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Book Review: *The Evolution of the Human Head*, by Daniel E. Lieberman

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Book Review

The Evolution of the Human Head, by Daniel E. Lieberman. Cambridge, MA: Belknap Press of Harvard University Press, 2011. 756 pp. (ISBN 978-0-674-04636-8) \$39.95 (hardcover).

At the outset of this immense and thoughtful book, Daniel Lieberman sets the theme for the ensuing pages. Chapter 1 (“A tinkered ape?”) discusses the evolutionary “problem” of complex structures or organs. After completing this chapter, one may be reminded of the challenge of understanding the evolution of the eye. How can such a complex organ be modified (and what good is an eye before it is fully evolved)? Lieberman visits this particular question later in the book (the specific challenge of understanding the evolution of the eye was taken up by Darwin and others since). Although this is an analogy of a part to a whole, the same question may be asked about the eye or the head. When natural selection “tinkers” with complex organs/structures/body regions; how is functionality maintained?

In the chapters that follow, Lieberman asks the reader to entertain the thought that tinkering with complex structures does not represent a sort of conundrum. Indeed, he suggests complexity may be fuel for further modification. Heads may be so various in form not “*in spite of* but *because of*” (p. 13) the multiple critical functions, and intense natural selection on the head. Chapters 2 through 5 cover the process of craniofacial development, discussing increasing complexity during embryonic development, the body tissues (and their growth characteristics) that comprise the head skeleton, and how the head is compartmentalized but also integrated. For most readers, Chapters 4 and 5 contain the most essential passages of the book—without really digesting this, your later reading will be compromised (shut the office door/send the kids to bed before reading). Chapters 6 through 10 maintain the development/integration theme while discussing functional anatomical regions (often corresponding to the “modules” or compartments discussed in Chapter 4).

The book is vast in scope and full of numerous high-quality illustrations. Think of the dentition and musculature that moves the jaws and the skull as a whole. Think of all of the structures that the skull protects (the brain, eye), transmits (nerves, nasal, and oropharyngeal passageways), and the organs/tissues we use to interact with the world around us. Each receives its own focus, and we are asked to consider how the growth and development of these structures impart multiple influences on cranial form (the head is “modular,” made of many components) which are merged into a whole head (“integration”). Lieberman explains how the skull reflects this. The skull itself does not exactly overlap the soft tissue modules during development. Rather, the numerous bones of the skull form *between* modules. Thus, the same part of the frontal bone is at once (part of) the floor for the brain and the roof for the orbit. The integrated skull tells a

story of growth and development, and the theme of a “developmental hierarchy” emerges. Thus, our regional understanding of the head must account for interactive development of its modules, during which some may exert primary influences (e.g., brain size influences cranial base angle/cranial base angle influences facial projection). Moreover, the entire course of development must be related to special attributes of the organism as a whole (e.g., being bipedal).

After reading Chapters 1 through 9, I was left wanting little in terms of anatomical discussion. Because I am wondering about it so often myself, I would have liked to know more of Lieberman’s thoughts on pneumatization. If paranasal sinuses are themselves growing “modules” (Moss assigned “pneumatic skeletal units” to house them), they are, of course, integrated during development. But the concept of paranasal sinuses as by-products (“spandrels”) implies they are a *consequence* of integration between two or more modules. Facial-expression musculature is of special importance to humans and their close relatives, and could have been discussed at greater length. These may have been too far tangential to the main narrative, though (perhaps here as well). However, the book has a nice trajectory leading toward reconstruction of our last common ancestor (LCA) with our closest living hominoid relative, the chimpanzee. Some cursory treatment of topics seems a wise choice. The narrative on growth, development and, anatomy builds until Chapters 11 through 13, where Lieberman takes the reader on a tour of fossil humans (and their close ancestors). Some differences from modern humans are seemingly profound (e.g., head posture) and others seemingly more subtle (e.g., enamel thickness).

The research that Lieberman cites comes from disparate specialized fields of study. Certain topics are given a short treatment, and the craniofacial biologist or histologist may quibble with certain passages. I believe Lieberman was appropriately judicious in the space devoted to concepts of microanatomy and growth of skeletal tissues. However, some errors or oversimplifications are present. Cartilage is not “poorly organized” (p. 21), although I appreciate that this may be meant to say that cartilage appears to be less highly organized than bone when viewed at a light microscopic level. Canaliculi are not cellular extensions (processes) of osteocytes (p. 46), rather they are the elongated spaces through which osteocytes (in their lacunae) send out extensions that communicate with other osteocytes. I also noted inconsistency in the description of how particular bones ossify. The inferior nasal concha is said to arise by intramembranous ossification (p. 131) or endochondral (p. 92) in two different passages (it is the latter mode of ossification in all cases I have seen). The vomer is grouped with elements that arise from the mesethmoid cartilage (p. 131). It should certainly be discussed as an element of the nasal septum, but it should be noted that it ossifies intramembranously. There are other minor inconsistencies, such as the names of ossification centers for the maxilla (pp. 91 and 131), but all are minor in relation to the vast literature on craniofacial biology that is synthesized.

Lieberman discusses many topics on human evolution that remain contentious, and his own opinions are clearly stated. No doubt, some specialists will

take issue with some passages (e.g., on the evolution of speech, nasal airflow, and the head posture of our ancestors). But the greatest strength of this book is not found in such passages. Rather, this book fills a critical void by using the nuanced language of ontogeny that has emerged with the writings of Gould, Moss, Enlow, and others to discuss a greatly distinctive and complex part of our human form. Until the final four chapters, Lieberman often engages the reader in a thought experiment: How would one transform an ape head to a human? In many ways, he posits that a “handful of ontogenetic shifts” (p. 151) can account for the differences. In Chapters 11 through 13, we are taken on a tour of more direct evidence—the fossils of hominins, and Lieberman gives us specific examples of the subtle developmental modifications that could account for the transformations from the LCA to modern humans. Admittedly, hominins, in particular, are not my specialty and are not a primary interest. But it is a pleasure to be taken on a tour of the hominoid head with the challenge to understand how the whole is integrated from multiple semiautonomous components.

So we return to the major theme of tinkering. Can a complex organ such as the eye or a multifunctional region such as the head be modified in increments by natural selection, and still remain functional? Lieberman says this is not difficult to envision, but he is aware that an alternative has been suggested, citing a book by Michael Behe (*Darwin's Black Box*) on page 13. A frequent refrain in Behe's book is that organisms as well as many aspects of their anatomy are “irreducibly complex,” and this complexity requires an explanation other than design by *natural* selection. The debates surrounding the assertion of irreducible complexity may have been philosophically interesting, but the underlying premise of intelligent design is untestable. To make the assertion also puts limits on inquiry, and that is a shame. The inquiry is well worth the challenge, and anyone interested in pondering the origin of some of our most uniquely human attributes should read this book. In practical terms, Lieberman's book deals with a complex region and complex developmental concepts, and some background knowledge on each will maximize the value. I recommend this book as a must-read to students or professionals in the fields of anthropology, anatomy, craniofacial biology, and many clinical specialties.

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