

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- ☐ ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- ☒ ☐ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☐ ☒ The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- ☒ ☐ A description of all covariates tested
- ☒ ☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- ☐ ☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- ☐ ☒ For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- ☒ ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- ☒ ☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- ☒ ☐ Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection

Data was collected on the original specimen or on the symmetrized reconstruction, as described in the text. Comparative data were collected from original fossils and CT scans of fossils collected from various sites in Kenya, Tanzania, and Ethiopia. Extant comparative data were collected from CT scans of Pan troglodytes ($n=20$) and Gorilla gorilla ($n=20$) crania.

Data analysis

For the micro CT-scan data analysis, we used Avizo 9.3 (ThermoFisher Scientific); Geomagic Design X (3D Systems Software srl); Viewbox 4.1 software (dHAL Software, Kifissia, Greece). For the phylogenetic analysis, we used PAUP* 3.99.164.0. Summary statistics, graphs and permutation testing were conducted in the R statistical platform version 3.5.1.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

We have presented most of the data in Extended Data Figures, Extended Data Tables and Supplementary Information. The data that support the findings of this study, but not included in the Supplementary Information, are available from the corresponding author upon reasonable request.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	This study describes a 3.8 Myr early hominin cranium from Ethiopia and assesses its taxonomic affinity.
Research sample	In our comparative analysis, we used originals and replicas of fossil specimens recovered from Kenya, Tanzania, Ethiopia, and South Africa.
Sampling strategy	No sample size calculation was performed. Sampling strategy was merely based on availability of fossil materials, particularly crania, from the time period of interest (3-4 million years ago).
Data collection	Data from the original specimen was collected by Y.H.S. and S.M.M. Micro-CT scan data processing and collection was conducted by T.M.R., S.B., and A.V. in collaboration with Y.H.S. and S.M.M.
Timing and spatial scale	Data collection started in the summer of 2016, followed by comparative data collection during the summer of 2017. Data on the original specimen was being collected between January and March when Y.H.S. and S.M.M. had access to the specimen before their field season. This continued until the write up of this manuscript.
Data exclusions	No data was excluded from the analysis.
Reproducibility	This is a comparative morphological description of a fossil specimen and no experiments were conducted to test repeatability.
Randomization	The comparative specimens have known taxonomic affinity and there was no randomization.
Blinding	Blinding was not relevant to this study because it was a field study not an experimental study.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Arid, limited tree cover, low relief river valley between high, basalt covered plateaus, and hot.
Location	Area around fossil discovery site in the Godaya River Valley of the Woranso Mille project area, Afar Region, Ethiopia (11°32'59.5" N; 40°27'54.6" E)
Access and import/export	Access and sample export followed the laws and regulations of Ethiopia and the Afar Regional state. Permission from the Authority for Research and Conservation of Cultural Heritage (ARCCCH), dated November 17, 2015 (Ref. # 08/KT-69/005), allowed us to conduct field research that led to the discovery of the subject of this manuscript. The Minister of Culture and Tourism authorized the export of the original fossil (MRD-VP-1/1) to the United States for CT-scanning on May 2, 2016, Ref. # 1/A-10/354.
Disturbance	Camping, road access, heat, and sample collection provided minimal disturbance.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involvement in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☐	☒ Palaeontology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

n/a	Involvement in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Palaeontology

Specimen provenance

The specimen was collected from Woranso-Mille Site, Lead Author's field site in the Afar region of Ethiopia. Field work at the site is conducted with permits from the Authority for Research and Conservation of Cultural Heritage of the Ministry of Culture and Tourism of Ethiopia issued on November 17, 2015, Ref. # 08/KT-69/005.

Specimen deposition

The original specimen is housed in the Paleoanthropology Laboratory of the National Museum of Ethiopia.

Dating methods

Age of the specimen was determined by using $^{40}\text{Ar}/^{39}\text{Ar}$ dating of volcanic tuffs at the Berkeley Geochronology Center, located in Berkeley, California. The methods are described in a companion manuscript.

☒ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.