Cortical Consolidation

Neurobiology of Neocortex. P. RAKIC and W. SINGER, Eds. Wiley-Interscience, New York, 1988. xii, 461 pp., illus. $112. Dahlem Workshop Life Sciences Research Report 42. From a workshop, Berlin, F.R.G., May 1987.

Neurobiology of Neocortex disseminates the results of a workshop convened to "define and discuss priorities and to indicate directions for further research" into cortical organization and function. The book contains essays of two types: background papers, supposedly "providing review of the field rather than a report on individual work," and group reports, based on discussions among the 46 invited participants. The editors aver that their efforts "seem to have achieved a rather complete identification of the questions that need to be answered and of the methodological problems that need to be resolved."

The book neither achieves its stated objectives nor lives up to its boasts, but may be valuable nevertheless. The four group reports fail to establish the promised priorities and future research directions, beyond the urgent necessity of pursuing the participants' current interests, and only three of the 18 background papers even attempt to expand their discussion much beyond the authors' customary topics. There are, however, a number of excellent and insightful contributions, and as whole the collection is interesting and novel. For example, the chapter by Bruce on the physiology of prefrontal cortex is one of the most successful attempts yet to synthesize a particularly impenetrable literature.

The strengths of the book lie in its principal themes, which would not have dominated such a volume a decade ago, and the consensus that appears to have developed on certain issues. Four related topics resonate through the volume: parallelism in cortical information processing, plasticity in both development and adulthood, the richness (not to mention complexity) of cortical pharmacology, and the search for cortical circuits and mechanisms.

As recently as 1981, a leading neurophysiologist declared that only about 5% of the human neocortex "is specialized for receiving inputs from eyes, ears, skin and projecting motor outputs down the pyramidal tract to bring about movements." In contrast, the current consensus is that most of the neocortex is involved in such activities and that a host of functionally distinct cortical fields process information in parallel, as well as through the traditional neural hierarchies. Perhaps the most elegant example of this principle can be found in the auditory cortex of an echolocating bat, surveyed in this volume by Suga. A half-dozen or so cortical fields play specialized roles in analyzing biosonar signals, and Suga's brief description of their parallel and hierarchical information processing is accompanied by elaborate and highly informative illustrations. Chapters by Allman, Zeki, and Andersen address similar principles in the visual system, where the number of maps, that is, models or representations of visual input, may approach two dozen in certain primates.

Several chapters elaborate how cortical maps may emerge (Rakic, Allman, von der Malsburg and Singer, and Stryker *et al.*). Whereas the static properties of sensory and motor maps have been emphasized in the past, the present volume emphasizes the idea that each individual's experience and evolutionary history influences its cortical maps. Merzenich and his colleagues summarize, as do Kaas and Mountcastle in separate chapters, data indicating that maps of skin receptors, found in the somatosensory cortex, can be altered during adulthood by nerve damage, rearrangement of skin surfaces, or tactile experience. A few authors venture to propose possible mechanisms of such plasticity, including the potential involvement of specific transmitter and receptor systems.

One of the most challenging questions in the neurobiology of neocortex concerns how information is processed in its many separate areas. Updates are presented about cortical circuitry and how it generates the sensory response properties of individual neurons, a problem inextricably linked to cortical pharmacology (Jones, Bloom, and Gilbert *et al.*). Consideration of single neurons generates questions about their participation in perception, attention, goal selection, and cerebral motor control (Mountcastle, Andersen, Bruce, Suga, Cynader *et al.*, and Foote *et al.*). Much discussion in this area has been devoted to resolving a perceived discrepancy between two model mechanisms, one relying on the existence of "grandmother cells," cells specifically discharging when and only when granny appears (or is considered), and another positing that she emerges from the combined activity of a neuronal ensemble. From the present volume emerges the reasonable view that the neuronal population concept is perfectly consistent with the existence of a small population of cells "coding" very specific features of the environment, even a grandmother or two. For example, the neural network model sketched by Andersen suggests how a constant spatial sense might be constructed without any individual neuron coding for a location in space. These cells, nevertheless, have rather specific spatial response properties. It is of interest that elements in Andersen's purely theoretical model have properties resembling neurons in the posterior parietal cortex, long thought to be important in guiding movements and in spatial perception. Andersen argues that a spatial sense is learned by the individual, an idea that relates in an instructive way to the work, mentioned above, on plasticity in the somatosensory cortex.

For the generalist, this book could be difficult to understand. Here is a quick test: There should be no difficulty if it is self-evident that, in some part of the reader's neocortex, the neural representation of the terms striate cortex, primary visual cortex, V1, V-I, and area 17 should be identical. The reader must also know that, depending on context, "visual cortex" might mean either V1 or a set of visual fields including area 18 (which in cats, but not monkeys, corresponds to V2 or VII) and areas 7a, LIP, PO, V3, V3A, and V5 (the equivalent of MT). A serious editing effort and a good index could have ameliorated the book's nomenclatural chaos. Unfortunately, the index is particularly unsatisfactory. The lack of cross-referencing of equivalent concepts and areas when incongruous terminologies are used among (and occasionally within) different chapters is an especially significant deficiency.

Despite its many flaws, which include more than occasional instances of poor scholarship, idiosyncratic opinions expressed as fact, a larger than usual number of typographical errors, and one blurred page, *Neurobiology of Neocortex* should be informative reading for specialists interested in cortical areas or hierarchical levels other than their favorite and for graduate students in cortical neurobiology.

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