Cite as: A. Picin *et al*., *Science* 10.1126/science.abi8330 (2021).

Comment on "A global environmental crisis 42,000 years ago"

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Cooper *et al*. (Research Articles, 19 February 2021, p. 811) propose that the Laschamps geomagnetic inversion ~42,000 years ago drove global climatic shifts, causing major behavioral changes within prehistoric groups, as well as events of human and megafaunal extinction. Other scientific studies indicate that this proposition is unproven from the current archaeological, paleoanthropological, and genetic records.

Cooper *et al*. recently reported a tree ring–based ^{14}C dataset (42 to 36 ka ^{14}C BP) based on four kauri trees, achieving high-precision data (±107 to 180 years, 1σ), ideal for reconstructing the increase of ^{14}C production during the Laschamps excursion and creating a detailed kauri-Hulu calibration curve (*1*). These data allowed the authors to model statistically possible variations of the global climate during the geomagnetic inversion. Although we appreciate the scientific advances accomplished in (*1*), we note with concern several statements relating the supposed impacts of the Laschamps on hominin and faunal extinctions and human behavioral changes, which misconstrue the current paleontological, archaeological, and genetic data. Geomagnetic reversals were frequent during the Pliocene and Pleistocene (*2*), and mass extinctions at the time of these inversions have not been documented in the paleontological and archaeological record so far. For example, the Blake excursion (~114 ± 1 ka BP) (*3*) occurred without apparent serious effects on the subsistence of Neanderthals in Eurasia, *Homo sapiens* in Africa, and megafauna in Australia. In our view, Cooper *et al*. have used the archaeological and paleontological data selectively in order to create a narrative that could support the Laschamps as the main driver of a global environmental crisis. Here, we contextualize the evidence at ~45 to 40 ka BP to show that the claimed huge impacts of the geomagnetic inversion on humans and megafauna go far beyond the available data. We observe three main issues in (*1*) that include the extinction of megafauna in Australia, the demise of Neanderthals and early groups of *Homo sapiens* in Europe, and the emergence of figurative art in caves.

In our view, the Greenland ice cores and marine records do not document any notable effects of the Laschamps excursion on the global climate (*4*). However, Cooper *et al*. argue that Laschamps-associated changes in climate can be linked to megafaunal extinctions, especially in Australia, which they suggest peaked at 42.1 ka. Recent research now suggests that much of Australia's megafauna survived beyond 40.1 ka BP (*5*). Although ancestry replacements frequently occurred during the last glacial period in Eurasian megafauna, synchronous bottlenecks or extinctions around 45 to 40 ka BP have not been noted (*6*). Most of these taxa, despite turnovers, survived the Last Glacial Maximum (e.g., *Coelodonta antiquitatis*) and even the Pleistocene-Holocene transition (e.g., *Mammuthus primigenius*).

The second main issue of (*1*) is the presumed relation between the climatic impact of the Laschamps and the extinction of Neanderthals and contemporaneous European *H. sapiens*. We clarify that during their evolutionary history, Neanderthals survived glaciation events and climatic fluctuations harsher than the stadials GS-11 and GS-10 (*7*). During Marine Isotope Stage (MIS) 6 and MIS 4, the Scandinavian ice sheet reached central Germany and the coast of Poland, respectively. Therefore, climate change may have played only a minor role in the fate of the Neanderthals (*8*). A more likely factor is gradual competitive exclusion, caused by the dispersals of *H. sapiens* in Europe

after ~46 ka BP (*9*), which disrupted the Neanderthal niche structure and food web.

Additionally, the radiocarbon dataset used by Cooper *et al.* [see figure S31 of (*1*)] for establishing the temporal range of Neanderthals' demise is arbitrary in the selection of ^{14}C dates. A better solution would have been to compare the chronological boundaries of key sites or the direct dates of human fossils (Fig. 1 and Table 1). In Iberia, Neanderthals may have persisted after a threshold of ~40 ka BP [(*10*) and references therein], whereas the chronology of the last Neanderthals in central and western Asia is still virtually unknown. Moreover, we note that the end of the Middle Paleolithic at one or a group of sites does not necessarily reflect the end of Neanderthals as a species, and current scenarios may change with further research in less investigated areas.

The claim that the Laschamps event had a negative impact on some early European *H. sapiens* populations is also problematic. If the weakened geomagnetic field allowed a rise in ultraviolet radiation in equatorial and low latitudes, *H. sapiens* in Africa should have been even more affected than groups living in temperate environments. Hence, the Laschamps should have slowed the dispersal out of Africa and beyond, whereas data suggest that it had no such effect. Similarly, no large-scale impact at ~42 ka BP is observed in the known African archaeological, paleoanthropological, or genetic records (*11*).

Furthermore, if we consider both the short (Uluzzian, 45/43 to 40 ka cal BP; Protoaurignacian, 41.5 to 39.9 ka cal BP; Early Aurignacian, 39.8 to 37.9 ka cal BP) and the long (Early Aurignacian, 42.5 to 37.9 ka cal BP) chronology for the cultural succession of the Early Upper Paleolithic (*12*), we note that *H. sapiens* certainly survived the climatic consequences of the Laschamps. This evidence makes it unclear how ultraviolet radiation affected only some European inhabitants when no data currently support the greater use of ochre as sunscreen in the Aurignacian or any other Upper Paleolithic culture. In addition, although the end of the Uluzzian temporally overlapped with the Protoaurignacian in northern Italy (*13*), the lamellar technologies of the Aurignacian may have originated in western Asia rather than developing from previous technical behaviors of *H. sapiens* in Europe (*12*).

Lastly, in the archaeological record, a large increase in the use of caves at 42 to 40 ka BP is not apparent in the data. Since the Lower Paleolithic, the occupations of these natural shelters were the results of complex settlement dynamics and subsistence strategies (*14*). Figurative cave paintings may have emerged as an artistic expression that tried to imitate and transfer natural patterns in new contexts. These behaviors had appeared in eastern Borneo by 52 to 40 ka BP, in Sulawesi by at least 45.5 ka BP, and possibly in Europe before 64 ka BP [(*15*) and references therein], a time period well before the increase in the ultraviolet radiation caused by the Laschamps event.

All in all, not only have Cooper *et al.* failed to provide convincing explanatory mechanisms relating the Laschamps excursion to cultural and biological changes, but their chronological coincidence with this geomagnetic reversal is highly questionable.

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3 April 2021; accepted 2 November 2021
Published online 19 November 2021
10.1126/science.abi8330

ACKNOWLEDGMENTS

Funding: A.P. and J.-J.H. are supported by the Max Planck Society. A.P. is supported by the German Research Foundation (DFG; project 429271700-STONE). S.B. is supported by ERC n. 724046 SUCCESS (www.erc-success.eu/). R.B. is supported by a Ramón y Cajal research contract by the Ministry of Economy and Competitiveness (RYC2019-026386-I). J.R. and R.B. develop their work within the Spanish AEI/FEDER projects PGC2018-093925-BC32 (J.R.), CGL2016-80000-P (J.R.), and PID2019-104949GB-I00 (R.B.), and Generalitat de Catalunya–AGAUR projects 2017 SGR 836 and CLT009/18/00055. The IPHES-CERCA has received financial support from the Spanish Ministry of Science and Innovation through the "María de Maeztu" program for Units of Excellence (CEX2019-000945-M). M.H. was supported by Marie Sklodowska Curie Actions (grant no. 844014). M.H. and P.S. were supported by Francis Crick Institute core funding (FC001595) from Cancer Research UK, the UK Medical Research Council, and the Wellcome Trust. P.S. was supported by the Vallee Foundation, the European Research Council (grant no. 852558), and the Wellcome Trust (217223/Z/19/Z). C.S.'s research is supported by the Calleva Foundation and the Human Origins Research Fund. S.T. has received funding from the European Research Council under the European Union's Horizon 2020 Research and Innovation Programme (grant agreement 803147 RESOLUTION, https://site.unibo.it/resolution-erc/en). For the purpose of open access, the authors have applied a CC BY public copyright license to any author accepted manuscript version arising from this submission. **Author contributions:** All authors contributed equally to this paper. **Competing interests:** The authors have no competing interests to declare. **Data and materials availability:** Table 1 can be downloaded from Zenodo (https://zenodo.org/record/5303753#.YSpCuY4zY2w).

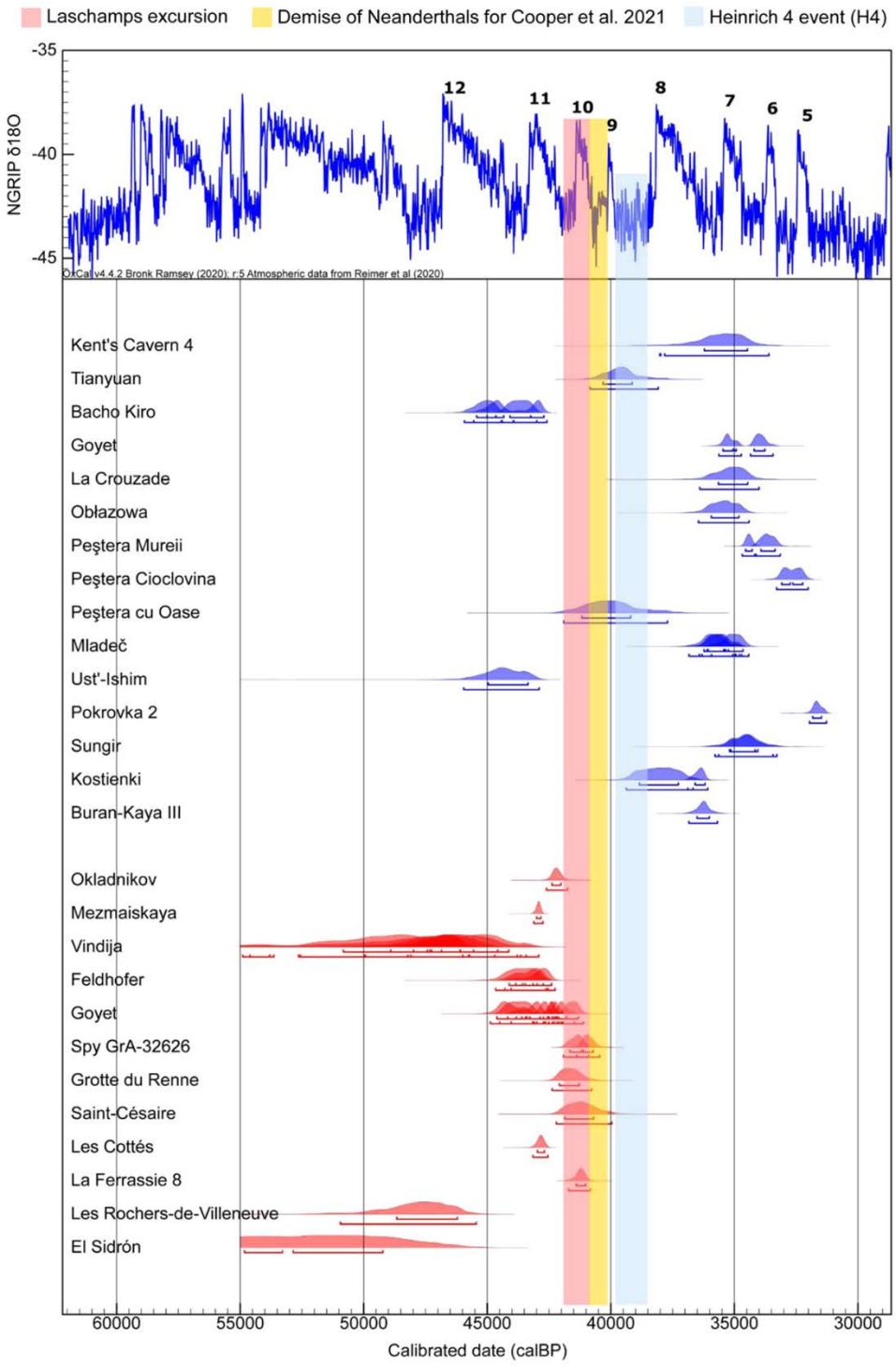

Fig. 1. Neanderthals and *Homo sapiens*' direct date*s* published before the Cooper *et al*. 2021 paper. Some hominins have more than one date (Spy, Goyet, Kleine Feldhofer, Vindija, Kostienki, Sungir, Peştera Mureii, Mladeč, and Bacho Kiro) and are merged together in one single line in the graph. The calibrated ranges are produced using IntCal 20 in the OxCal 4.4 program (*16*, *17*).

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Science, 374 (6570), eabi8330. • DOI: 10.1126/science.abi8330