory.

The late David Marr worked on a newly discovered problem, namely, how the brain obtains from the retinal image a labelled description of its luminance edges, a description that Marr called the 'primal sketch' and that must form the basis of all further visual processing. He suggested that two operations were needed. The image must be blurred, which can be achieved by taking the weighted sum of luminance over a region around a given receptor, and the second derivative of the blurred luminance distribution must be found; this function will show two departures from zero, one positive and one negative, on either side of any luminance step in the image. These operations can be achieved by filters of different sizes that respond to luminance changes over different extents. There remains the problem of how to locate the position of an edge from the output of the filters. Marr proposed that this is achieved by locating the points at which the second derivative passes through zero: as one moves across the image towards the edge of a dark figure, there will be a decrease in the second derivative followed by a rise as one moves inside the figure. Thus, the zero crossing gives the position of the edge.

In *Visual Processing*, Roger Watt describes and defends a different and highly ingenious theory developed by himself and Professor Mike Morgan. He argues that where a luminance change extends over some distance, as for example in the penumbra of a shadow, marks on the surface or noise may produce zero crossings that will mask the zero crossing produced by the overall brightness change. His solution is to sum separately all positive outputs from the different sized filters and all negative outputs. In this way the overall change in brightness will be preserved as both for the positive and the negative outputs, the points at which the resultant curves touch zero are determined only by

the output from the largest filter. He argues that to detect even finer detail the largest filters are successively switched off.

Watt produces considerable evidence in favour of his theory, mainly from work on the contrast at which gratings of different widths can be seen and from the accuracy at which edges can be located. One wonders, however, just how far he has optimized the parameters of rival theories in making these comparisons, and also how far he has searched for data that disconfirm his theory.

He develops the theory to account for visual attention and the grouping of neighbouring items in the visual image. For example, on his theory a group of a dozen or so black dots randomly spaced but close together in the visual field will be imme-

diately detected as a group because the brightness difference between the region containing them and the background will be detected by the largest filter. The following *Gedanken* experiment suggests that at the very least this is not the whole story. Imagine a group of small black and white dots on a grey background. *Prima facie*, these will be just as readily seen to form a group as a region containing only black dots, but the broadest filter will not respond since there is now no overall brightness change. Marr's theory would account for this phenomenon, since he assembled groups from the individual members rather than proceeding in the reverse direction.

The hidden man — this 'picture', which originally appeared in an article by P. B. Porter in 1954, is taken from *Theories of Visual Perception*, by Ian E. Gordon, published by Wiley.

Visual Processing is imaginative and stimulating, though not easy reading, partly because of the intrinsic difficulty of the subject matter and partly because Watt often does not take sufficient pains to make himself clear. *Visual Cognition* is also difficult: it is very dense, has an uneven prose style and in places the undue number of typographical errors is distracting. In so far as the book has a theme, it would appear to be the recovery of meaning from the visual image. It does not deal in depth with many of the more traditional problems, such as colour vision, depth perception, the constancies or acuity, but concentrates on the primal sketch, object recognition, motion perception, imagery, visual attention and

think of and, of more importance, any combination of tasks. The use of such evidence for theory construction is clearly hazardous.

Despite the thoroughness of the reviews of each topic in *Visual Cognition*, one is left with qualms. The authors are interested mainly in the order in which different processes take place. It may well be that the existing evidence does not allow one to go beyond this, or even in many cases to reach it, but graphs containing sequences of boxes labelled "face identity units", "person identity nodes", "name generation" and so on, make one feel uneasy. It would after all be strange if one could put a name to a face without having recognized it. What one really wants to know is what goes on in each box. How are faces recognized and how are names generated?

Despite this reservation, the authors have done an excellent job in systematizing the existing evidence. The book will undoubtedly be useful as an advanced text for some years, indeed until such time as a host of new experiments has made it necessary to complicate even further their already complex exegesis. As they rightly remark, "Unfortunately the argument cannot stand there as the empirical evidence suggests a yet more complicated picture". It will continue to do so. □

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