Neocortical Development

Shirley A. Bayer and Joseph Altman
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To encounter, searching through our medical library, this well-written, beautifully illustrated, and accurate book has been an unexpected pleasure and, I dare say, a rare event these days. During the past two decades, the amount of data accumulated in the field of neuroscience has been unprecedented, the number of neuroscientists increases continuously, and the journals devoted to the field have proliferated beyond expectations. As a result, the search for any pertinent information has been transformed into a difficult and often frustrating experience and, at times, into an impossible enterprise. In our competitive world for scientific fundings, the much swayed emphasis of most published reports toward new findings belonging to that nebulous category of "the cutting edge" has often resulted in incompleteness, repetitions, misquotations, frequent rediscoveries, unsupported generalizations, and, in rare instances, even in scientific misconduct. If the present situation is of concern for senior investigators, it is considerably worse for the novice; the young research fellows who from the start are being forced to specialize, thus potentially limiting their horizons and their understanding to a narrow field. The task of imparting a global point of view and a general education to our young investigators—future neuroscientists—has become increasingly difficult. To come across this little book has been for me, as surely it will be for many students, a welcome relief.

The book explores, analyzes, and exposes with clarity and accuracy the complex cellular events that occur during the early establishment and subsequent prenatal development of the mammalian neocortex. In the first three chapters, its main topic—neocortical development—is presented to the reader from a general point of view. Chapter I comprises an historical overview signalizing important features and ideas concerning the early development of the mammalian neocortex. From the start, the reader is familiarized with basic developmental concepts, major cellular events, and their nomenclature. In this chapter, the importance of neurogenic gradients in the organization of the developing neocortex and the idea of a tripartite composition of the neocortex are pointed out. Chapter II encompasses a general view, "a chronological atlas" of fundamental anatomic and histologic features of the developing neocortex. Chapter III analyzes, in more detail, the neurogenic gradients, emphasizing their significant role in the cytoarchitectural organization of the neocortex and adding a list of valuable neurogenic times tables. The authors' contributions on the role of neurogenic gradients in cortical development are numerous and recognized worldwide.

In the next three chapters, each of the three fundamental players of neocortical development is analyzed separately and in greater detail; the germinal matrix in Chapter IV, the primordial plexiform layer and its subsequent partition into layer I and VII (subplate) in Chapter V, and the progressive formation of the cortical plate and, hence, of layers VI, V, IV, III, and II of the neocortex in Chapter VI. Of great interest for their instructive and illuminating capabilities are the extraordinary computer-enhanced (Skandha procedure) three-dimensional color reconstructions of the progressive development of the main neocortical players: the ventricular zone, the transitional field zone (intermediate zone), and the cortical plate (Chapter IV).

In the next three chapters (VII, VIII, and IX), cell movement, orientation, migration, destination, and developmental delays in their sojourn throughout the intermediate (transitional field) zone are carefully explored. Here, the authors' contributions on these aspects of neocortical development are noticeable. For instance, Rakic's original hypothesis of radial neuronal migration from ependymal to pial surface seems to be an oversimplification since many neurons do follow lateral paths in their migration. Possible developmental interrelationships among those neurons that migrate in a lateral path, a special (nonradial) kind of glial fiber, and the thalamocortical fiber system as it crosses the intermediate zone are explored and discussed.

An experimental model that uses X-irradiation is explored in Chapter X. Since damage to specific cell populations can be induced and manipulated with this method, the resulting affected neocortical development can be studied at different embryonic stages and compared with normal control. A considerable amount of information has resulted from these experimental studies. The specific radial and transverse developmental neurogenic gradients for the developing visual, auditory, somatosensory, motor, and limbic cortical regions are

analyzed in detail in Chapters XI, XII, XIII, XIV, and XV, respectively. The unique developmental features that characterize each of these cortical regions are also explored and discussed.

The book provides an interesting chapter (XVI) dedicated to theoretical issues pertaining to developmental and/or evolutionary aspects of the mammalian cerebral cortex. The authors introduce a novel idea concerning the neocortex's evolutionary place in relation to the other components of the cerebrum. Based on differences in neurogenic gradients, they propose (1) that the limbic system may be the central link between the paleo/archicortex and the neocortical systems; (2) that only the neocortex has open neurogenic gradients; and (3) that the neocortex probably evolves from a single primordium, supporting Herrick's original hypothesis. An overall summary and the main conclusions of the book are explored in Chapter XVII. The book is completed with six appendices, each describing one of the different procedures used: developmental histology (1) autoradiography (2), statistics (3), three-dimensional computer reconstructions (4), quantitation of cell density, size, and orientation (5), and X-irradiation (6) procedures.

Neocortical Development is indeed an excellent, informative, accurate, and beautifully illustrated book that covers its main topic with clarity and from many different angles. The cited bibliography is extensive and up to date. The authors, both well-known developmental neurobiologists, should be congratulated. I strongly recommend their book to young neuroscientists as well as to senior ones because we all could learn from it.

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Plasticity of Development

Steven E. Brauth, William S. Hall, and Robert J. Dooling (Eds.)
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This slim volume provides written accounts of invited lectures that were delivered at the University of Maryland in the 1986–1987 academic year by six leading developmental researchers: Jerome Kagan, Stephen Suomi, Sandra Scarr, Patricia Kuhl, Peter Marler, and Pasko Rakic. The rather lengthy delay between the completion of the lecture series and the publication of this book most probably reflects the well-known difficulty of getting a written manuscript from well-intentioned individuals overburdened with ever more pressing professional commitments. Although the editors note in the introduction that the lectures were revised in 1990, there is just a mere sprinkling of references to articles published after 1987. Thus, for the most part, the present volume represents an account of each invited speaker's research program at the time the lecture series was held.

As might be expected, from the foregoing listing of the participants, the topics addressed by the speakers were highly dissimilar, ranging from cognitive development in human infants to the migration of neurons in the formation of the monkey visual cortex. Thus, Kagan deals with the issue of continuity and discontinuity in relation to the development of temperament in human infants; Suomi describes the ontogeny of social behaviors in rhesus monkeys; Scarr summarizes studies dealing with intellectual development in human infants; Kuhl does the same for speech and language; Marler provides an overview of his work on vocal learning in songbirds; and Rakic describes his model of cortical development in primates.

In spite of this diversity of subject matter, as pointed out by the editors in an introductory chapter and in the epilogue, several common themes did emerge. Perhaps the most dominant of these is the acceptance of the epigenetic approach as the appropriate framework for explaining the development of all behaviors. This point is made particularly cogent by Peter Marler in his brief historical discussion of instinct and learned behaviors, a dichotomy that he aptly reformulates in contemporary parlance as "instincts to learn." Related to this theme is the notion of plasticity (ergo the title of the book) invoking the remarkable modifiability of behavior as a result of various experiences, beginning *in utero* and continuing throughout life. All of the chapters in the volume confine themselves to a discussion of early development. A chapter dealing with plasticity during maturity would have been a worthwhile and interesting addition, particularly for this aging reviewer.

It is not entirely clear who is the intended audience for this volume. For researchers in the field of development and plasticity much of this material is already rather dated. For graduate students and nonspecialists, most of the chapters are too restricted to the research program of the individual author. Thus, for the most part, one does not get enough of an overview to appreciate how the work of each lecturer fits into a broader perspective. The citations in these chapters are rather sparse (with the notable exception of those provided by Kuhl), and in most cases, these refer extensively to the work of the author. (For instance, of the 39 references cited by Rakic, 28 are to studies from his laboratory.) This is not, of course, inappropriate for a transcript of a lecture delivered to an audience at a departmental seminar. Nevertheless, the general reader would get a rather biased account of any given research area. Perhaps this is what the editors intended: Individual chapters by these distinguished researchers could be read just before at-