*Original Research Article*

Journal of Social Archaeology
2023, Vol. 0(0) 1–20



DOI: 10.1177/14696053231153499
journals.sagepub.com/home/jsa

# Events, narrative and data: Why new chronologies or ethically Bayesian approaches should change how we write archaeology

**Seren Griffiths**
History, Politics and Philosophy, Manchester Metropolitan University, Manchester, UK

**Neil Carlin**
Archaeology, University College Dublin, Dublin, Ireland

**Ben Edwards**
History, Politics and Philosophy, Manchester Metropolitan University, Manchester, UK

**Nicholas Overton**
Department of Classics, Ancient History, Archaeology and Egyptology, The University of Manchester, Manchester, UK

**Penny Johnston**
History, Politics and Philosophy, Manchester Metropolitan University, Manchester, UK

**Julian Thomas**
Department of Classics, Ancient History, Archaeology and Egyptology, The University of Manchester, Manchester, UK

**Corresponding author:**
Seren Griffiths, History, Politics and Philosophy, Manchester Metropolitan University, Geoffrey Manton Building, Rosamond St West, Manchester M15 6EB, UK.
Email: seren.griffiths@mmu.ac.uk

**Abstract**
In this paper, we discuss how the history of our discipline continues to shape how we think with material culture to produce narratives. We argue that recent developments in scientific dating—in combination with New Materialist and Big Data approaches—offer the potential to produce radical new interpretations. However, we can only achieve this if we adopt 'ethically Bayesian' approaches which recognise that some of the most fundamental aspects of our epistemological structures are highly situated, reflecting a Eurocentric, colonial legacy. This legacy is especially important when we study societies that did/do not produce texts—so-called 'prehistoric' societies. We suggest that the revolutionary potential of radiocarbon dating on archaeology has not been fully achieved, precisely because chronometric data have not yet been made sufficiently independent from materials-determined narrative structures. We outline the importance of ethically Bayesian approaches as means to challenge this disciplinary inheritance. We argue that we need to describe the richness and specificity of the pasts we bring into being in ways that take better account of the historical processes through which heterogeneous assemblages emerge, rather than to search for preconfigured entities (like 'the Bronze Age'). Times have changed; we need our approaches to time to catch up.

**Keywords**
Ethically Bayesian, narrative, chronology, Big Data, New Materialism

## Introduction

Time is present in archaeology in many ways. As a structuring principle behind our notions of past and future, archaeology has come to grapple with the nature of time and how it is experienced, represented, and measured, and indeed how it was perceived by past societies. We must, therefore, acknowledge the complexity of time in archaeological practice (cf. Bailey, 2008; Gardner, 2001; Hodder, 1995; Holdaway and Wandsnider, 2008; Lucas, 2005, 2008, 2015, 2018; Lucas and Olivier, 2022; Ramenofsky and Steffen, 1998).

This paper considers the legacy of time models in archaeological thought and the impact of scientific dating in archaeology. We advocate for a revised approach to chronology which seeks to avoid the analytical categories of culture history and the Three Age system (which are still employed by many archaeologists despite having long been recognised as problematic). We argue that because archaeologists have failed to reconcile the continued structuring impact of our disciplinary history with developments in scientific dating, archaeology requires 'ethically Bayesian' approaches.

Bayesian inference uses contemporary archaeological understandings about the nature of the past to revise our chronologies and create narratives. But in doing so, there is a danger that we reproduce problematic and situated knowledge structures about the nature of the past, which have been created over our disciplinary history, in these chronologies

and then in our narratives. To avoid this, we must challenge these ideas and create richer, less predetermined narratives.

Ethically Bayesian approaches recognise that some of the most seemingly neutral inherited aspects of our knowledge structures are biased and problematic, and in some cases owe much to Eurocentric, colonial approaches to people and the world. The idea that there is a universal, fine-scale linear time model through which societies move is bound up with the Western Settler Construct, which has been especially damaging to indigenous peoples (Rifkin, 2017) and is highly culturally specific. Ethically Bayesian approaches should challenge these inherited legacies. Without doing so, it will not be possible to take advantage of recent exciting developments in archaeology—such as Big Data perspectives and New Materialism approaches—and we will continue to write what are fundamentally essentializing Eurocentric archaeologies, which owe more to our discipline's history of thought and origins in 19th century AD/CE Western Europe than anything else. If we recognise people as vibrant, creative beings, full of potential and existing in messy and complex worlds (cf. Bennett, 2010; Deleuze and Guattari, 2004), then we need to move away from our continued reliance on our inherited knowledge structures as ways to make sense of the past. An ethically Bayesian approach should accommodate the past in terms of the immediate and contemporary, the durational, and the enduring qualities of the world, including over the very long term, rather than reproduce inherited disciplinary understandings about the nature of the past.

## The need for ethically Bayesian approaches

### *Time models*

As archaeologists, time models are one of the fundamental ways with which we attempt to create meaning and we assemble evidence. We use time models as standardized ways to frame our understandings, research questions, modes of inquiry, and the narratives we produce. These time models are situated in, and in turn shape, our knowledge structures; they are created through processes of practice, but they also influence how we think. However, while these time models are habitual, they are not neutral (Clarke, 1972), and their continued use reflects a combination of disciplinary 'zombie' categories (cf. Beck and Beck-Gernsheim, 2002) and academic inertia. The most common and long-standing of these time models played a critical part in the development of our discipline in the 19th and earlier 20th centuries AD/CE in Europe (Rowley-Conwy, 2007), and they created foundational or natural disciplinary knowledge concepts. These foundational concepts include the creation of: a distinction between 'prehistoric' and 'historical' archaeology (Daniel, 1964: 10); various successive culture historic entities (e.g. 'the Neolithic' is replaced by 'the Bronze Age'); and the various cultural groups or 'peoples' (e.g. 'the Beaker People'). The development of these concepts was influenced by ideas about functionalism, historical materialism, stratigraphy, evolution, and geology. But these 'natural' concepts were also influenced by then-contemporary ideas about empire, development, and industry, and included implicitly and explicitly Eurocentric and colonial

approaches to people and things, which are ethically problematic and had disastrous implications for indigenous peoples (Kehoe, 2013; Crellin et al., 2021; Rifkin, 2017).

The very idea of 'prehistory' creates the spurious distinction between groups of people with and without writing, whereby the later are considered inferior to societies with written text and beyond the legitimate empirical investigation of historians (Eskildsen, 2012: 29; McNiven and Russell, 2009: 429; Mulvaney, 1990). This idea of 'prehistory' also creates the space for 'ages' or 'peoples' defined by 'packages' of material culture (including site 'types'), which in turn essentialize individual people and groups of people in these material terms. Such approaches to people and things are entangled with evolutionary ideas, that value successive 'ages' or 'cultures' as *progressive* stages characterised by ever-increasing material and social 'sophistication'. They emphasise material culture in terms of functionality rather than potentiality, and they identify complexity in the proliferation of things rather than recognising that societies are not only defined or experienced in material terms. Such models necessitate an artificial linear sequence along the passage of time, whereby different ways of life 'naturally' replace each other, and changes that we identify are understood to be exclusively inevitable and completely coherent. These ideas are implicitly teleological; they presuppose a finite future which is predictable and legitimate.

These kinds of social evolutionary models attempt to fix the past by establishing sequences of things, rather than by anticipating uncertain and undetermined pasts that were created by the contingent interactions of people with places, things, animals, and plants. When we talk in terms of the existence of 'the Neolithic' or 'the Beaker People', we use the language inherited with our disciplinary time models, and we perpetuate this impression of unchanging groups of people, who all did things in exactly the same ways because they all shared the same ideas and identity. Such models present the past as a series of successive homogenous temporal units, where change only occurs *en masse* and suddenly at the beginning and end of these units (Crellin, 2020).

The idea of culture historic entities becomes even more problematic when these units are further understood *to belong to* specific points in time. For example, archaeologists routinely define 'the Bronze Age' in Britain as *being* between 2500–800 cal BC/BCE. When we do this, we do something fundamental to the archaeological pasts we bring into being. When we talk about 'the Neolithic', we create an idea of a homogenous group of people who are identified by an inalienable package of material culture, *and* whose potentiality is fixed in time.

When we simultaneously predetermine whole societies by groups of things and fix their existence in both time and space, we create a narrative in which we can anticipate no potential for change, no possibility for flux, and no prospect that there might have been other pasts or other futures. The potentiality of people is reduced. The past is determined. There never could have been any other actuality. This is simply one inevitable stage in a sequence that leads inextricably, teleologically, to the Present. This kind of progress-driven narrative also prevents the creation of dynamic, varied pasts which allow regional and temporal variation.

Implicit in such models is a privileging of change over continuity in ways that are colonial, Eurocentric (Montón-Subías and Hernando, 2018), and fundamentally at odds with recent New Materialist work in archaeology (see discussion below).

Some of the fundamental problems with our foundational time concepts and their impact on how archaeologists think have been pointed out before (e.g. Daniel, 1964: 56), yet we continue to employ the analytical categories of culture history and the Three Age system. Archaeologists further confer these disciplinary zombie entities with spurious legitimacy when they attempt to go out and 'find' these idealised, temporally defined cultural units (Crellin, 2020: 30, 181; Griffiths, 2017), often commenting on deviation from the expected norm as validation of the foundational concepts of our practice. Many research agendas explicitly focus on refining the timing of the sequences within these constructs—to define the chronological sequence of the Chalcolithic in distinction from the Early Bronze Age, for example. Globally we spend millions obtaining radiocarbon measurements to say, 'Oh, this is later Neolithic', or 'We have the earliest Bronze Age!'. In these cases, chronometric data are used to reinforce the 'naturalness' of local culture historic models rather than to rewrite or challenge the fundamental assumptions at the heart of these structures. The seductive nature of these terms and their preternatural resilience derive from the ease with which they enable us to talk across space and time about the material record, but this comes at a cost! If we continue to employ these concepts to create our pasts, we are still effectively practicing archaeology as culture history. Because these time models are so structuring, they can prevent us from thinking critically and recognizing how our narratives implicitly perpetuate problematic approaches and interpretations. They stop us writing nuanced narratives about the past; they are intrinsically normalising, they collapse variation, and they limit the potentiality of the past. They ensure that we do bad archaeology.

## *Radiocarbon revolutions*

Some 30 years ago, Bayesian chronological inference was first developed for archaeology (Buck et al., 1991, 1992, 1994). Applications of these approaches have resulted in unexpected research findings: producing very precise chronologies for individual sites (e.g. Whittle, 2018), groups of types of sites (e.g. Whitehouse et al., 2014), packages of material culture (e.g. Bebber et al., 2022), or environmental changes (e.g. Kim et al., 2021). The impact of Bayesian chronological inference was termed 'a revolution in understanding' (cf. Bronk Ramsey, 2008; Bayliss, 2009), the latest in a series of 'revolutions' identified in archaeology as a result of the radiocarbon method. Lewis Binford felt that the first radiocarbon 'revolution' '… changed the activities of archaeologists, so that now, *in many ways for the first time*, they direct their methodological investments toward theory building rather than towards chronology building' (quoted in Taylor, 2000: 15; our emphasis). Colin Renfrew reflected that '… all that was needed was a couple of ounces of charcoal … and science would do the rest' (Renfrew, 1973: 53).

In fact, we argue that this optimism was misjudged. Certainly, the full potential of the first revolution has not been achieved, exactly because the production of 'independent' chronometric data does not occur 'outside' of archaeology (cf. Latour, 1987). We have failed to disentangle our inherited disciplinary knowledge, and until we do so we cannot escape from writing narratives that essentialize people, things, and the past. After all, there really wasn't a 'Bronze Age', and there certainly weren't any 'Bronze Age people'. We

contend that in terms of paradigmatic revolutions in archaeology, the first radiocarbon revolution should have been the start of a fundamental change to archaeological thinking about the many ways time features in archaeological narratives. The full implications of the Bayesian revolution ought to allow us to recognise the impacts of these existing foundational knowledge structures and to challenge them with more nuanced narratives.

## *On the nature of radiocarbon data*

Some recent writers have suggested that Bayesian chronologies are incompatible with recent theoretical developments, or that they focus on changes that are driven by humans alone (e.g. Draşovean et al., 2017: 637; Ebersbach et al., 2017: 13; for further discussion of this viewpoint, see Crellin, 2020: 89–90, 177–178).

We disagree. But we do need to revisit the nature of chronometric data in archaeology. We suggest that part of the resilience of our inherited time models may be due to the ways in which chronometric data are created in archaeological practice (cf. Lucas 2018) and the specific qualities that archaeologists attribute to chronometric data. In archaeology, chronometric data can seem like very powerful knowledge claims; they are produced by the collective endeavour of numerous specialists across different disciplines, through drawn-out processes; they are measurements of the innate physical qualities of the material past; and they are very expensive. The ways these knowledge claims are described indicate their standing in archaeological narratives; they are 'scientific', and they are 'absolute'. At the same time, chronometric data have a reputation of being difficult to use, hard to summarise, and apparently imprecise when compared with the certainty of a qualified culture historic designation (e.g. 'earlier Neolithic Carinate Bowl'); this all means that the nuances of chronometric measurements often become disassociated in the archaeological narratives which leverage these data. Chronometric measurements therefore have peculiar natures in archaeological work. They take on qualities of incontrovertible 'science factiness' (cf. Griffiths, 2022) and at the same time they exist in tension with other, more readily employed modes of time reckoning.

Actually, chronological data are neither neutral nor independent: they are situated. Temporal constructs, including 'events' and 'scales', and culture historic entities, are not observable, but '… latent and observed through, *but not defined by*, noisy and nuanced data' (Parnell et al., 2008: 1873; our emphasis; cf. Evans, 2003: 96). Chapman and Wylie (2016) suggest that the robustness of a radiocarbon datum depends on extended practical arguments, with contingent local scaffolding. To evaluate correlations, potential causations, and narrative interpretations, chronometric data and data-transformations need to be traceable and reversible from the field onwards; if this '… chain is interrupted at any point, it ceases to transport truth …' as Latour (1999: 69) put it.

Chronometric data are therefore not innately truthful witnesses of the past; chronometric data are mutable. Yet many archaeologists have failed to recognise just how situated and mutable these data are; we see exactly this when people describe radiocarbon 'dates' as the constituents of 'absolute' chronologies. Data are transformed along chains of inquiry, and when they are incorporated into inherited knowledge structures they can become framed using essentializing value-laden temporal terms. Radiocarbon

measurements are numbers; it's what you do with them that counts. Analyses that shear away both the theoretically constructed context of temporal terms and the data scaffolding that underpin chronometric measurements risk creating 'coherent myths' (Oldfield, 2001: 123), 'just so stories', or 'Panglossian Paradigms' (cf. Gould and Lewontin, 1979). In these cases, spurious causal relationships that result from data mutability are marshalled into simplistic narratives; for example, with humans responding in simplistic, environmentally deterministic ways to 'climate change' (cf. Lowe and Higham, 1998: 429; Baillie, 1991; Griffiths and Robinson, 2018), or with social change attributed to simplistic, monocausal mechanisms through grand narratives like 'migration', 'famine', or 'war' (cf. Sherratt, 1995, and see discussion below).

## The potential of ethically Bayesian approaches

We argue that there are several distinct challenges in creating more considered narratives of the past. Ethically Bayesian approaches should recognise that the knowledge structures we employ have been created over the history of our discipline and are situated. Ethically Bayesian approaches should recognise that some of the most seemingly neutral aspects of these inherited knowledge structures are biased and problematic, and in some cases owe much to Eurocentric, colonial approaches to people, the world, and the ways time and change are represented. Ethically Bayesian approaches should challenge these legacies. If we recognise people as vibrant, creative beings, full of potential, and existing in messy and complex worlds, then we need to move away from approaches that perpetuate essentializing 'ages' within the past. We need to stop writing about pasts in terms of entities like 'the Bronze Age' or 'the Iron Age', as if a fixed set of things and types of sites are supposedly intrinsic to a society.

We need to recognise our failure—so far—to reconcile the potential of scientific dating with narrative approaches that take *as their starting points* the uncertain and emergent qualities of the world (rather than centring our narratives on the innateness of things). We need to foreground practice and process over final forms (as we perceive them from the archaeological record) in order to consider a wider variety of lived practices hiding beneath homogenised categories of periods, site-types, and material culture typologies. The importance here is on shifting the narrative emphasis from fixed stuff to dynamic *processes* (cf. Gosden and Malafouris, 2015; Harris, 2021; Malafouris et al., 2021), in order to cut across traditional research divides in culture history (Feinman and Neitzel, 2020), or typological categories in future narratives. In short, we need narratives where our pasts are defined not in terms of proper nouns, but described using dynamic verbs.

This is the approach that we apply to Bayesian modelling in our project 'Third and fourth millennia BC/BCE Ireland and Britain: a history of Major social change Explored' (Project TIME). In this project, we consider the lives of people in the 4th and 3rd millennia, across traditional typologies and period boundaries (beyond the 'Neolithic', 'Chalcolithic', and 'Bronze Age' that culture history has created for us in this part of the world).

We argue that by emphasising practices and processes and by using time, expressed in millennia, centuries, decades, and years, as the basis for our new narrative structures, we

can counter what remains a Eurocentric working model of 'prehistory' in archaeology, where the past is defined in a series of teleological, developmental 'ages' representing staging posts along which our predetermined idea of the past progresses. We argue that rather than working from this normative assumption, archaeological enquiry should focus much more particularly on the specificity of events and practises at locations defined both in time and, simultaneously, in space. In doing so we can make room for regionality, for variation, and for the potentiality of the past.

We are not arguing that chronometric measurements will inevitably create a neutral time-scape. All models of time are culturally specific (see Gell, 1992, on time models and cultural relativism), and there are many, highly culturally variable representations of the experience of time. But we also recognise that *all* humans experience flow and flux as time emerges in multiple different ways (cf. Rovelli, 2018: 170; Gardner, 2001: 36; and Bergson, 1999, on 'real' time), and that describing time in 'years', 'decades', 'centuries', and 'millennia' provides us with a means to reflect this emergence and challenge the continued use of our inherited time models in important and useful ways.

## Recent developments in archaeology

We suggest that an ethically Bayesian approach could provide challenging new approaches to the past especially when used in conjunction with two exciting research trends in archaeology—the use of Big Data in aDNA studies, and New Materialism approaches (cf. Kristiansen, 2014; Huggett, 2020). We focus on both of these approaches because—although they adopt distinctly different vantage points—we argue that each has so far been overly reliant on inherited knowledge structures and in doing so each has perpetuated the essentialism implicit in culture historic ways of thinking. We argue that an ethically Bayesian approach can resolve some of these issues by providing a means to engage with the temporal granularity of the past and thereby avoid the kind of problematic generalisations that can occur in Big Data studies (and aDNA work especially). This approach also enables New Materialism to better focus on processes and relationality by avoiding the essentialization of materials as typological constructs and as cultural packages. Unless New Materialist and Big Data approaches can engage in an ethically Bayesian way, we argue they will fail to reach their full potential, with ethical and epistemological implications for the kinds of narratives created.

### *Big Data approaches and chronology*

Kitchin (2014) recently defined 'Big Data' as: huge in volume, exhaustive in scope, and striving to capture entire populations or systems. Archaeological Big Data projects are not comparable in scale to other disciplines (e.g. Big Data projects in the social sciences; González-Bailón, 2013); however, the *nature* of some archaeological research has the all-encompassing, completist 'Big Data' qualities that Kitchin (2014) describes. Archaeological 'Big Data' studies include: chronological research (e.g. Bevan et al., 2017), entire datasets spanning professional practice (e.g. Cooper and Green, 2016; Fulford and Holbrook, 2011), and ancient DNA studies (e.g. Montgomery and Fernando, 2016).

Ancient DNA studies that seek to represent entire populations are in these terms 'Big Data' by-their-nature regardless of the actual number of datapoints. These methods can be attractive because they may provide a means to process our way beyond the complexity and incompleteness of the archaeological record.

Narrative simplicity, backed by vast swathes of data where the sample *is* the whole population, can be highly persuasive. These narratives seem to negotiate the 'nuance traps' (Healy, 2017) of our complex subject matter by 'letting the data speak for themselves' (Haraway, 1991: 193); however, there may be a dangerous seduction in such completist approaches. The interpretation of some aDNA studies has been controversial (cf. Booth, 2019; Furholt, 2019a, 2019b; Frieman and Hofmann, 2019; Sykes et al., 2019) because of the causal mechanisms that are employed to explain patterns in evidence. For example, projects working in the European 'Bronze Age' have identified massive population movement with corresponding social changes (e.g. Patterson et al., 2022), which has reopened old debates about 'invasion hypotheses' and migration in archaeology (cf. Carlin, 2020; Childe, 1936: 31; Clark, 1966). These types of grand causal narrative had until recently been regarded as 'forbidden' themes (Kristiansen, 2014: 14) because they echoed explanatory models which originated in the 19th and earlier 20th centuries AD/CE, and which radiocarbon measurements demonstrated (in many cases) to reflect the problematic social values of these times rather than patterns in archaeological evidence.

We argue that the most problematic interpretations of Big Data-aDNA projects revive these themes precisely because 'scientific' chronologies are still not yet sufficiently independent; our ideas about time are still too embedded in inherited culture historic modes of thought. In the case of aDNA studies, we see a further amplification of the issues identified above in terms of culture historic thinking, as archaeology comes into contact with other disciplinary communities (in this case geneticists). In this example of interdisciplinary practice, archaeology's historically contingent, situated knowledge is not communicated effectively, and heuristic devices—like 'the Bronze Age'—become the entities about which knowledge production focuses. This kind of failure to effectively communicate the nuance of fundamental aspects of our disciplinary history perpetuates the impression that 'cultural groups' were real historical entities, and cultural traits become grafted onto essentialized genetic profiles. This happens, for example, when genetic clusters are statistically identified as 'population groups' and then labelled using cultural terms like 'Early_Farmer' (Eisenmann et al., 2018). In this abandonment of nuance, there is a trend for narratives to further rationalise aspects of our evidence, so in these explanations we see a further emphasis on what are perceived to be the fundamental aspects of humans—origins (where people 'come from') and identity (who people 'are') defined through material culture or 'inalienable', phenotypical, 'natural' biology. The elision of nuance, the essentialization of certain aspects of archaeological evidence, and the reliance on disciplinary zombie concepts create highly problematic transformations from data to narrative. This process recalls the ways in which data and explanatory narratives are related in other disciplines (cf. Hubálek, 2021).

These issues with aDNA can be seen in some other examples of Big Data research in archaeology more broadly. Indeed, proponents of 'slow archaeology' (Caraher, 2016)

have noted that Big Data approaches promote an acceleration away from theoretically informed archaeology. Big Data can standardise entities in a way that downplays diversity in space and time, while 'black boxing' procedures and outcomes in ways that obscure the underlying methodologies and datasets (Caraher, 2016: 430; Huggett, 2020: 512; Latour, 1987), making results inaccessible and unverifiable. This has the unwelcome consequence of rendering particular interpretations resistant to challenge and contestation (Cunningham and MacEachan, 2016: 630).

Big Data approaches—coupled with huge increases in commonly-accessible processing capacity—have the potential for really radical, new understandings. However, critical to any new understandings will be the ways in which data are communicated, transformed, and reproduced as part of new analyses and interpretations—including the identification of tensions between epistemology and analytical processes. Unless analyses are sufficiently theoretically integrated, Big Data projects can simply replicate pre-existing knowledge structures and reinforce simplistic 'grand narrative' causal mechanisms; we suggest the recent debates about migration discussed above are an example of this. We argue that unless we introduce an ethically Bayesian approach that works to make chronological evidence *more* independent of our inherited knowledge structures, Big Data-aDNA analyses will probably fail to move beyond traditional grand narrative tropes.

## *New Materialist and Posthuman approaches and chronology*

In our traditional, material culture-defined approaches to the past, we assume a unifying 'essence' in particular packages of things which makes them all 'Neolithic', or in particular vessels which make them all 'Grooved Ware' (though in many cases the incompleteness of these approaches is apparent in the frequent qualification of such ideas with additional descriptive terms. For example, the *secondary* or *middle* Neolithic, the Neolithic of *north east England*, *Durrington Walls-style* Grooved Ware, and so on). But just as it is impossible for typologies to accurately reflect the range of material qualities, so too do they fail to deal with the different historical processes through which assemblages emerge, and the different agentic impacts that morphologically, typologically, or taxonomically similar components will have in different configurations (Harris, 2017; Hamilakis and Jones, 2017: 79). However, there are significant problems with these approaches, for things and people; 'the Beaker People' did not make this specific example of an All Over Corded vessel, an individual person did.

New Materialist and Posthuman approaches emphasise a heterogeneity of life (Webmoor and Witmore, 2008; Haraway, 2007; Alberti et al., 2011; Olsen et al., 2012; Crellin et al., 2021), the interrelationships between things and beings, and that humans and non-humans bring each other into existence (e.g. Argent, 2013; Oma, 2010; Overton and Hamilakis, 2013; Pétursdóttir and Olsen, 2018; Tsing, 2015) in a constantly emerging world (e.g. Hill, 2011; Marshall and Alberti, 2014). New Materialism argues that because assemblages are always changing or 'becoming', coming together and breaking apart (Deleuze and Guattari, 2004: 98), archaeological assemblages represent the unique historical processes that brought them into being (Harris, 2017). Such approaches move away from anthropocentricism and Western industrialised ways of thinking to avoid

problematic dualisms that derive from recent European thought. They foreground the sensorial and material properties of an emergent world (Harris, 2017; Hamilakis, 2014) and examine the character of socially significant and mutual interactions and engagements between humans and nonhumans emerging in particular contexts. The focus on the unique historical process of assemblages should directly challenge the concepts and heuristic devices that frame archaeological narratives, including culture historic terms, material culture typologies, and even the ontological stability of humans and non-humans.

New Materialism does, however, understand there to be limits to this heterogeneity. Life emerges from the virtual elements of an assemblage, which can be actualised differently (Harris, 2017; Deleuze and Guattari, 2004: 156); there is an envelope of possibilities present within an assemblage, through which people and things *might* emerge together (Robb, 2013: 667). Such a perspective also offers a new way to think about 'change'. In New Materialist narratives where humans are part of assemblages with things, materials, animals, places, ideas, and memories, we cannot assume a monocausal reason for change (Crellin, 2017: 118), and indeed we might suggest that the *processes* through which these assemblages emerge might be more important than the resulting material culture package (Harris, 2017, 2021; Gosden and Malafouris, 2015; Lucas, 2012: 196; Malafouris et al., 2021).

Put simply, typological categories or packages promote essentialized views of the past which do not reflect the true heterogeneity, vibrancy, and instability of the world. This is what we do when we write about 'the Neolithic', 'the Bronze Age', 'the Iron Age', or indeed 'the transition' between any of these culture historic entities. Indeed, we would argue that it should not be possible to write a New Materialist archaeology of 'the Neolithic', as the idea of culture historic concepts is fundamentally incompatible with any understanding of the world as unstable, emerging, and undetermined. We argue that exploring the temporality and flux in the *processes* through which the past came into being beyond conventional culture historic categories—and across time (represented in years, decades, centuries, and millennia) *and* space—are the key contributions that an ethically Bayesian approach can make. Without this kind of critique there is the danger that New Materialist narratives will simply reproduce the finite times and worlds in preconceived archaeological cultures or ages.

## Structural changes: The importance of practises

For both Big Data and New Materials approaches in archaeology, the legacy of our disciplinary knowledge structures poses significant barriers to challenging existing narratives. We have suggested that using chronometric data to write process-based narratives provides ways to counter this inheritance. In the last part of this discussion we outline the ways in which—by focusing on practises identified at the site level and the processes that bring things into being—we propose to create these new kinds of ethically Bayesian narratives.

### *Architecture of doing*

Archaeological approaches to classifying the past using 'types' of monuments that we understand to have certain cultural currency presents a number of challenges. Recent

Bayesian analyses of the chronologies of different types of sites have provided very precise sequences (e.g. for causewayed enclosures; Whittle et al., 2011). However, in many cases, these sites are predetermined by a fundamental characteristic, their location in a culture historic framework. In such cases, sites are conceived of as by-their-nature *being* 'Neolithic', even when these places existed across various culture historic pasts and continue to be in the present. We can see this tension with one of the most iconic 'Neolithic' and 'Bronze Age' site-types in Irish and British archaeology. 'Henges' or 'embanked enclosures' are an almost talismanic monument type. Yet while the term is used to cover a wide variety of sites, it is difficult to establish what a 'henge' is, even when the corpus of sites is broken into different configurations or sub-types (Gibson, 2012). Squeezing a suite of varied sites into a single type flattens differences between sites and assumes a unifying essence. This is not to say similarities do not exist; however, by working with homogenising typologies, such narratives foreground the material and the architectural, instead of examining the unity and differences in *practises* across time and space. The use of monument 'types' strips away the variable temporal depth of particular sites. In the case of 'henges', it is now clear that the construction of earthen banks and the excavations of ditches were, at least in some cases, later actions at multi-phase sites, where activities occurred from 'the Neolithic' and 'the Bronze Age' into 'the Iron Age' and our own 'Present' 'Anthropocene' times. Certainly, henges are not fixed architectural entities and are not best described in terms of their deviation from an idealised form (cf. McFadyen, 2016).

We suggest that a more creative narrative for these places can be achieved using an ethically Bayesian approach, which takes practises identified in time and space (rather than defined in culture historic terms) as our basis (cf. Pauketat and Robb, 2013). In this we can follow explorations of these sites by researchers such as Brophy and Noble (2012) who identify acts of 'henging', 'blocking' and 'mounding' as intentional acts at particular sites: restricting access to or entirely closing off places, actions which could memorialise sites, but equally could represent moments of 'no return', sealing and forgetting sites beyond use. Similarly, Pollard (2012) argues acts of erecting timber settings and 'henging' at sites in Wessex reflect changes in the ontological status of these places and structures, bound into the historical processes at particular sites. Acts of 'mounding', 'henging', or 'blocking' could be understood as a common response to something, and these events need to be understood both in terms of the ongoing emergence and wider transformative processes occurring at these specific places. Both the potentiality and uncertainty of these practises, and their outcomes, needs to be central to our narratives. But we cannot write these unstable, uncertain pasts if we understand that a type of site existed, by-its-nature, in certain culture historic settings prespecified in time and space.

We suggest a larger vocabulary of practises: 'henging', 'mounding', and 'blocking' could be added to other verbs including 'burning', 'middening', 'reworking', 'destroying', 'venerating', 'enclosing', and 'depositing' to identify similar broad practises manifest in specific, or locally 'idiosyncratic' ways (cf. Bradley, 2007: 121). These undertakings are at least as important as other data (e.g. about material culture, architecture, and lifeways) in allowing the production of temporally specific narratives which go beyond normative ideas about what the past was and engage with commonalities and

distinctions beyond individual sites. By avoiding the assumption of uniformity within 'types', such analyses can interrogate the potential for a heterogeneous picture of the world being brought into being across the 4th and 3rd millennia cal BC/BCE. Through practises we can decentre the fixedness of the world and the essentialness of things and think about the transformation of places across time. This enables our narratives to focus on the emergence and duration of various ongoing human interactions with a dynamic material world of other people, places, animals, plants, and things.

## *Things as beings*

Typology—and the notion of technological evolution—was fundamental to the emergence of archaeology as a distinctive discipline (Schnapp, 2002: 139). Ceramic typologies are perhaps the best example of a class of evidence (in our case study) that has been reified into categories for archaeological study; things are described in reference to a standardised idea, deviation in form or fabric is described in reference to a finished conception of how a particular vessel type should be. Pottery plays this role in Ireland and Britain because of its ubiquity across many times and places, and because the range of forms and fabrics facilitated the creation of typological sequences over the history of our discipline.

Archaeology's reliance on artefact sequences as a proxy form of dating contributed to a 'chest of drawers' temporal approach influenced by geological time, in which one style or tradition gives way to another. These approaches and underlying assumptions promote a 'block time' approach to change in the past (Crellin, 2020: 6), where change is compressed into brief episodes of transition between static 'period' blocks. The implication is often drawn by non-pottery specialists that ceramic traditions remain homogeneous through time, merely appearing and disappearing in the fashion represented by the 'battleship curves' (McNutt, 1973). The enduring legacy of this normative approach to material culture (cf. Binford, 1965) is that the internal coherence of styles, types, and assemblages is valorised over their variability, not merely because this outlook is rooted in a notion of shared and transmitted cognitive dispositions, but because these entities formed the building blocks of a particular kind of narrative. Lucas and Olivier (2022: 62) have recently emphasized the importance of 'material' time as a specific aspect of the specific nature of time in archaeology.

A New Materialist (and particularly assemblage-based) approach could counter this perception of the static nature of materials by emphasising *becoming* as continuous processes (Jervis, 2019: 14). In such an approach, change should not be something that afflicts entities at intervals, but should be considered to be the normal state of affairs. Material traditions will always be metastable assemblages, which are constantly fraying around the edges, discarding some elements and acquiring new ones (Fowler, 2017).

These approaches are attractive, but we suggest that we need to go further in our understanding of the role of essentialized material culture in the process of archaeological knowledge construction. Culture historic ways of writing the past could have become outmoded with the introduction of scientific forms of direct dating. However, relative chronologies derived from pottery typologies and 'packages' of material culture remain central to our discipline for multiple reasons. We suggest that the persistence of inherited

culture historic ideas occurs in part because of the ways that new archaeological knowledge is constructed from the site upwards (cf. Lucas, 2018: 91). The haptic, iterative process of the recovery of pottery (or other diagnostic culture historic elements for other areas of study) on sites means that relative, typological chronologies are built in the field within the framework of our inherited knowledge structures; this inheritance is composed of 'handy' concepts. These site-specific chronologies are created, reified, and reinforced by the processes of embodied fieldwork. The immediacy of these pottery chronologies means that this knowledge is interwoven with the site as its narrative comes into being. The framing of site histories within the powerful iconic models which we use to think with about 'prehistory' is further compounded by the nature of our 'independent' chronologies. While chronometric data have aspects of 'science factiness' (see discussion above; Griffiths, 2022), chronometric time is also often only built *after* the limits of our understandings of the site have been created through fieldwork; independent chronologies are built as secondary to the closely observed, highly warranted knowledge claims established in the field (Griffiths, 2022; Chapman and Wylie, 2016).

In order to emphasise *processes*, as well as thinginess, we need to think critically about how both knowledge about 'diagnostic' material culture and chronometric data are produced. This should include the development of new integrated approaches to create various aspects of archaeological time on site, including the production of chronometric data. If not, rather than understanding things that do things and things that are deployed specifically and meaningfully, we will simply recreate the world as we know how to study it. We need things that are not predefined as part of the fixed expression of the time dimensions in archaeology. The advantage of the ethically Bayesian approach that we advocate is that if we challenge the definition of artefact 'types'—as products of particular predetermined social groups (i.e. no vessel should be determined as by-its-nature *Neolithic*)—we can challenge the convention that material traditions are static or predetermined (cf. Fowler, 2013, 2017). In an ethically Bayesian approach, we can investigate the *processes* by which these traditions gain coherence and then disperse, and the relative degrees of their boundedness and variability. In an ethically Bayesian approach, we should be less interested in things-in-themselves, and more interested in how they become present in the archaeological contexts from which they are recovered.

## Conclusions

While substantial revisions to individual archaeological sequences have been produced from Bayesian analyses, the full implications of (ethically) Bayesian approaches to archaeological chronologies have not, yet, been achieved. *Pace* Binford (Taylor, 2000: 15), building chronological sequences is never theoretically neutral because these sequences are situated in significant, latent structuring knowledge frameworks. To fully embrace the potential of chronometric measurements we need to fundamentally challenge how we understand these data to be located within our existing knowledge structures. We need to move beyond our culture historical inheritance and decentre our narratives from a very specific type of dependence on materials. Applying new methods within extant structures runs the risk of simply perpetuating inherited narratives.

To achieve an ethically Bayesian approach, we need to engage more critically with chronometric data to try and make them *more* independent from traditional ways of understanding the past. Only then can we hope to fully realise the potential of both the original radiocarbon revolution and to embrace perspectives offered by both Big Data analyses and New Materialism to create in-depth, disciplinary-rich research questions. Our particular narratives should create the general, not be subsumed within it. An ethically Bayesian approach provides the means to create these structural changes in terms of how we write about the past.

## Acknowledgements

We would like to thank two anonymous reviewers who provided very helpful comments that helped us to produce a much better paper. We would like to thank the journal and the editor for their ongoing support.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research/project was funded by UKRI AHRC award AH/T001631/1. No new data were created for this publication.

## References

Alberti B, Fowles S, Holbraad M, et al. (2011) 'Worlds otherwise': Archaeology, anthropology, and ontological difference. *Current Anthropology* 52: 896–912. DOI: 10.1086/662027

Argent G (2013) Inked: Human-horse apprenticeship, tattoos, and time in the Pazyryk world. *Society and Animals* 21: 178–193. DOI: 10.1163/15685306-12341301

Bailey G (2008) Time perspectivism: Origins and consequences. In: Holdaway S and Wandsnider L (eds) *Time in Archaeology*. Salt Lake City: University of Utah Press, 13–30.

Baillie M (1991) Suck-in and smear: Two related chronological problems for the 90s. *Journal of Theoretical Archaeology* 2: 12–16.

Bayliss A (2009) Rolling out revolution: Using radiocarbon dates in archaeology. *Radiocarbon* 51: 123–147. DOI: 10.1017/S0033822200033750

Beck U and Beck-Gernsheim E (2002) Zombie categories: Interview with Ulrich Beck. In: Beck U and Beck-Gernsheim E (eds) *Individualization: Institutionalized Individualism and its Social and Political Consequences*. London: SAGE Publications Ltd. DOI: 10.4135/9781446218693

Bebber M, Buchanan B and Holland-Lulewicz J (2022) Refining the chronology of North America's copper using traditions: A macroscalar approach via Bayesian modeling. *PLoS One* 17(4): e0266908. DOI: 10.1371/journal.pone.0266908

Bennett J (2010) *Vibrant Matter: A Political Ecology of Things*. London: Duke University Press.

Bergson H (1999) *Duration and Simultaneity*. Translated by L Jacobson. Manchester: Clinamen Press.

Bevan A, Colledge S, Fuller D, et al. (2017) Holocene population, food production, and climate. *Proceedings of the National Academy of Sciences* 114: E10524–E10531. DOI: 10.1073/pnas.1709190114

Binford L (1965) Archaeological systematics and the study of culture process. *American Antiquity* 31: 203–210.

Booth T (2019) A stranger in a strange land: A perspective on archaeological responses to the palaeogenetic revolution from an archaeologist working amongst palaeogeneticists. *World Archaeology* 51(4): 586–601. DOI: 10.1080/00438243.2019.1627240

Bradley R (2007) *The Prehistory of Britain and Ireland*. Cambridge: Cambridge University Press.

Bronk Ramsey C (2008) Radiocarbon dating: Revolutions in understanding. *Archaeometry* 50: 249–275. DOI: 10.1111/j.1475-4754.2008.00394

Brophy K and Noble G (2012) Henging, mounding and blocking: The Forteviot henge group. In: Gibson A (ed) *Enclosing the Neolithic: Recent Studies in Britain and Europe*. Oxford: Archaeopress, 21–35.

Buck C, Kenworthy J, Litton C, et al. (1991) Combining archaeological and radiocarbon information: A Bayesian approach to calibration. *Antiquity* 65: 808–821.

Buck C, Litton C and Scott E (1994) Making the most of radiocarbon dating: Some statistical considerations. *Antiquity* 68: 252–263.

Buck C, Litton C and Smith A (1992) Calibration of radiocarbon results pertaining to related archaeological events. *Journal of Archaeological Science* 19: 487–512.

Caraher W (2016) Slow archaeology: Technology, efficiency, and archaeological work. In: Averett E, Gordon J and Counts D (eds) *Mobilizing the Past for a Digital Future*. Great Forks: University of North Dakota, pp. 421–441.

Carlin N (2020) Haunted by the ghost of the Beaker folk? *The Biochemist* 42: 30–33. DOI: 10.1042/BIO04201030

Chapman R and Wylie A (2016) *Evidential Reasoning in Archaeology*. London: Bloomsbury.

Childe V (1936) *Man Makes Himself*. London: Watts.

Clark G (1966) The invasion hypothesis in British archaeology. *Antiquity* 40(159): 172–189. DOI: 10.1017/S0003598X00032488

Clarke D (1972) *Models in Archaeology*. London: Methuen.

Cooper A and Green C (2016) Embracing the complexities of 'Big Data' in archaeology: The case of the English Landscape and Identities project. *Journal of Archaeological Method and Theory* 23: 271–304. DOI: 10.1007/s10816-015-9240-4

Crellin R (2017) Changing assemblages: Vibrant matter in burial assemblages. *Cambridge Archaeological Journal* 27: 111–125. DOI: 10.1017/S0959774316000664

Crellin R (2020) *Change and Archaeology*. Abingdon: Routledge.

Crellin R, Cipolla C, Montgomery L, et al. (2021) *Archaeological Theory in Dialogue: Situating Relationality, Ontology, Posthumanism and Indigenous Paradigms*. London: Routledge.

Cunningham J and MacEachan S (2016) Ethnoarchaeology as slow science. *World Archaeology* 48: 628–641. DOI: 10.1080/00438243.2016.1260046

Daniel G (1964) *The Idea of Prehistory*. Harmondsworth: Penguin.

Deleuze G and Guattari F (2004) *A Thousand Plateaus: Capitalism and Schizophrenia*. London: Continuum.

Drașovean F, Schier W, Bayliss A, et al. (2017) The lives of houses: Duration, context, and history at Neolithic Uivar, Romania. *European Journal of Archaeology* 20: 636–662. DOI: 10.1017/eaa.2017.37

Ebersbach R, Doppler T, Hofmann D, et al. (2017) No time out: Scaling material diversity and change in the Alpine foreland Neolithic. *Journal of Anthropological Archaeology* 45: 1–14. DOI: 10.1016/j.jaa.2016.10.001

Eisenmann S, Bánffy E, van Dommenlen P, et al. (2018) Reconciling material cultures in archaeology with genetic data: The nomenclature of clusters emerging from archaeogenomic analysis. *Nature Science Reports* 8: 13003. DOI: 10.1038/s41598-018-31123-z

Eskildsen K (2012) The language of objects: Christian Jürgensen Thomsen's science of the past. *Isis* 103: 24–53. DOI: 10.1086/664975

Evans J (2003) *Environmental Archaeology and the Social Order*. London: Routledge.

Fowler C (2013) *The Emergent Past: A Relational Realist Archaeology of Early Bronze Age Mortuary Practices*. Oxford: Oxford University Press.

Fowler C (2017) Relational typologies, assemblage theory and Early Bronze Age burials. *Cambridge Archaeological Journal* 27: 95–109. DOI: 10.1017/S0959774316000615

Feinman G and Neitzel J (2020) Excising culture history from contemporary archaeology. *Journal of Anthropological Archaeology* 60: 101230. DOI: 10.1016/j.jaa.2020.101230

Frieman C and Hofmann D (2019) Present pasts in the archaeology of genetics, identity, and migration in Europe: A critical essay. *World Archaeology* 51(4): 528–545.

Furholt M (2019a) Re-integrating archaeology: A contribution to aDNA studies and the migration discourse on the 3rd millennium BC in Europe. *Proceedings of the Prehistoric Society* 85: 115–129. DOI: 10.1017/ppr.2019.4

Furholt M (2019b) De-contaminating the aDNA–archaeology dialogue on mobility and migration: Discussing the culture-historical legacy. *Current Swedish Archaeology* 27(1): 53–68. DOI: 10.37718/CSA.2019.03

Fulford M and Holbrook N (2011) Assessing the contribution of commercial archaeology to the study of the Roman period in England, 1990–2004. *The Antiquaries Journal* 91: 323–345. DOI: 10.1017/S0003581511000138

Gardner A (2001) The times of archaeology: Archaeologies of time. *Papers from the Institute of Archaeology* 12: 35–47.

Gell A (1992) *The Anthropology of Time*. London: Routledge.

Gibson A (2012) An introduction to the study of henges: Time for a change? In: Gibson A (ed) *Enclosing the Neolithic: Recent Studies in Britain and Europe*. Oxford: Archaeopress, 1–20.

González-Bailón S (2013) Social science in the era of big data. *Policy and Internet* 5: 147–160. DOI: 10.1002/1944-2866.POI328

Gould S and Lewontin R (1979) The spandrels of San Marco and the Panglossian Paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society of London B* 205: 581–598.

Gosden C and Malafouris L (2015) Process archaeology (P-Arch). *World Archaeology* 47: 701–717. DOI: 10.1080/00438243.2015.1078741

Griffiths S (2017) We're all culture historians now: Radiocarbon dating revolutions and archaeological theory. *Radiocarbon* 59: 1347–1357. DOI: 10.1017/RDC.2017.20

Griffiths S (ed) (2022) *Scientific Dating in Archaeology*. Oxford: Oxbow.

Griffiths S and Robinson E (2018) The 8.2ka event evidence for human-environment interaction in north-west Atlantic Europe. *Quaternary International* 465(B): 251–257. DOI: 10.1016/j.quaint.2017.10.017

Hamilakis Y and Jones A (2017) Archaeology and assemblage. *Cambridge Archaeological Journal* 27: 77–84. DOI: 10.1017/S0959774316000688

Hamilakis Y (2014) *Archaeology and the Senses: Human Experience, Memory, and Affect*. Cambridge: Cambridge University Press.

Haraway D (1991) *Simians, Cyborgs and Women: The Reinvention of Nature*. New York: Routledge.

Haraway D (2007) *When Species Meet*. Minneapolis: University of Minnesota Press.

Harris O (2017) Assemblages and scale in archaeology. *Cambridge Archaeological Journal* 27: 127–139. DOI: 10.1017/S0959774316000597

Harris O (2021) *Assembling Past Worlds: Materials, Bodies and Architecture in Neolithic Britain*. London: Routledge.

Healy K (2017) Fuck nuance. *Sociological Theory* 35: 118–127. DOI: 10.1177/0735275117709046

Hill E (2011) Animals as agents: Hunting ritual and relational ontologies in prehistoric Alaska and Chukotka. *Cambridge Archaeological Journal* 21: 407–426.

Hodder I (1995) Of mice and men: Collingwood and the development of archaeological thought. In: Boucher D, Connolly I and Modood T (eds) *Philosophy, History and Civilisation*. Cardiff: University of Wales Press, pp. 364–383.

Holdaway S and Wandsnider L (2008) *Time in Archaeology*. Salt Lake City: University of Utah Press.

Hubálek M (2021) A brief (hi)story of just-so stories in evolutionary science. *Philosophy of the Social Sciences* 51: 447–468. DOI: 10.1177/0048393120944223

Huggett J (2020) Is Big Digital Data different? Towards a new archaeological paradigm. *Journal of Field Archaeology* 45(1): 8–17. DOI: 10.1080/00934690.2020.1713281

Jervis B (2019) *Assemblage Thought and Archaeology*. London: Routledge.

Kehoe A (2013) 'Prehistory's' history. In: Schmidt P and Mrozowski S (eds) *Death of Prehistory*. Oxford: Oxford University Press, pp. 31–46.

Kim H, Lee G and Crema E (2021) Bayesian analyses question the role of climate in Chulmun demography. *Nature Science Reports* 11: 23797. DOI: 10.1038/s41598-021-03180-4

Kitchin R (2014) Big Data, new epistemologies and paradigm shifts. *Big Data and Society* 1: 1–12. DOI: 10.1177/2053951714528481

Kristiansen K (2014) Towards a new paradigm? The third science revolution and its possible consequences in archaeology. *Current Swedish Archaeology* 22: 11–34. DOI: 10.37718/CSA.2014.01

Latour B (1987) *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

Latour B (1999) *Pandora's Hope*. Cambridge, MA: Harvard University Press.

Lowe D and Higham T (1998) Hit-or-myth? *Antiquity* 72: 427–431. DOI: 10.1017/S0003598X00086737

Lucas G (2005) *The Archaeology of Time*. London: Routledge.

Lucas G (2008) Time and the archaeological event. *Cambridge Archaeological Journal* 18(1): 59–65.

Lucas G (2012) *Understanding the Archaeological Record*. Cambridge: Cambridge University Press.

Lucas G (2015) Archaeology and contemporaneity. *Archaeological Dialogues* 22(1): 1–15.

Lucas G (2018) Periodization in archaeology. Starting in the ground. In: Souvatzi S, Baysal A and Baysal EL (eds) *Time and History in Prehistory*. London: Routledge, 77–94.

Lucas G and Olivier L (2022) *Conversations about Time*. London: Routledge.

Malafouris L, Gosden C and Bogaard A (2021) Process archaeology. *World Archaeology* 53: 1–14. DOI: 10.1080/00438243.2021.2006963

Marshall Y and Alberti B (2014) A matter of difference: Karen Barad, ontology and archaeological bodies. *Cambridge Archaeological Journal* 24: 19–36. DOI: 10.1017/S0959774314000067

McFadyen L (2016) Immanent architecture. In: Bille M and Sorensen T (eds) *Elements of Architecture*. London: Routledge, pp. 53–62.

McNiven I and Russell L (2009) Towards a postcolonial archaeology of Indigenous Australia. In: Bentley R, Maschner H and Chippendale C (eds) *Handbook of Archaeological Theories*. New York: AltaMira, 423–447.

McNutt C (1973) On the methodological validity of frequency seriation. *American Antiquity* 38: 45–60. DOI: 10.2307/279310

Montgomery S and Fernando R (2016) Ancient DNA and human history. *Proceedings of the National Academy of Sciences* 113(23): 6380–6387. DOI: 10.1073/pnas.1524306113

Montón-Subías S and Hernando A (2018) Modern colonialism, Eurocentrism and historical archaeology: Some engendered thoughts. *European Journal of Archaeology* 21(3): 455–471. DOI: 10.1017/eaa.2017.83

Mulvaney J (1990) Afterword: The view from the window. In: Janson S and MacIntyre S (eds) *Through White Eyes*. St. Leonards: Allen & Unwin, pp. 155–167.

Oldfield F (2001) A question of timing. *Holocene* 11: 123–124.

Olsen B, Shanks M, Webmoor T, et al. (2012) *Archaeology: The Discipline of Things*. Berkeley: University of California Press.

Oma K (2010) Between trust and domination: Social contracts between humans and animals. *World Archaeology* 42: 175–187. DOI: 10.1080/00438241003672724

Overton N and Hamilakis Y (2013) A manifesto for a social zooarchaeology: Swans and other beings in the Mesolithic. *Archaeological Dialogues* 20: 111–136.

Parnell A, Haslett J, Allen J, et al. (2008) A flexible approach to assessing synchroneity of past events using Bayesian reconstructions of sedimentation history. *Quaternary Science Reviews* 27: 1872–1885. DOI: 10.1016/j.quascirev.2008.07.009

Pauketat A and Robb J (eds) (2013) *Big Histories, Human Lives: Tackling Problems of Scale in Archaeology*. Santa Fe, NM: School for Advanced Research Press.

Pétursdóttir Þ. and Olsen B (2018) Theory adrift: The matter of archaeological thinking. *Journal of Social Archaeology* 18: 1–21. DOI: 10.1177/1469605317737426

Pollard J (2012) Living with sacred spaces: The henge monuments of Wessex. In: Gibson A (ed) *Enclosing the Neolithic: Recent Studies in Britain and Europe*. Oxford: Archaeopress, pp. 93–107.

Patterson N, Isakov M, Booth T, et al. (2022) Large-scale migration into Britain during the Middle to Late Bronze Age. *Nature* 601: 588–594. DOI: 10.1038/s41586-021-04287-4

Ramenofsky A and Steffen A (1998) *Unit Issues in Archaeology*. Salt Lake City: University of Utah Press.

Renfrew C (1973) *Before Civilization*. London: Cape.

Rifkin M (2017) *Beyond Settler Time: Temporal Sovereignty and Indigenous Self-Determination*. Durham, NC: Duke University Press.

Robb J (2013) Material culture, landscapes of action, and emergent causation: A new model for the origins of the European Neolithic. *Current Anthropology* 54: 657–683. DOI: 10.1086/673859

Rovelli C (2018) *The Order of Time*. London: Penguin.

Rowley-Conwy P (2007) *From Genesis to Prehistory: The Archaeological Three Age System and its Contested Reception in Denmark, Britain, and Ireland*. Oxford: Oxford University Press.

Schnapp A (2002) Between antiquarians and archaeologists: Continuities and ruptures. *Antiquity* 76: 134–140. DOI: 10.1017/S0003598X00089900

Sherratt A (1995) Reviewing the grand narrative: Archaeology and long-term change. *Journal of European Archaeology* 3: 1–32. DOI: 10.1179/096576695800688223

Sykes N, Spriggs M and Evin A (2019) Beyond curse or blessing: The opportunities and challenges of aDNA analysis. *World Archaeology* 51(4): 503–516. DOI: 10.1080/00438243.2019.1741970

Taylor R (2000) The contribution of radiocarbon to new world archaeology. *Radiocarbon* 42: 1–21. DOI: 10.1017/S0033822200053017

Tsing A (2015) *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton, NJ: Princeton University Press.

Webmoor T and Witmore C (2008) Things are us! A commentary on human/thing relations under the banner of a 'social' archaeology. *Norwegian Archaeological Review* 41: 53–70. DOI: 10.1080/00293650701698423

Whitehouse N, Schulting R, McClatchie M, et al. (2014) Neolithic agriculture on the European western frontier: The boom and bust of early farming in Ireland. *Journal of Archaeological Science* 51: 181–205. DOI: 10.1016/j.jas.2013.08.009

Whittle A (2018) *The Times of Their Lives*. Oxford: Oxbow.

Whittle A, Bayliss A and Healy F (2011) *Gathering Time: Dating the Early Neolithic Enclosures of Southern Britain and Ireland*. Oxford: Oxbow.

## Author biographies

Seren Griffiths Corresponding author. Reader in Public Heritage and Archaeological Science at Manchester Metropolitan University. Co-PI on the Irish Research Council (IRC)- and UK Research and Innovation Arts and Humanities Research Council (UKRI AHRC)-funded 'Project Radiocarbon'. PI on the AHRC-funded 'Project Time'.

Neil Carlin Assistant Professor in Archaeology at University College in Dublin. Co PI on the IRC- and AHRC-funded 'Project Radiocarbon'. CoI on the AHRC-funded 'Project Time'.

Ben Edwards Reader in Heritage and Archaeology at Manchester Metropolitan University. CoI on the AHRC-funded 'Project Time'.

Nick Overton Research Associate in Osteology at University of Manchester on the AHRC-funded 'Project Time'.

Penny Johnston Research Associate in Archaeobotany at Manchester Metropolitan University on the United Kingdom Research and Innovation: Arts and Humanities Research Council (AHRC)-funded 'Project Time'.

Julian Thomas Professor of Archaeology at the University of Manchester. CoI on the AHRC-funded Project TIME.