REVIEW

A fruitful partnership

Eye, Brain and Vision
by David Hubel, *W. H. Freeman, pp 241, £14·95*

Horace Barlow

ANYONE who is interested in eyes or brains, and anyone who is interested in the way discoveries are made, should read this book. In 10 short chapters, David Hubel succeeds in giving a vivid and well-illustrated account of the work he has done over the past 30 years on the visual pathway of cats and monkeys. "I have had the astronomer in mind as my prototypical reader," Hubel says, "someone with scientific training but not an expert in biology, let alone neurobiology." He does not aim *Eye, Brain and Vision* at vision researchers, but instead provides a refreshing personal account of the work he did in Stephen Kuffler's lab with Torsten Wiesel and other colleagues, and the major advances in understanding the neurophysiology of vision that resulted.

Hubel begins by introducing the gross anatomy of the brain, the neurons that make it up, and the impulses the neurons send and receive along their axons—the long filaments that connect nerve cells to sense organs, muscles, and to each other. He follows this with a chapter on the eye that explains the anatomy of the retina and the functions of the photoreceptors.

Such material can be tedious if it is presented as "necessary groundwork", but Hubel has a light touch, and clearly appreciates the difficulties and achievements of those who have found how the neurons, synapses and receptors work. Thus, after describing recent advances in the physiology of photoreceptors, he says: "Perhaps a few years from now students of biology will regard this entire story of the receptors as one more thing to learn—I hope not. To appreciate fully its impact, it helps to have spent the years wondering how the receptors could possibly work; then suddenly, in the space of a decade or less of spectacular research, it all unfolds. The sense of excitement still has not subsided."

The excitement is well sustained through the next chapters, in which Hubel recounts the discoveries made by himself and Wiesel in their amazingly successful partnership of more than 20 years' duration. One of the features that keeps the account lively is Hubel's emphasis on the fact that many of the discoveries were quite unplanned.

One experiment, the one Hubel and Wiesel intended to do in the primary visual cortex, involved observing responses of single neurons to circular spots of light and dark patches. The two researchers chose this approach because the fibres leading visual information into the cortex respond well to such stimuli. Unfortunately, the cortical neurons were unenthusiastic about these stimuli; one of them, however, responded vigorously, repeatedly, and reliably to the faint image of the edge of the glass slide on which the researchers had mounted the stimulus. It turned out that this was because the edge was straight, and just happened to have an orientation appropriate for the cell being recorded. Thus Hubel and Wiesel discovered the orientational selectivity of cortical neurons.

When will those who talk about the importance of planning and management in science realise that discoveries occur in spite of planning, not because of it?

Hubel goes on to write on colour vision, on deprivation and development, and on what the future holds (briefly). The presentation is not like a textbook, but Hubel succeeds very well in conveying much of what is known about the cerebral cortex, and (more difficult) how it came to be known. Furthermore, he gets across the fact that what is firmly established is still only a small island in a sea of ignorance.

In his brief final chapter, Hubel rightly emphasises the importance of these islands of knowledge: they are enough, he says, to tell us "that total understanding is *in principle* possible, that we do not need to appeal to mystical life forces—or to the mind".

Are there no flaws in this splendid book? Well, yes. It certainly does not give a balanced, up-to-date view of the neurobiological mechanisms responsible for the early stages of processing of visual information; there is, for example, no mention of spatial-frequency filtering, of the X-Y systems in cats, of hyperacuity, of the direct input from geniculate fibres to complex cells, or of anomalous visual pigments, to mention just a few of the topics that are relevant to Hubel's story and which have aroused much interest in the vision research community over the past few decades.

Hubel's credit attributions are also sometimes bizarre; for example, Hartline introduced the concept of *receptive field* in 1938, not Kuffler in 1952. But this is unashamedly "the Harvard Neurobiology viewpoint", and because he is so open about it, and because it is his book, one cannot complain very loudly.

Has this somewhat blinkered view lead Hubel astray? I've alluded to some striking omissions and minor errors, but I think there is quite a serious weak point in his outlook. He has a strong anatomical bias; he seeks to associate function with named structure, and structure with identified function, and that is what he has been strikingly successful in doing. But he pays little or no attention to the quantitative analysis of function, and quantitative clues can be very revealing.

For instance, both Derrington, and Blakemore and Vital-Durand, have shown that visual experience is necessary for cortical neurons to develop quantitative sensitivity to contrast, and resolving power, even though qualitative observation shows that binocularity and orientation selectivity appear without it. Surely, recognition of this quantitative evidence would make Hubel modify his guess "that the primary visual cortex, and perhaps the next few stages too, are all wired entirely according to genetically coded instructions". Perhaps he just means the initial or potential wiring, because the facts in this very book show it is not true of the final wiring.

This is a minor complaint about a book on which the author worked, he tells me, for more than 20 years. It isn't a teaching text or scholarly monograph, but many people from a wide range of disciplines will earn much good science from it; not least, they may gain some idea of how great discoveries are made. □

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