



## Debate

# Cultural evolution as inheritance, not intentions

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Cultural inheritance is a central issue in archaeology. If variation were not inherited, cultures could not evolve. Some archaeologists have dismissed cultural evolutionary theory in general, and the significance of inheritance specifically, substituting instead a view of culture change that results from agency and intentionality amid a range of options in terms of social identity, cultural values and behaviours. This emphasis projects the modern academic imagination onto the past. Much of the archaeological record, however, is consistent with an inter-generational inheritance process in which cultural traditions were the defining characteristics of behaviour.

Keywords: Neolithic, agency, cultural evolution, inheritance, intentionality, kinship

## Introduction

Since the early twentieth century, archaeologists have examined how inherited cultural practices such as kinship, wealth, subsistence and access to resources are reflected in the archaeological record (e.g. Kroeber 1916; Colton 1942). While inheritance is essential to evolutionary theory, both biological and cultural (Shennan 2011a; Bonduriansky & Day 2018), some anthropologists and archaeologists are calling for the dismissal of inheritance in cultural evolution altogether. One proposal, for instance, offers a new concept, ‘perdurance’, defined as the “continual bringing forth or production of a world that—in the passage of generations—is ever in formation” (Ingold 2022: S37). This contrasts with evolutionary archaeology, which views items in the archaeological record as proxies for studying the transmission of cultural traits between people in a process of descent with modification (O’Brien & Lyman 2002). On an intergenerational timescale, this is nothing but cultural inheritance, akin to biological inheritance.

Key themes in this debate include agency—how individuals shape and are shaped by social norms, cosmology and status hierarchies—and intentionality. Cultural historian Albert Spaulding (1954: 14) characterised culture by “its continuous transmission through the agency of person-to-person contact”. Agency theory is compatible with evolutionary archaeology (e.g. Ribeiro 2022), despite a focus in agency theory on how variants are intentionally introduced into cultural evolution. Evolutionary archaeology, by contrast, analyses variation regardless of intent (O’Brien & Holland 1992), not only because “evidence of these

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individual decisions cannot be recovered by archaeologists” (Flannery 1967: 122) but also because short-term intentions, as microevolutionary processes, do not direct the long-term process of macroevolution. Weeding and seed harvesting, for example, are short-term individual intentions, whereas generations of those inherited practices were unintentionally pivotal to the cultural evolution of agriculture (Rindos 1984), “with unexpectedly sustained cultural connections in deep time” (Allaby *et al.* 2022: 268).

## **Inheritance and learning**

Most archaeologists would agree that intentionality is framed by inherited social practices and knowledge (e.g. Hodder & Cessford 2004; Ribeiro 2022). In life, daily routines become embedded in social rules, obligations and interactions, to the point of being ‘embodied’ human movements (Roux 2007). The creativity of children, for example, usually becomes constrained in adolescence by social norms (Lew-Levy *et al.* 2020). As Hodder and Cessford described:

*As a child grows up within routinized domestic space, it learns that particular practices, movements, ways of holding oneself, deferential gestures, and so on are positively valued while others are not. The child learns social rules in the practices of daily life within the house. In this way daily practices become social practices* (Hodder & Cessford 2004: 18).

In evolutionary archaeology, this learning is termed cultural inheritance, which creates traditions, which are identifiable as patterned ways of doing things over extended periods of time (O’Brien *et al.* 2010). Learning is an “extension of biology through culture” (Whiten 2017: 1). In cultural evolutionary theory, culture is information—such as knowledge, beliefs and skills—transmitted between individuals through learning pathways. As cultural inheritance is often cumulative, “beneficial modifications are culturally transmitted and progressively accumulated over time” (Derex 2021: 1).

## **Cultural inheritance and the *longue durée***

Most of the archaeological record documents the slow evolution of cultural practices through time—the ‘*longue durée*’ (Braudel 1958). Consistency through time is the result of cultural inheritance. Take, for example, the 700 000-year-long sequence of Acheulean stone tools (1.2–0.5mya) at Olorgesailie, Kenya (Deino *et al.* 2018). The thousands of handaxes at this site, spread across 29 stratigraphic levels, arguably represent the longest sequence of cultural inheritance in the archaeological record, perhaps with some genetically induced hardwiring in the brain as an assist (Corbey *et al.* 2016). Does this mean that Acheulean handaxes never changed, even slightly, through time? No; within this millennia-long tradition (Key 2022), variations in handaxe form and production were subject to the evolutionary processes of isolation, drift and selection. The practice was inherited through a learning balance between imitation (copy how to do it) and emulation (copy the goal and figure out how to do it).

As tools became more complex, imitation became predominant. Neanderthals maintained the Mousterian stone-tool technology for roughly 250 000 years, exhibiting only a few different knapping methods (Lycett & Eren 2013). Neanderthal diet was similarly conservative for tens of thousands of years—mainly meat (Richards & Trinkhaus 2009) from hunting strategies focused on local animals (Berlitz *et al.* 2023). This behavioural tradition is consistent with genetic evidence that Neanderthals lived in small groups of closely related kin, with sustained parental investment in children (Ríos *et al.* 2019; Skov *et al.* 2022). After modern humans entered western Europe about 45 000 years ago, Neanderthals rapidly learned a new material culture and even interbred with the new arrivals (Hajdinjak *et al.* 2021).

In Holocene Europe, isotopic and ancient DNA (aDNA) evidence suggests that co-existing groups in certain regions maintained their distinct, inherited forms of subsistence, including hunting–gathering, pastoralism and crop cultivation, potentially for millennia (Bollongino *et al.* 2013; Lazaridis *et al.* 2014). Archaeological assemblages such as the Linearbandkeramik—with distinctive longhouses, incised pottery, stone tools, cultivation practices and livestock, division of labour (Masclans *et al.* 2021) and intergenerational wealth transfers (Kohler *et al.* 2017)—reflect long-term cultural inheritance (e.g. Shennan 2011b). This led to regional variations (e.g. Bickle *et al.* 2014), and the inherited memories of specific places were such that later Neolithic houses were sometimes constructed on or near houses or burials from preceding centuries (e.g. Quinn 2015; Pyzel 2019).

## Kinship and inheritance

In Europe during and after the Neolithic, the inheritance of subsistence practices, social structures and material cultures followed kinship lines (Figure 1). Such kinship systems, which in central Europe were most often patrilocal and patrilineal, were themselves inherited, according to isotopic, genetic and linguistic evidence (Knipper *et al.* 2017; Moravec *et al.* 2018; Mittnik *et al.* 2019; Sjögren *et al.* 2020; Bentley 2022; Blöcher *et al.* 2023). Additional evidence comes from sites such as Gurgy les Noisats, France, where aDNA links dozens of males to one male ancestor (Rivollat *et al.* 2023), and Hazleton North, England, where 15 men, but no women, buried over five generations were descended from a single male (Fowler *et al.* 2022). These interpretations of patriliney or patrilocality in Neolithic Europe have been criticised as reflecting heteronormative male bias (e.g. Bickle & Hoffman 2007; Frieman 2021) or an “obsession with nuclear families” (Ensor 2021: 241), which present “a gendered travel dichotomy [in which] women who travel do so for men” (Frieman *et al.* 2019: 156).

In emphasising the agency for creative expression of kinship (e.g. Bickle & Hofmann 2007; Johnson & Paul 2016; Brück 2021; Ensor 2021), the objections seem to miss what was possible in the past. There is no reason to assume that women migrated for men (Montón-Subías & Hernando 2018; Frieman 2021). Women in post-Neolithic Europe were physically strong (Macintosh *et al.* 2017), and the aDNA and isotopic evidence appears to reflect women as the protagonists in these patrilineal kinship systems (e.g. Bickle 2020; Fowler 2022). The bioarchaeological evidence actually indicates that men were more restricted in their movements than women—especially women with status and wealth.

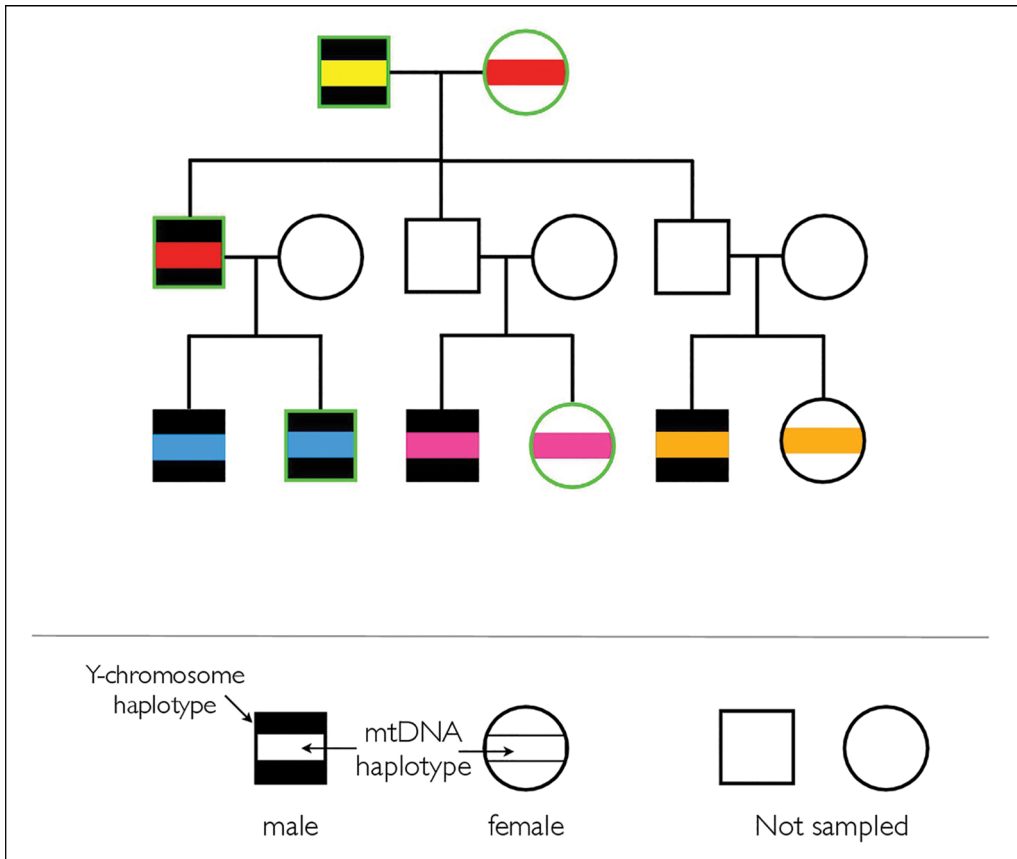


Figure 1. Representation of at least three generations of a larger paternal lineage, in burials from Haunstetten Postillionstraße in southern Germany, late third to early second millennia BC. Black fill indicates Y-chromosomal haplogroup consistent with one lineage. The colour of the bar in the middle of each symbol represents the mtDNA haplogroup. Individuals with rich grave goods are outlined in green. Additional individuals in richly furnished burials, not shown, were determined to be related to the patrilineage (figure by authors after Mittnik *et al.* 2019: fig. 3 and Mittnik *et al.* 2023: fig. 7).

In late Neolithic and early Bronze Age central and western Europe, mobile women (determined from isotopes) were buried with greater wealth than local women (Mittnik *et al.* 2019). At the Bronze Age site of La Almoloya, Spain, for example—where a richly adorned woman was buried together with an unadorned man (Curry 2023)—genome-wide data from 67 individuals identified all first-degree relationships among adults as involving at least one adult male, with no first-degree relationships among the 30 adult women analysed (Villalba-Mouco *et al.* 2021). At Hazleton North, maternal sub-lineages are suggested by the descendants of one male being buried in association with each of four respective female partners (Curry 2023; Fowler *et al.* 2022). In Chalcolithic–Early Bronze Age Britain, “the significance of women within patrilineal communities may be indicated by the presence of female inhumations in central positions within mortuary monuments” (Booth *et al.* 2021). In Bronze Age and Iron Age Europe, women were not only elites and specialists (Bergerbrant 2019; Blank *et al.* 2021; Jarman 2021) but also highly ranked warriors (Price *et al.* 2019; Moen & Walsh 2021).

If we allow that bioarchaeological patterns reflect inherited kinship systems, a compelling research question follows: why did patrilocality and patriliney arise in Neolithic central Europe specifically? As close as southern Scandinavia, where Bronze Age women were buried in tree coffins with arm rings and belt plates (Bergerbrant 2019), isotopic analysis suggests the presence of more-varied mobility (and hence kinship?) patterns than in central Europe (Frei *et al.* 2019). Elsewhere in the prehistoric world, bioarchaeological and cultural-phylogenetic methods reveal greater diversity of kinship systems, including matriliney (Jordan *et al.* 2009; Alt *et al.* 2013; Larsen *et al.* 2015; Kennett *et al.* 2017; Miller *et al.* 2021; Yaka *et al.* 2021; Bentley 2022; Lee *et al.* 2023). Taken together, this suggests that patriliney arose in Neolithic central Europe as a regional anomaly that persisted through its own rules of inheritance. Similarly, in human behavioural ecology, patriliney is explained as a relatively recent departure from the matrifocal origins of human society as cooperative breeders (Hrady 2009; Shenk *et al.* 2019). The proximal causes for patriliney—often as interferences to how relations ('alloparents') can help parents raise children—can include wealth inheritance, pastoralism, settlement pattern, intensive cultivation and religion (Sear & Mace 2008; Strassman *et al.* 2012; Perry & Daly 2017; Scelza *et al.* 2020).

## Projecting our agency onto the past

To assume prehistoric life was much more variable, or more intentional, than the evidence indicates biases in archaeological interpretation. Contemporary scholars are surrounded by thousands, or millions, of times more material objects, ideas and social contacts than most humans who ever lived (Colwell 2023). In contrast, prehistoric knowledge was transferred from teachers to learners over generations, with increasing teacher–learner investment as technologies became more complex. Ethnohistorical and experimental archaeology indicate that, whereas it took hundreds of hours to master the knapping skills for an Acheulean handaxe (Stout *et al.* 2015), it required a decade of apprenticeship to become an expert in Harappan bead-making or ceramic wheel-throwing (Roux 2007). It may be hard for modern scholars to conceptualise the inheritance of cultural traditions—such as cultivating crops, herding livestock and barrow-building (Haughton & Løvschal 2023), replastering house walls (Hodder & Cessford 2004), telling folk tales (Graça da Silva & Tehrani 2016) or depositing human bodies in bogs (van Beek *et al.* 2023)—over centuries or millennia.

Periods of slow cultural change were eventually punctuated by cascades of innovation in sociopolitical organisation, specialised-product innovation, exchange networks and food production (Radivojević & Grujić 2018; Frieman & Lewis 2021; Bellwood 2023) and even kinship systems (Moravec *et al.* 2018). Cascades often reflect feedback in the inheritance of technologies and practices in regional networks, such as gold mining within the Bronze Age Caucasus (Erb-Satullo 2021). But while innovation cascades may seem to reflect intentional creativity (Soafer 2018), or a game-changing invention spurring complementary inventions (Kolodny *et al.* 2015; Derex 2021), they are ultimately driven by the effective size of the population exchanging ideas (Bettencourt & West 2010; Shennan 2011a; Vaesen & Houkes 2021; Vidiella *et al.* 2022), which is affected by mobility and social networks (Scharl 2016; Soafer 2018; Romano *et al.* 2020).

It is difficult not to unintentionally project our expectations for material and social possibility onto other cultures, past or present. A half-century after Evans-Pritchard (1940) complained that he was never able to discuss anything but livestock with the Nuer of Sudan, Hutchinson (1985: 625) wrote “in Nuerland, the first question I was asked upon meeting new faces was always the same: ‘Where you come from, do people marry with cattle or with money?’” But cultural inheritance is never a limitation of the individual mind. As Hutchinson (1992: 296) later added, “because cattle and people were in some sense ‘one’, individuals were able to transcend some of the profoundest human frailties and thereby achieve a greater sense of mastery over their world”. Individuals who understood hundreds of local plants at Ohalo II, in Israel, 23 000 years ago (Snir *et al.* 2015) had much more mastery of this knowledge than someone who Googles those plants today.

In summary, cultural inheritance is consistent with multiple perspectives, from macroscopic, intergenerational evolution of cultures to microscopic intentionality in an individual lifetime. There is no need, however, to project the modern academic imagination onto the past (Chapman & Wylie 2016). There is more common ground, and the research questions are more vital, in studying the cultural evolutionary process that is central to our understanding of ancient innovation, social organisation and regional diversity.

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### **Debate responses**

*Antiquity* invited four authors to respond to this debate article; with a final response from the original authors.

*On the poverty of academic imagination: a response to Bentley & O’Brien* by Tim Ingold. *Antiquity* 98. <https://doi.org/10.15184/aqy.2024.106>

*The past was diverse and deeply creative: a response to Bentley & O’Brien* by Catherine J. Frieman. *Antiquity* 98. <https://doi.org/10.15184/aqy.2024.103>

*Human intent and cultural lineages: a response to Bentley & O’Brien* by Anna Marie Prentiss. *Antiquity* 98. <https://doi.org/10.15184/aqy.2024.102>

*Cultural inheritance and technological evolution: a response to Bentley & O’Brien* by A.M. Pollard. *Antiquity* 98. <https://doi.org/10.15184/aqy.2024.113>

Final response from Bentley & O’Brien. *On cultural traditions and innovation: finding common ground*. *Antiquity* 98. <https://doi.org/10.15184/aqy.2024.123>

## References

- ALLABY, R.G., C.J. STEVENS, L. KISTLER & D.Q. FULLER. 2022. Emerging evidence of plant domestication as a landscape-level process. *Trends in Ecology & Evolution* 37: 268–79. <https://doi.org/10.1016/j.tree.2021.11.002>
- ALT, K.W. *et al.* 2013. Earliest evidence for social endogamy in the 9,000-year-old-population of Basta, Jordan. *PLoS ONE* 8. <https://doi.org/10.1371/journal.pone.0065649>
- BELLWOOD, P. 2023. *First farmers: the origins of agricultural societies* (second edition). New York: Wiley.
- BENTLEY, R.A. 2022. Prehistory of kinship. *Annual Review of Anthropology* 51: 137–54. <https://doi.org/10.1146/annurev-anthro-041320-021036>
- BERGERBRANT, S. 2019. Revisiting the 'Egtved Girl', in R. Berge & M.M. Henriksen (ed.) *Arkeologi og kulturhistorie fra norskekysten til Østersjøen*: 19–39. Trondheim: Museumsforlaget.
- BERLIOZ, E., E. CAPDEPON & E. DISCAMPS. 2023. A long-term perspective on Neanderthal environment and subsistence: insights from the dental microwear texture analysis of hunted ungulates at Combe-Grenal (Dordogne, France). *PLoS ONE* 18. <https://doi.org/10.1371/journal.pone.0278395>
- BETTENCOURT, L. & G.W. WEST. 2010. A unified theory of urban living. *Nature* 467: 912–13. <https://doi.org/10.1038/467912a>
- BICKLE, P. 2020. Thinking gender differently: new approaches to identity difference in the Central European Neolithic. *Cambridge Archaeological Journal* 30: 201–18. <https://doi.org/10.1017/S0959774319000453>
- BICKLE, P. & D. HOFMANN. 2007. Moving on: the contribution of isotope studies to the early Neolithic of Central Europe. *Antiquity* 81: 1029–41. <https://doi.org/10.1017/S0003598X00096095>
- BICKLE, P. *et al.* 2014. Early Neolithic lifeways in Moravia and western Slovakia: comparing archaeological, osteological and isotopic data from cemetery and settlement burials of the Linearbandkeramik (LBK). *Anthropologie* 52: 35–72.
- BLANK M. *et al.* 2021. Mobility patterns in inland southwestern Sweden during the Neolithic and Early Bronze Age. *Archaeological and Anthropological Sciences* 13. <https://doi.org/10.1007/s12520-021-01294-4>
- BLÖCHER, J. *et al.* 2023. Descent, marriage, and residence practices of a 3,800-year-old pastoral community in Central Eurasia. *Proceedings of the National Academy of Sciences USA* 120. <https://doi.org/10.1073/pnas.2303574120>
- BOLLONGINO, R. *et al.* 2013. 2000 years of parallel societies in Stone Age Central Europe. *Science* 342: 479–81. <https://doi.org/10.1126/science.1245049>
- BONDURIANSKY, R. & T. DAY. 2018. *Extended heredity: a new understanding of inheritance and evolution*. Princeton (NJ): Princeton University Press.
- BOOTH, T.J., J. BRÜCK, S. BRACE & I. BARNES. 2021. Tales from the supplementary information: ancestry change in Chalcolithic–Early Bronze Age Britain was gradual with varied kinship organization. *Cambridge Archaeological Journal* 31: 379–400. <https://doi.org/10.1017/S0959774321000019>
- BRUAUDEL, F. 1958. Histoire et sciences sociales: la longue durée. *Annales. Histoire, Sciences Sociales* 13: 725–53.
- BRÜCK, J. 2021. Ancient DNA, kinship and relational identities in Bronze Age Britain. *Antiquity* 95: 228–37. <https://doi.org/10.15184/aqy.2020.216>
- CHAPMAN, R. & A. WYLIE. 2016. *Evidential reasoning in archaeology*. London: Bloomsbury Academic.
- COLTON, H.S. 1942. Archaeology and the reconstruction of history. *American Antiquity* 8: 33–40. <https://doi.org/10.2307/275633>
- CORBAY, R., A., JAGICH, K. VAESSEN & M. COLLARD. 2016. The Acheulean handaxe: more like a bird's song than a Beatles' tune? *Evolutionary Anthropology* 25: 6–19. <https://doi.org/10.1002/evan.21467>
- COLWELL, C. 2023. *So much stuff: how humans discovered tools, invented meaning, and made more of everything*. Chicago (IL): University of Chicago Press.
- CURRY, A. 2023. Family ties. *Science* 382: 24–27. <https://doi.org/10.1126/science.adl1577>
- DEINO, A.L., A.K. BEHRENSMEYER, A.S. BROOKS, J.E. YELLEN, W.D. SHARP & R. POTTS. 2018. Chronology of the Acheulean to Middle Stone Age transition in eastern Africa. *Science* 360: 95–98. <https://doi.org/10.1126/science.aao2216>

- DEREX, M. 2021. Human cumulative culture and the exploitation of natural phenomena. *Philosophical Transactions of the Royal Society B* 377: 20200311. <https://doi.org/10.1098/rstb.2020.0311>
- ENSOR, B.E. 2021. Making aDNA useful for kinship analysis. *Antiquity* 95: 241–43. <https://doi.org/10.15184/aqy.2020.234>
- ERB-SATULLO, N.L. 2021. Technological rejection in regions of early gold innovation revealed by geospatial analysis. *Scientific Reports* 11: 20255. <https://doi.org/10.1038/s41598-021-98514-7>
- EVANS-PRITCHARD, E.E. 1940. *The Nuer: a description of the modes of livelihood and political institutions of a Nilotic people*. Oxford: Oxford University Press.
- FLANNERY, K.V. 1967. Culture history v. cultural process: a debate in American archaeology. *Scientific American* 217(2): 119–22.
- FOWLER, C. 2022. Social arrangements. Kinship, descent and affinity in the mortuary architecture of Early Neolithic Britain and Ireland. *Archaeological Dialogues* 29: 67–88.
- FOWLER, C. *et al.* 2022. A high-resolution picture of kinship practices in an Early Neolithic tomb. *Nature* 601: 584–87. <https://doi.org/10.1038/s41586-021-04241-4>
- FREI, K.M. *et al.* 2019. Mapping human mobility during the third and second millennia BC in present-day Denmark. *PLoS ONE* 14: e0219850. <https://doi.org/10.1371/journal.pone.0219850>
- FRIEMAN, C.J. 2021. Emergent or imposed? *Antiquity* 95: 247–48. <https://doi.org/10.15184/aqy.2020.238>
- FRIEMAN, C.J. & J. LEWIS. 2021. Trickle down innovation? Creativity and innovation at the margins. *World Archaeology* 53: 723–40. <https://doi.org/10.1080/00438243.2021.2014948>
- FRIEMAN, C.J., A. TEATHER & C. MORGAN. 2019. Bodies in motion: narratives and counter narratives of gendered mobility in European later prehistory. *Norwegian Archaeological Review* 52: 148–69. <https://doi.org/10.1080/00293652.2019.1697355>
- GRAÇA DA SILVA, S. & J.J. TEHRANI. 2016. Comparative phylogenetic analyses uncover the ancient roots of Indo-European folktales. *Royal Society Open Science* 3. <https://doi.org/10.1098/rsos.150645>
- HAJDINJAK, M. *et al.* 2021. Initial Upper Palaeolithic humans in Europe had recent Neanderthal ancestry. *Nature* 592: 253–57. <https://doi.org/10.1038/s41586-021-03335-3>
- HAUGHTON, M. & M. LÖVSCHAL. 2023. Ancestral commons: the deep-time emergence of Bronze Age pastoral mobility. *Antiquity* 97: 1470–87. <https://doi.org/10.15184/aqy.2023.154>
- HODDER, I. & C. CESSFORD. 2004. Daily practice and social memory at Çatalhöyük. *American Antiquity* 69: 17–40. <https://doi.org/10.2307/4128346>
- HRDY, S.B. 2009. *Mothers and others: the evolutionary origins of mutual understanding*. Cambridge (MA): Harvard University Press.
- HUTCHINSON, S. 1985. Changing concepts of incest among the Nuer. *American Ethnologist* 12: 625–41.
- 1992. The cattle of money and the cattle of girls among the Nuer, 1930–83. *American Ethnologist* 19: 294–316.
- INGOLD, T. 2022. Evolution without inheritance: steps to an ecology of learning. *Current Anthropology* 63: S32–S55. <https://doi.org/10.1086/722437>
- JARMAN, C. 2021. *River kings: a new history of the Vikings from Scandinavia to the Silk Road*. Glasgow: Collins.
- JOHNSON, K.M. & K.S. PAUL. 2016. Bioarchaeology and kinship: integrating theory, social relatedness, and biology in ancient family research. *Journal of Archaeological Research* 24: 75–123. <https://doi.org/10.1007/s10814-015-9086-z>
- JORDAN, F.M., R.D. GRAY, S.J. GREENHILL & R. MACE. 2009. Matrilocal residence is ancestral in Austronesian societies. *Proceedings of the Royal Society B* 276: 1957–64. <https://doi.org/10.1098/rspb.2009.0088>
- KENNETT, D.J. *et al.* 2017. Archaeogenomic evidence reveals prehistoric matrilineal dynasty. *Nature Communications* 8: 14115. <https://doi.org/10.1038/ncomms14115>
- KEY, A. 2022. The Acheulean is a temporally cohesive tradition. *World Archaeology* 54: 365–89. <https://doi.org/10.1080/00438243.2023.2169340>
- KNIPPER, C. *et al.* 2017. Female exogamy and gene pool diversification at the transition from the Final Neolithic to the Early Bronze Age in Central Europe. *Proceedings of the National Academy of Sciences USA* 114: 10083–88. <https://doi.org/10.1073/pnas.1706355114>
- KOHLER, T.A. *et al.* 2017. Greater post-Neolithic wealth disparities in Eurasia than in North America and Mesoamerica. *Nature* 551: 619–22. <https://doi.org/10.1038/nature24646>



- KOLODNY, O., N. CREANZA & M.W. FELDMAN. 2015. Evolution in leaps: the punctuated accumulation and loss of cultural innovations. *Proceedings of the National Academy of Sciences USA* 112: E6762–69. <https://doi.org/10.1073/pnas.1520492112>
- KROEBER, A.L. 1916. Zufii potsherds. *American Museum of Natural History Anthropological Papers* 18(1): 1–37.
- LARSEN, C.S. *et al.* 2015. Bioarchaeology of Neolithic Çatalhöyük: lives and lifestyles of an early farming society in transition. *Journal of World Prehistory* 28: 27–68. <https://doi.org/10.1007/s10963-015-9084-6>
- LAZARIDIS, I. *et al.* 2014. Ancient human genomes suggest three ancestral populations for present-day Europeans. *Nature* 513: 409–13. <https://doi.org/10.1038/nature13673>
- LEE, J., B.K. MILLER, J. BAYARSAIKHAN, E. JOHANNESSON, A.V. MILLER, C. WARINNER & C. JEONG. 2023. Genetic population structure of the Xiongnu Empire at imperial and local scales. *Science Advances* 9. <https://doi.org/10.1126/sciadv.adf3904>
- LEW-LEVY, S., A. MILKS, N. LAVI, S.M. POPE & D.E. FRIESEM. 2020. Where innovations flourish: an ethnographic and archaeological overview of hunter–gatherer learning contexts. *Evolutionary Human Sciences* 2. <https://doi.org/10.1017/ehs.2020.35>
- LYCETT, S.J. & M.I. EREN. 2013. Levallois lessons: the challenge of integrating mathematical models, quantitative experiments and the archaeological record. *World Archaeology* 45: 519–38. <https://doi.org/10.1080/00438243.2013.821670>
- MACINTOSH, A.A., R. PINHASI & J. STOCK. 2017. Prehistoric women's manual labor exceeded that of athletes through the first 5500 years of farming in Central Europe. *Science Advances* 3. <https://doi.org/10.1126/sciadv.aao3893>
- MASCLANS, A., C. HAMON, C. JEUNESSE & P. BICKLE. 2021. A sexual division of labour at the start of agriculture? A multi-proxy comparison through grave good stone tool technological and use-wear analysis. *PLoS ONE* 16. <https://doi.org/10.1371/journal.pone.0249130>
- MILLER, J.M., D.R. MOORE & J.M. BAYMAN. 2021. Gendered households and ceramic assemblage formation in the Mariana Islands, Western Pacific. *Asian Perspectives* 60: 178–96. <https://doi.org/10.1353/asi.2020.0041>
- MITTNIK, A. *et al.* 2019. Kinship-based social inequality in Bronze Age Europe. *Science* 366: 731–34. <https://doi.org/10.1126/science.aax6219>
- 2023. Kinship, status, and mobility in the Bronze Age Lech Valley, in H. Meller, J. Krause, W. Haak & R. Risch (ed.) *Kinship, sex, and biological relatedness: the contribution of archaeogenetics to the understanding of social and biological relations*: 195–217. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt.
- MOEN, M. & M.J. WALSH. 2021. Agents of death: reassessing social agency and gendered narratives of human sacrifice in the Viking Age. *Cambridge Archaeological Journal* 31: 597–611. <https://doi.org/10.1017/S0959774321000111>
- MONTÓN-SUBÍAS, S. & A. HERNANDO. 2018. Modern colonialism, Eurocentrism and historical archaeology: some engendered thoughts. *European Journal of Archaeology* 21: 455–71. <https://doi.org/10.1017/eea.2017.83>
- MORAVEC, J.C. *et al.* 2018. Post-marital residence patterns show lineage-specific evolution. *Evolution and Human Behavior* 39: 594–601. <https://doi.org/10.1016/j.evolhumbehav.2018.06.002>
- O'BRIEN, M.J. & T.D. HOLLAND. 1992. The role of adaptation in archaeological explanation. *American Antiquity* 57: 3–59. <https://doi.org/10.2307/2694834>
- O'BRIEN, M.J. & R.L. LYMAN. 2002. Evolutionary archeology: current status and future prospects. *Evolutionary Anthropology* 11: 26–36. <https://doi.org/10.1002/evan.10007>
- O'BRIEN, M.J., R.L. LYMAN, A. MESOUDI & T.L. VANPOOL. 2010. Cultural traits as units of analysis. *Philosophical Transactions of the Royal Society B* 365: 3797–806. <https://doi.org/10.1098/rstb.2010.0012>
- PERRY, G. & M. DALY. 2017. A model explaining the matrilineal bias in alloparental investment. *Proceedings of the National Academy of Sciences USA* 114: 9290–95. <https://doi.org/10.1073/pnas.1705910114>
- PRICE, N. *et al.* 2019. Viking warrior women? Reassessing Birka chamber grave Bj.581. *Antiquity* 93: 181–98. <https://doi.org/10.15184/aqy.2018.258>
- PYZEL, J. 2019. Cultures of remembrance, cultures of forgetting: the past in the post-LBK societies in Rhineland and Kuyavia. *Germania* 97: 1–40.

- QUINN, C.P. 2015. Returning and reuse: diachronic perspectives on multi-component cemeteries and mortuary politics at Middle Neolithic and Early Bronze Age Tara, Ireland. *Journal of Anthropological Archaeology* 37: 1–18. <https://doi.org/10.1016/j.jaa.2014.10.003>
- RADIJOVIĆ, M. & J. GRUJIĆ. 2018. Community structure of copper supply networks in the prehistoric Balkans: an independent evaluation of the archaeological record from the 7th to the 4th millennium BC. *Journal of Complex Networks* 6: 106–24. <https://doi.org/10.1093/comnet/cnx013>
- RIBEIRO, A.S.P. 2022. *Archaeology and intentionality: understanding ethics and freedom in past and present societies*. London: Routledge.
- RICHARDS, M.P. & E. TRINKHAUS. 2009. Isotopic evidence for the diets of European Neanderthals and early modern humans. *Proceedings of the National Academy of Sciences USA* 106: 16034–39. <https://doi.org/10.1073/pnas.0903821106>
- RINDOS, D. 1984. *The origins of agriculture: an evolutionary perspective*. New York: Academic.
- RÍOS, L. *et al.* 2019. Skeletal anomalies in the Neandertal family of El Sidrón (Spain) support a role of inbreeding in Neandertal extinction. *Scientific Reports* 9. <https://doi.org/10.1038/s41598-019-38571-1>
- RIVOLLAT, M. *et al.* 2023. Extensive pedigrees reveal the social organization of a Neolithic community. *Nature* 620: 600–6. <https://doi.org/10.1038/s41586-023-06350-8>
- ROMANO, V., S. LOZANO & J. FERNÁNDEZ-LÓPEZ DE PABLO. 2020. A multilevel analytical framework for studying cultural evolution in prehistoric hunter–gatherer societies. *Biological Reviews* 95: 1020–35. <https://doi.org/10.1111/brv.12599>
- ROUX, V. 2007. Ethnoarchaeology: a non-historical science of reference necessary for interpreting the past. *Journal of Archaeological Method and Theory* 14: 153–78. <https://doi.org/10.1007/s10816-007-9030-8>
- SCELZA, B.A. *et al.* 2020. High rate of extrapair paternity in a human population demonstrates diversity in human reproductive strategies. *Scientific Advances* 6. <https://doi.org/10.1126/sciadv.aay6195>
- SCHARL, S. 2016. Patterns of innovation transfer and the spread of copper metallurgy to Central Europe. *European Journal of Archaeology* 19: 215–44. <https://doi.org/10.1080/14619571.2016.1147313>
- SEAR, R. & R. MACE. 2008. Who keeps children alive? A review of the effects of kin on child survival. *Evolution and Human Behavior* 29: 1–18. <https://doi.org/10.1016/j.evolhumbehav.2007.10.001>
- SHENK, M.K., R.O. BEGLEY, D.A. NOLIN & A. SWIATEK. 2019. When does matriliney fail? The frequencies and causes of transitions to and from matriliney estimated from a de novo coding of a cross-cultural sample. *Philosophical Transactions of the Royal Society B* 374. <https://doi.org/10.1098/rstb.2019.0006>
- SHENNAN, S.J. 2011a. Descent with modification and the archaeological record. *Philosophical Transactions of the Royal Society B* 366: 1070–79. <https://doi.org/10.1098/rstb.2010.0380>
- 2011b. Property and wealth inequality as cultural niche construction. *Philosophical Transactions of the Royal Society B* 366: 918–26. <https://doi.org/10.1098/rstb.2010.0309>
- SJÖGREN, K. *et al.* 2020. Kinship and social organization in Copper Age Europe: a cross-disciplinary analysis of archaeology, DNA, isotopes, and anthropology from two Bell Beaker cemeteries. *PLoS ONE* 15. <https://doi.org/10.1371/journal.pone.0241278>
- SKOV, L. *et al.* 2022. Genetic insights into the social organization of Neanderthals. *Nature* 610: 519–25. <https://doi.org/10.1038/s41586-022-05283-y>
- SNIR, A., D. NADEL, I. GROMAN-YAROSLAVSKI, Y. MELAMED, M. STERNBERG, O. BAR-YOSEF & E. WEISS. 2015. The origin of cultivation and proto-weeds, long before Neolithic farming. *PLoS ONE* 10. <https://doi.org/10.1371/journal.pone.0131422>
- SOAFER, J. (ed.) 2018. *Considering creativity: creativity, knowledge and practice in Bronze Age Europe*. Oxford: Archaeopress.
- SPAULDING, A.C. 1954. Prehistoric cultural development in the eastern United States, in B.J. Meggers & C. Evans (ed.) *New interpretations of aboriginal American culture history*: 12–27. Washington, D.C.: Anthropological Society of Washington.
- STOUT, D., E. HECHT, N. KHREISHEH, B. BRADLEY & T. CHAMINADE. 2015. Cognitive demands of Lower Paleolithic toolmaking. *PLoS ONE* 10. <https://doi.org/10.1371/journal.pone.0121804>

- STRASSMANN, B.I., N.T. KURAPATI, B.F. HUG, E.E. BURKE, B.W. GILLESPIE, T.M. KARAFET & M.F. HAMMER. 2012. Religion as a means to assure paternity. *Proceedings of the National Academy of Sciences USA* 109: 9781–85. <https://doi.org/10.1073/pnas.1110442109>
- VAESSEN, K. & W. HOUKES. 2021. Is human culture cumulative? *Current Anthropology* 62: 218–38. <https://doi.org/10.1086/714032>
- VAN BEEK, R., C. QUIK, S. BERGERBRANT, F. HUISMAN & P. KAMA. 2023. Bogs, bones and bodies: the deposition of human remains in northern European mires (9000 BC–AD 1900). *Antiquity* 97: 120–40. <https://doi.org/10.15184/aqy.2022.163>
- VIDIELLA, B., S. CARRIGNON, R.A. BENTLEY, M.J. O'BRIEN & S. VALVERDE. 2022. A cultural evolutionary theory that explains both gradual and punctuated change. *Journal of the Royal Society Interface* 19. <https://doi.org/10.1098/rsif.2022.0570>
- VILLALBA-MOUCO, V. *et al.* 2021. Genomic transformation and social organization during the Copper Age–Bronze Age transition in southern Iberia. *Science Advances* 7. <https://doi.org/10.1126/sciadv.abi7038>
- WHITEN, A. 2017. A second inheritance system: the extension of biology through culture. *Interface Focus* 7. <https://doi.org/10.1098/rsfs.2016.0142>
- YAKA, R. *et al.* 2021. Variable kinship patterns in Neolithic Anatolia revealed by ancient genomes. *Current Biology* 31: 2455–68. <https://doi.org/10.1016/j.cub.2021.03.050>