Replacement of Neanderthals by Modern Humans Series

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Hiroki C. Tanabe *Editors*

Digital Endocasts

From Skulls to Brains

Springer

Replacement of Neanderthals by Modern Humans Series

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The planned series of volumes will report the results of a major research project entitled "Replacement of Neanderthals by Modern Humans: Testing Evolutionary Models of Learning", offering new perspectives on the process of replacement and on interactions between Neanderthals and modern humans and hence on the origins of prehistoric modern cultures. The projected volumes will present the diverse achievements of research activities, originally designed to implement the project's strategy, in the fields of archaeology, paleoanthropology, cultural anthropology, population biology, earth sciences, developmental psychology, biomechanics, and neuroscience. Comprehensive research models will be used to integrate the discipline-specific research outcomes from those various perspectives. The series, aimed mainly at providing a set of multidisciplinary perspectives united under the overarching concept of learning strategies, will include monographs and edited collections of papers focusing on specific problems related to the goals of the project, employing a variety of approaches to the analysis of the newly acquired data sets.

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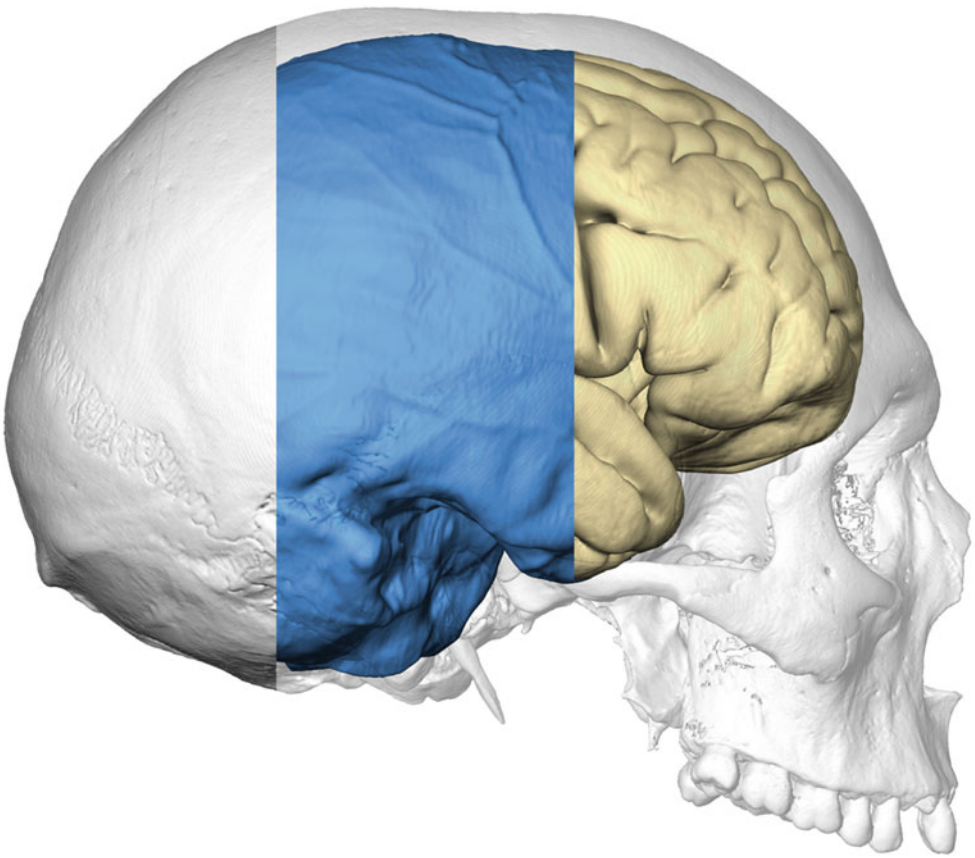

Brain, endocast, and skull digital reconstruction (courtesy of Simon Neubauer)

Preface

In recent years, computer-based techniques have led to a noticeable renaissance of most anatomical disciplines, involving new challenges and re-introducing old problems. Digital anatomy has represented a major advance in the visualization and exploration of anatomical elements, and computed morphometrics has supplied numerical and statistical tools for analyzing anatomical systems using proper quantitative approaches. Before this "pixel revolution," anatomy was often limited by reduced sample sizes and by methodological difficulties associated with physical dissections. Working with bodies, most of all when dealing with humans, implies a limited availability of individuals, difficulties in management and administration, and large and complex histological preparations. Furthermore, dissections only allow the study of the anatomical components outside of their functional conditions. Digital tools can be used to investigate large samples with an extreme resolution and within their biological context, preventing most of those limitations, which, decades ago, contributed to a sort of "freezing" of the anatomical fields, slowing down their development and often impeding the efficient dissemination of their achievements. Once the computed tools had become available on a large scale and many forgotten topics had been recovered from past literature, we realized that we still lacked much information regarding our own anatomy. In fact, we have spent the last decades principally investigating molecules and microscopic features, but we do not yet have a robust knowledge of our bones and vessels. For many macroanatomical traits, we still ignore the variations, influences, and developmental processes that generate the phenotypic variability of our species. Importantly, some of these anatomical traits may be crucial not only from an evolutionary perspective, but also from a medical point of view.

Physical dissections and other non-digital approaches are still mandatory and essential, but the complementary potentialities of these computed methods are outstanding. Nonetheless, as usual, power must be accompanied by adequate control of its capacities and limitations. Most of these methods are based on very complex and complicated technical and numerical assumptions and criteria that rely on elaborate programs, devices, and algebraic transformations, and they are based on an important background integrating electronics, informatics, and statistics. Therefore, the entangled numerical elaboration associated with these digital models requires competence and caution. Frequently, programs are sufficiently "user-friendly" to allow a basic manipulation of the data without any comprehensive knowledge of the processes involved. This usability further increases the possibility of a superficial use, interpretation, or understanding, of the actual outputs of a computerized analysis. Multidisciplinarity is, indeed, strictly required in such a complicated methodological context.

Most anatomical disciplines have taken advantage of these methodological changes, but one that probably has been particularly privileged by these digital approaches is neuroscience. Structural and functional imaging has induced a considerable revolution in all kinds of brain studies, including evolutionary neuroanatomy. This book is part of the 5-year (2010–2014) project "Replacement of Neanderthals by Modern Humans: Testing Evolutionary Models of Learning" (RNMH), funded by the Japanese Government (Ministry of Education, Culture, Sports, Science, and Technology, Grant-in-Aid for Scientific Research on Innovative Areas No. 22101001) and coordinated by Professor Takeru Akazawa. The project is based on a multidisciplinary approach, integrating cultural anthropology, biological sciences, and engineering, to investigate and compare cognitive and cultural capacities in modern humans and Neanderthals, and to make inferences on their respective learning abilities. This new volume of the RNMH Series is dedicated to brain evolution and paleoanthropology, focusing on recent advances in all those research areas investigating the brain form in extinct species. The book includes chapters on craniology, digital techniques, endocast reconstruction, craniovascular traits, surface analyses, landmarking, and on the relationships between the brain and the braincase. Furthermore, the volume includes chapters concerning the principal brain districts, and reviews the current knowledge regarding their evolution in humans and in nonhuman primates. The aim is to supply a comprehensive and updated reference on the challenges, advances, and limitations associated with the study of the brain form and functions in fossils, introducing the current state of the art and future directions of human paleoneurology.

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