question of reducibility of psychology to neuroscience is the fundamental problem in the philosophy of mind. Yet the analogy I draw from the case of genetics is that the philosophical concept of reduction is inadequate to the representation of the relations among many theories (or fields) of science*. To borrow Churchland's own terminology, I think that the concept of reduction may belong to *folk metascience*.

A second concern about her argument derives from a different way of appealing to the unity of science. One of the leading themes of functionalism is the view that there are generalizations about psychological processes — couched in terms of representation and computation — which apply to systems that are built out of very different materials. Assuming that such generalizations cannot be integrated into neuroscience, the functionalist may reasonably protest against their sacrifice on the altar of the unity of science *on the grounds that they already contribute to a unified science by linking together the study of different forms of intelligence both artificial and natural*. Churchland's apparently clinching argument thus seems to presuppose a particular view of how an ideally unified science must be organized, a view on which neuroscience stands as the neighbouring discipline to psychology. Functionalists who believe in unified science should adopt a different picture of its structure, and they may accuse Churchland of extracting more from a methodological principle than it can fairly yield.

These reservations do not detract from the achievement of the second part of *Neurophilosophy*. Whether or not one agrees with her, Churchland has performed a great service for philosophers, psychologists and neuroscientists through her elaboration of the major positions and her clear presentation of arguments. Equally, the long and fascinating chapter that makes up the third and final part of the book, should serve as the starting point for serious interdisciplinary discussions.

We learned in Churchland's review of neuroscience that the various branches of the field are urgently in need of theory. Attention to the philosophy of mind offered the moral that philosophical conceptions, including those that strike us as untutored common sense, may have to be "reconfigured". But what are the prospects for theories in neuroscience? And how can we make sense of mental activities without employing the ideas of folk psychology and assuming that thought involves the manipulation of symbols? Churchland's final chapter outlines some answers to these questions. She gives a lucid account of some recent research: the tensor network theory of Pellionisz and Llinas (and a related proposal by Paul Churchland), the parallel models of computation developed by Rumelhart and McClelland, and a hypothesis of Crick's about the neurobiology of attention. In each case, there appears to be an exciting symbiosis between naturalistic philosophy and theoretical neuroscience, with the liberation from conceptual chains leading to new prospects for developing theory.

Tensor network theory receives the most extended treatment. The core of the Pellionisz–Llinas proposal is that synaptic connections in the cerebellum can be viewed as an array for performing matrix multiplication. So, to simplify enormously, sensorimotor coordination might be achieved by means of the registering of information on a sensory map in the brain, the "computation" in the cerebellum of an appropriate vector in a motor map, and, as the result of the stimulation of the right region of the motor map, the activation of the proper muscles. The proposal is especially stimulating because the "computation" does not involve manipulation of symbols. Algebra gives way to geometry. Churchland offers a succinct summary:

> What is needed is a way to conceive of what nonsentential representing might be, and the tensor network theory provides that much, even if, in the end, it turns out not to be right [p.452].

Functionalists will be quick to protest that managing without symbol manipulation in the case of sensorimotor coordination is one thing, doing the same in the case of language learning quite another. Neuroscience can cope with the more mundane operations of the brain, but the higher cognitive functions require a more abstract treatment. Taken as a cautionary note, this is perfectly correct, but the point should not be overinterpreted. The work Churchland describes is extremely tantalizing, for neuroscience, for psychology and for philosophy. We do well to recognize exactly how far we have gone, but not to make unwarranted judgments about how far we may go.

Churchland is plainly optimistic, and her optimism may ultimately prove unjustified. But, whatever the outcome of the trends in theoretical neuroscience that she favours, the value of her book is independent of its more speculative claims and its more controversial arguments. While reading it, I was reminded of the comments of numerous friends, who mourn the good old days — days when there were far fewer academic books, when books were read by several generations of graduate students, when the brief bright ideas emerged on journal pages but not in the more enduring medium of hard covers. Such people should be happy with Churchland, for she has given them a book of the old-fashioned sort, one that deserves to be read and pondered by philosophers, psychologists and neuroscientists for a good long time. □

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*For a study of the example of genetics that seeks to develop more sophisticated metascientific concepts, see my article "1953 and All That. A Tale of Two Sciences" (*Philosophical Review* **93**, 335–373; 1984)

Revival in optics

O.S. Heavens

Optical Interferometry. By P. Hariharan. *Academic: 1986. Pp.303. $58, £49.50.*

OPTICS — until recently perhaps regarded as satisfactorily completed and with little more to be expected — has experienced a resurgence of interest since the arrival of the laser, a tool of almost infinite sharpness compared with the light sources previously available. The laser has not only made many traditional optical techniques more convenient, but has made possible methods such as holography which were hitherto practically impossible.

An account of optical interferometry can thus be expected to contain some new excitements to complement the more traditional material. In this sense, Hariharan's book is no disappointment: holography, holographic interferometry and speckle inteferometry — all post-laser subjects — are well covered in a mainly readable fashion. There are some grumbles. The pedagogue tires of explaining to students why the term "phase of a photon" is completely meaningless, but here it is again. There is, too, an uneven quality to the book in that rather basic algebra is spelled out at length while a knowledge of Jones matrices is assumed. Some carelessness in checking the matching of symbols in text and figures has introduced glitches in reading, and many of the line diagrams could have been made clearer by the use of shading.

One instinctively draws a comparison between this book and the classic work of Steel, *Interferometry*, of which a new edition appeared in 1983 and which is now available in paperback (Cambridge, £12.95, $24.95). They have much in common, since Steel's updating of the earlier (1967) book was thorough. The better diagrams of Steel's version and freedom from some of the blemishes referred to above, will probably mean that its sales will not suffer. □

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