Combining Paleoenvironmental and Paleoanthropological Datasets to Understand Human Brain and Body Size Evolution

Manuel Will[1], Mario Krapp[2], Jay T. Stock[3] & Andrea Manica[2]

[1] Dept. of Early Prehistory and Quaternary Ecology, Univ. of Tübingen, Burgsteige 11, 72070 Tübingen, Germany
[2] Evolutionary Ecology Group, Dept. of Zoology, Univ. of Cambridge, Downing St, Cambridge, CB2 3EJ, United Kingdom
[3] Dept. of Anthropology, Western Univ., London, Ontario, Canada, N6A 3K7, Canada

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Body and brain size are essential biological parameters of hominins. While recent research has clarified taxonomic and temporal trends within the human lineage, the causal mechanisms for these changes remain contentious, including environmental change, but also demographic, social, dietary and technological factors. Here we test the influence of environmental factors on the evolution of body and brain size in the genus *Homo* over the last one million years by formalized hypotheses in a quantitative statistical framework. To this end, we for the first time combine a large fossil dataset (n=208) including spatial coordinates with a global climate model emulator that provides environmental variables for each space-time combination of individual fossils. Our results show different patterns of correspondence between modelled environmental variables and body and brain size evolution in *Homo*. Temperature predicted body size according to Bergmann's rule across all studied *Homo* taxa, likely a direct effect of climate on human physiology. On the other hand, net primary productivity and long-term variability in mean annual precipitation were good predictors of brain size in archaic but not modern humans. These environmental variables likely worked more indirectly in their effects, affecting cognitive abilities and extinction probabilities. While environmental challenges faced by hominins over their lifetime had some influence on body and brain size evolution in Middle Pleistocene *Homo*, Neanderthals and *Homo sapiens*, they explain only a part of the observed temporal patterns. Multiple interacting causal mechanisms at different time and on different taxa likely underlie the evolution of these key biological characteristics of *Homo* in the Pleistocene. Quantitative modelling with machine learning methods based on further interdisciplinary combination of large databases, for example from archaeology, will be key to further our understanding on brain and body size evolution within the genus *Homo*.

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ORCID®
Manuel Will https://orcid.org/0000-0001-8116-2543
Mario Krapp https://orcid.org/0000-0002-2599-0683
Jay T. Stock https://orcid.org/0000-0003-0147-8631
Andrea Manica https://orcid.org/0000-0003-1895-450X

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