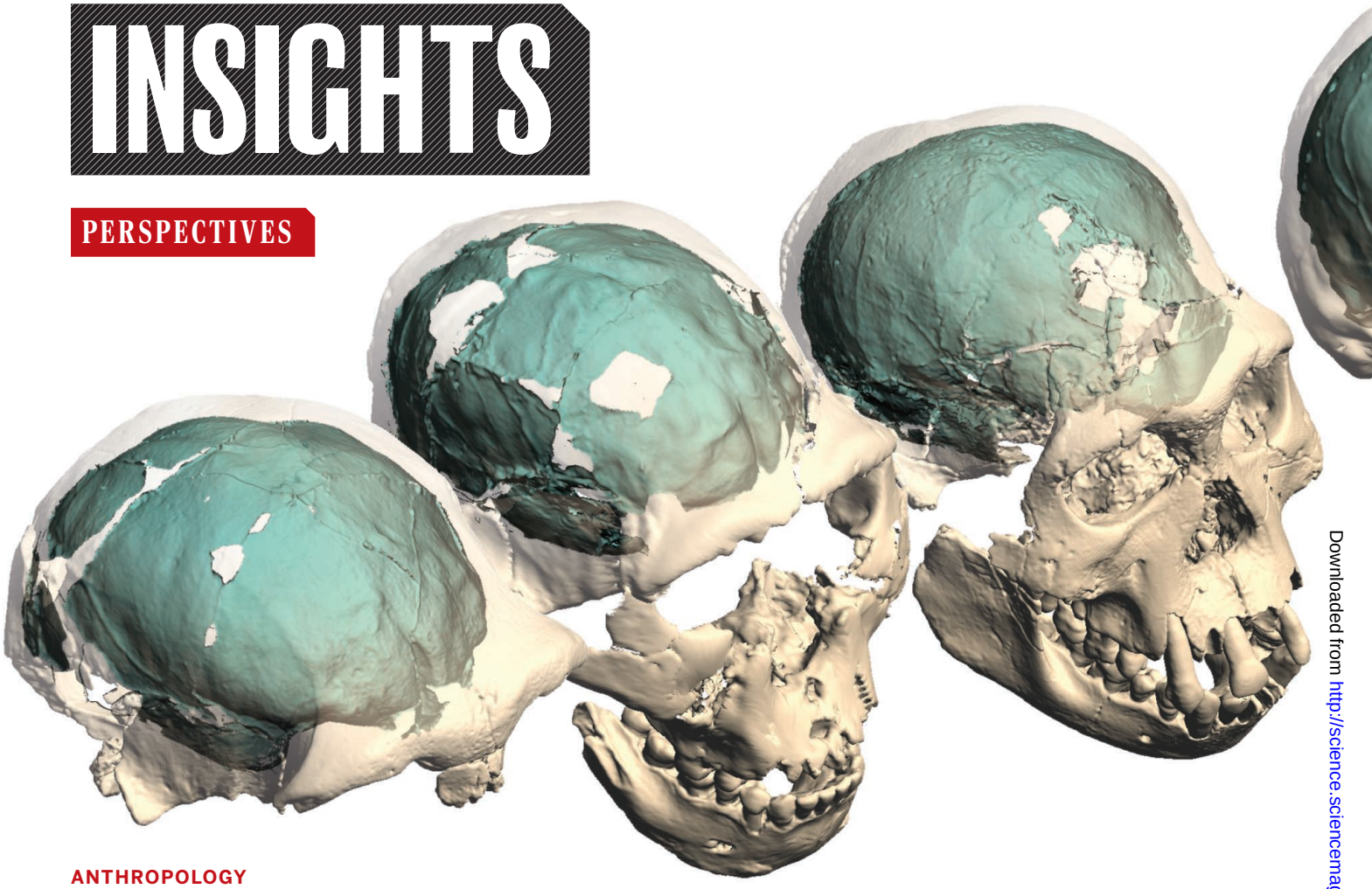

ANTHROPOLOGY

The enigmatic origins of the human brain

Evolutionary history of the human brain appears more complex than thought

By **Amélie Beaudet**[1,2,3]

Tracking the emergence of humanlike cerebral features in the hominin fossil record could provide evidence of the timing and process of brain changes and offer a glimpse into the behavior of our ancestors and relatives. Because brain tissues rarely fossilize, changes in brain size, shape, and organization are gleaned from brain endocasts (replicas of the inner surface of the braincase) (*1*). After his observations of brain imprints preserved in fossil cranial specimens from Olduvai (Tanzania) (*2*), paleoanthropologist Phillip V. Tobias stated that "hominid evolution attained a new level of organization…with the emergence of the genus *Homo*." There have since been debates on whether humanlike brain organization emerged concomitantly with the appearance of the genus *Homo*. On page 165 of this issue, Ponce de León *et al.* (*3*) challenge this view by suggesting that *Homo* in Dmanisi (foothills of the Georgian Caucasus) 1.85 to 1.77 million years (Ma) ago showed a primitive organization of the brain.

Reconstructing the chronology and mode of hominin brain evolution requires a good knowledge of subtle changes in brain areas. In this respect, the inferior part of the frontal lobe, where Broca's cap is located, has been the focus of thorough investigations and intense discussions (*4*). In addition to its use as a critical landmark for brain reorganization, Broca's cap plays a fundamental role in language production and comprehension, the evolution of which is an equally intriguing topic. The Broca's cap of extant humans differs structurally from that of our closest living relatives, the chimpanzees and bonobos. Chimpanzees and bonobos have one distinct furrow in that region called the fronto-orbital sulcus. This is absent in humans, who instead have two vertical furrows. In human evolutionary studies, it is assumed that the chimpanzee and bonobo brains more closely approximate the primitive condition for the hominin brain. Within this context, the "single-furrow condition" is interpreted as representing the ancestral condition.

Despite crucial recent discoveries of germane specimens and ground-breaking computer-assisted revision of the fossil record (*5*, *6*), little is known about the brain of early *Homo*. This unfortunate situation can be partially explained by the scarcity of complete or at least partial fossil crania from that time period. For example, the putative earliest human remains from Ledi-Geraru (Ethiopia), dated to 2.8 Ma, do not preserve

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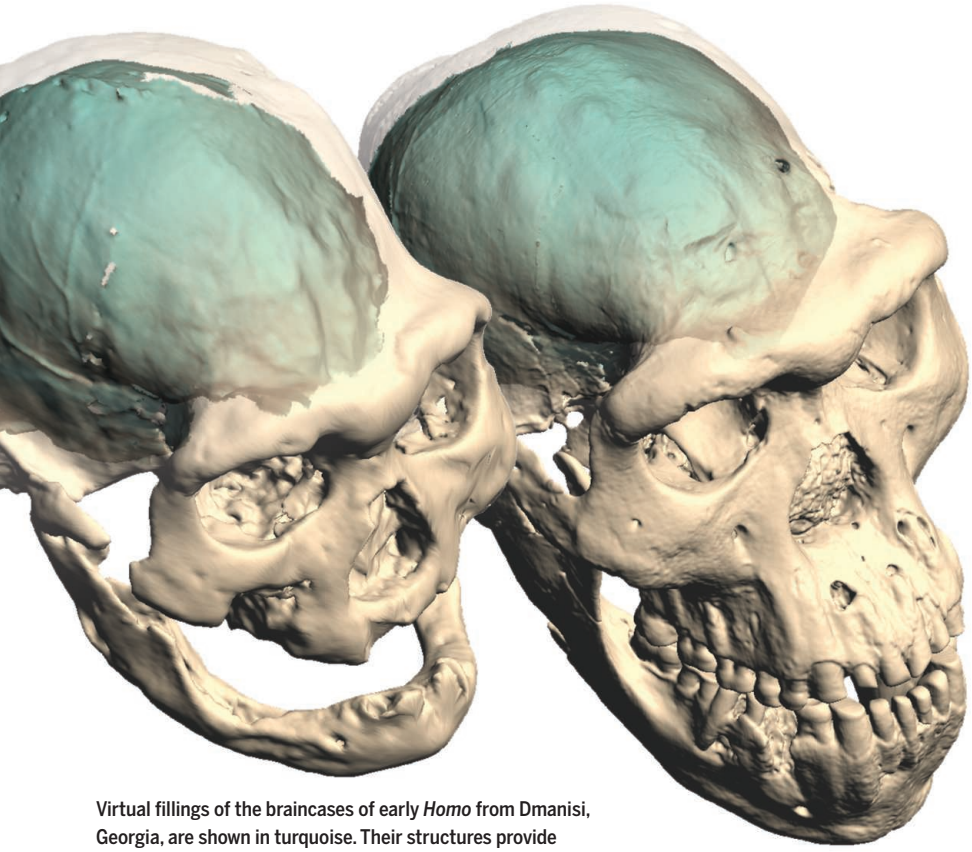


Virtual fillings of the braincases of early *Homo* from Dmanisi, Georgia, are shown in turquoise. Their structures provide new insights into human brain evolution 1.8 million years ago.

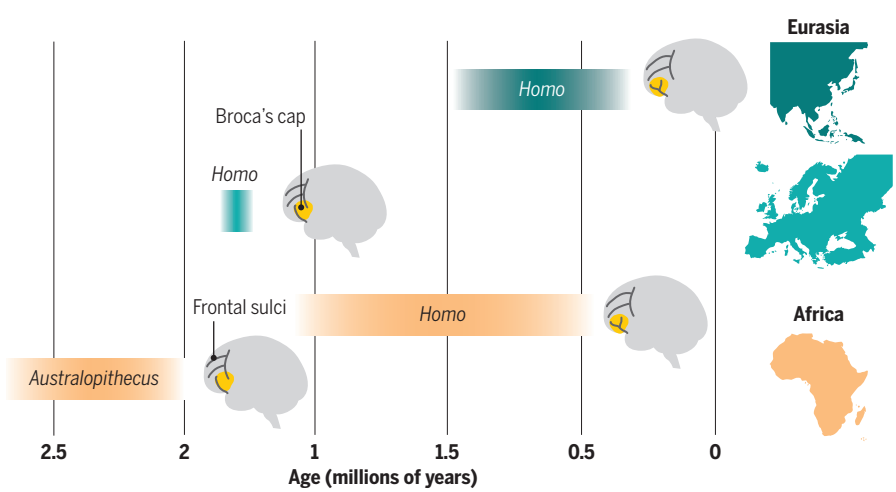
the braincase (*7*). The early *Homo* specimens for which there are an exploitable amount of endocast data (description of the organization of the cerebral areas) are from African and Asian localities that are geologically relatively young (less than 1.8 Ma) (*8*, *9*), leaving a gap of about 1 Ma in our knowledge of human brain evolution. In terms of frontal organization, this 1 Ma break in the usable fossil record is crucial. Early hominins that wandered in Africa before 2.8 Ma show a relatively primitive organization of this region (*4*), whereas imprints on later human endocasts indicate a derived human condition (*5*). In this case, the hypothesis of a derived organization emerging at the same time as the earliest humans could not be discounted.

Through their comprehensive study of the notable assemblage from Dmanisi and their revision of the African and Asian fossil material, Ponce de León *et al.* cast new understanding on the cerebral organization of early *Homo* in general, and *Homo erectus* (*sensu lato*) in particular, challenging the idea of the emergence of a fully derived human brain at the time of the earliest representatives of the genus *Homo*. The hominin fossil-bearing site of Dmanisi is exceptional for its geographical (Europe) and chronological (1.85 to 1.77 Ma) contexts (*10*). As such, fossiliferous deposits of this locality document one of the earliest dispersals of *Homo* out of Africa. By combining various methods of high-resolution imaging (including synchrotron radiation) and three-dimensional modeling techniques (including geometric morphometrics), the authors demonstrate that the endocast of *H. erectus* at about 1.8 Ma reflects a primitive organization of the frontal lobes, whereas later *H. erectus* specimens in Southeast Asia and Africa show a derived condition (see the figure). Accordingly, the authors suggest that the humanlike frontal lobe organization emerged after the genus *Homo* and the earliest dispersals out of Africa.

The question that will need to be addressed next deals with the nature of the underlying evolutionary processes. What kind of selection pressure may have been responsible for the reorganization of the frontal lobes? This question has tremendous functional and behavioral implications because, apart from language, it has been demonstrated that the Broca's cap was also certainly involved in toolmaking (*11*). The other possibility, which probably deserves more attention, is that there was no selection at all, and changes that affected the Broca's cap were a by-product of the reorganization of other areas of the brain, and that, ultimately, the emergence of language was the result of an exaptation (previously existing anatomical features co-opted for a new use) (*12*). In that respect, the description of the brain imprints of the endocasts of earlier *Homo* specimens, such as the braincase recently found at Drimolen (South Africa) (*13*), and future discoveries of new specimens from that time period will be essential to understanding the evolutionary context of these brain changes. ■

An evolutionary scenario for the hominin frontal lobes

The evolutionary scenario is based on the evidence of brain changes preserved in the fossil record and investigated by Ponce de León *et al*. Dark gray curves indicate the position of the frontal sulci.



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