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MOVEMENTS OF THE EYES.

By R. H. S. Carpenter. Pion, London. $27.00. xvii + 420 p.; ill.; index. 1977.

Full understanding of any central part of the nervous system will at last consist of the answers to rather different sets of questions. A first set of questions concerns the computational problems that the system solves. At a second level one will describe the algorithms and the specific tricks used by the system. Underlying circuitry and elementary components will represent the subject of still another level. A reasonable understanding at these levels appears to be still far away for nearly all central neural systems. There is one potential exception: the oculomotor apparatus. The recent upsurge of interest in the systems controlling eye movements is certainly a consequence of this promise.

Carpenter's book provides a very good and timely overview of the present state of research on the mammalian oculomotor system at all three levels. Besides anatomy and single-cell neurophysiology, the book covers in an excellent way the behavioral and phenomenological aspects of eye movements. In general, recent literature is critically reviewed. The appendix on linear systems analysis is careful, intelligent, and fully understandable to the nonengineer. In the whole book, I was able to find only one (typographical) error (20° instead of 2°, p. 82). As a definitely minor criticism, I feel that a few pages on visually guided movements in other species, especially invertebrates, where there have been recent major advances, might have significantly broadened the perspective of the book.

Finally, I have some comments about the style of theoretical thinking and modelling that is reflected in Carpenter's monograph. Traditional modelling of the oculomotor system is heavily based on linear systems analysis and concepts like filters, transfer functions, gain, and phase. Notwithstanding its merits and its deep influence on contemporary oculomotor research, it may well be that the "classical" control system language has already provided its most important contributions to motor research. The future role of this kind of analysis is, indeed, severely restricted because of three of its main features: the basic role of linearity; its one input-one output structure; and its analog-like character. As a consequence, system theoretical models may be inadequate to describe concisely a system that performs a *complex* information processing task as several motor control systems do. Carpenter says (p. 342) that "practically everything the nervous system does by way of information processing can be thought of as filtering of one sort or another." This is certainly true in principle, but essentially nobody now describes complex computer programs in terms of filters, transfer functions, and the like. At some point in the scale of complexity, another theoretical language, based on nonlinear functional analysis and concepts like procedural algorithms, symbolic representations, and data structures, is needed to complement traditional systems analysis. Since, as Carpenter writes at the very end of this book (p. 308), the study of the oculomotor system has made clear that "nothing in the brain is ever as simple as it seems," such a new, more computational approach may play an important role in *future* research on the mammalian oculomotor system.

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