

The use of ethnographic data in Neanderthal archaeological research

Recent trends and their interpretative implications

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Abstract: Archaeologists frequently use ethnographic data on recent hunter-gatherers to interpret and analyse data from prehistoric groups. This use of ethnographic data is not limited to the archaeology of *Homo sapiens*, but also to that of archaic hominins. In this article, I examine how archaeologists use ethnographic data in their research on Neanderthals. An analysis of articles published in five international journals in the ‘genomic era’ of Neanderthal research (post-2010) shows that while not ubiquitous, many archaeologists use ethnographic data to interpret a range of Neanderthal behaviours. Several key patterns in the use of ethnographic data are identified, including limited engagement with ethnographic sources, the frequent use of data to substantiate a claim, or ‘fill in the gaps’ of a sparse archaeological record, and little acknowledgement of the problems or limitations of the application of these data to Neanderthal contexts. These practices may reflect the current trend in Neanderthal research which emphasises similarities with early *Homo sapiens*, and takes for granted the appropriateness of analogues with recent foragers. I argue that the prevailing use of ethnographic data does not account adequately for biological and cognitive differences between Neanderthals and *Homo sapiens*. I demonstrate this using the example of the effects of Neanderthal biology on demography and mobility and provide some recommendations for best practice of the use of ethnographic data in Neanderthal archaeological research.

Keywords: Neanderthals, Palaeolithic archaeology, ethnographic analogy

1. Ethnographic data, prehistoric hunter-gatherers and archaic hominins

The use of ethnographic analogy (here defined very broadly as ‘the comparison of different things, settings and practices that share certain properties so as to infer or imply other non-observable commonalities’; Lane 2014:105) has a long history in archaeology. The use of analogy is especially prominent in prehistory, where the comparative richness of the ethnographic database of

recent small-scale societies contrasts with an often-underwhelming archaeological record. After decades of discussion on the relative strengths and weaknesses of different types of analogy, and the validity of analogies in archaeological reasoning (eg Gould & Watson 1982; Stahl 1993; Wylie 1985), current consensus views ethnographic analogy as neither universally appropriate nor inappropriate, but something whose validity should be assessed on a context-by-context basis (Currie 2016). In any event, the use of ethnographic analogy in archaeological interpretation is largely inevitable, particularly in early prehistory (Palaeolithic and Mesolithic).

Nonetheless, calls for caution in the use of ethnographic analogy should be taken seriously. For prehistoric hunter-gatherers these typically take two forms. First is the relevance of recent foragers as a source of analogies. Ethnographic hunter-gatherers are largely restricted geographically to marginally productive areas (cf Porter & Marlowe 2007) and are enmeshed in modern world systems (Headland & Reid 1989; Kent 1992; Layton 2001). The question then is how typical they are of the hunter-gatherer adaptation more broadly (if such a thing exists) and whether their lack of cultural 'purity' prevents them from being relevant for understanding prehistoric foragers. When the 'modern' adaptation emerged (ie that similar to those of ethnographically documented groups), and how this would be recognised archaeologically, has been a particularly important line of enquiry, with many arguing that it only emerged with *Homo sapiens* in the late Pleistocene (Kuhn & Stiner 2001; Kusimba 2005; Pettitt 2014) or early Holocene (Foley 1988; Richerson & Boyd 2013:292–302).

Secondly, there is the issue of implementation. A key concern is to avoid replicating the ethnographic present in the past; the action of 'affirming the consequent' (Gould 1980:29). One possible outcome of this is the inability to recognise unique cases (or those which have no recent counterpart) in the archaeological record, thereby reducing our understanding of the diversity of past societies and practices. The challenge is how to draw on these data in ways which allow for, rather than obscure, any differences between archaeological and ethnographic hunter-gatherers (Wobst 1978; see also Finlayson & Warren 2017 and papers therein).

The relevance of recent foragers to prehistoric hunter-gatherers, and the challenge of imagining ways of being a hunter-gatherer which differ from those seen ethnographically, are compounded when applied to archaic hominins (non-*Homo sapiens*). Here, we have the additional challenge of studying hominins who are biologically distinct enough from recent foragers to belong to a different species. While it is an anthropological truism that humanity has lived by hunting and gathering for 99% of its existence, definitions of

'hunter-gatherer' usually include behaviours beyond these economic activities, including a common mode of social organisation (the 'band' eg Lee 1992), similarities in world view (eg the 'foraging mode of thought'; Barnard 2002 or 'hunter-gatherer sociality'; Ingold 1987), and gendered division of labour (Barnard 2014:52). The archaic hominins of the Lower and Middle Palaeolithic were undoubtedly pre-agriculture, but it is unclear if and how differences in biology and cognition affected both the way in which they hunted and gathered, and their behaviour and social structures, including those which characterise foragers in the ethnographic present.

With these challenges in mind, rather than offering another 'ethnographic cautionary tale' this paper tasks itself with answering the question: how do archaeologists use ethnographic data in their research on archaic hominins? How these data are *actually* used is a starting point for a broader discussion of the potentials and challenges of their use (ie how they *should* be used). My focus is on the role of ethnographic analogies in recent research on Neanderthals (*Homo neanderthalensis*) and the identification of key trends in researchers' use of data from recent hunter-gatherers to interpret the Neanderthal archaeological record.

The Neanderthals are our closest evolutionary relatives who occupied Eurasia from approximately 300,000 years ago until 40,000 years ago, during the Middle Palaeolithic period of the Middle to Late Pleistocene. Since 2010, studies of the Neanderthal genome have confirmed that some Neanderthals and early *Homo sapiens* interbred (eg Green et al 2010; Kuhlwilm et al 2016) and that Neanderthals therefore played a role in the origins of *Homo sapiens*. These findings spearheaded the latest in a long line of fluctuating scholastic opinions on Neanderthals which emphasise the similarities between Neanderthals and *Homo sapiens* and ushered in the current 'genomic era' of Neanderthal research (the focus of this study). As the most recent and well-documented archaic hominin, Neanderthals are an excellent case study for discussing both the possible diversity of prehistoric hunter-gatherer adaptations and the implications of biological and cognitive differences between archaic hominins and *Homo sapiens* for the use of analogies with recent foragers. This paper builds on the recent work of Spikins and colleagues (2017) in considering critically both the current role of ethnographic data in Neanderthal research, the wider implications of this role for interpretations of Neanderthal behaviour, and in providing reflections on best practice.

2. Characterising the use of ethnographic data in recent Neanderthal archaeological research

2.1 *The database*

How do archaeologists use ethnographic data in their research on Neanderthals? To answer this question a quantitative and qualitative analysis of academic articles published in five international journals (*Journal of Anthropological Archaeology* [JAA], *Journal of Archaeological Science* [JAS], *Journal of Human Evolution* [JHE], *Current Anthropology* [CA], and *Quaternary International* [QI]) from the years 2010 to 2017 was carried out. These journals range from primarily archaeological (JAA, JAS) to interdisciplinary publications combining archaeology, palaeoanthropology and quaternary science (CA, QI, JHE), and from quantitative/scientifically (QI, JHE, JAS) to more interpretative/anthropologically oriented (JAA, CA). They form a representative, if not comprehensive, sample of recent Neanderthal research.

Online searches of these journals were made using the key words 'Neandert(h)al' and 'Middle Pal(aeolithic)'. Articles containing these phrases were screened to identify all full-length papers with a primarily archaeological focus on Neanderthals. Articles with a narrow palaeoanthropological or genetic emphasis and/or principally reporting new chronometric/excavation data were excluded, as were articles available online but listed as 'in press' in January 2018. The resultant database contained 241 articles (Appendix: supplementary data). Each of these 241 articles was read to collect data on five key questions: 1) Do the authors draw on ethnographic data? 2) If ethnographic data are used, what aspects of Neanderthal behaviour are the focus? (each article was assigned up to three of the classifications listed in Table 1); 3) How are ethnographic data used? 4) How specific is the authors' reference to ethnographic data and how are their choices of data justified? and 5) Do the authors acknowledge the difficulties and limitations of the use of ethnographic data?

While every attempt has been made to provide a fair and objective assessment of the use of ethnographic data in these articles, there are some obvious caveats. To maximise the database, the entries are not controlled for authorship/research group, and the varying number of published outputs of individuals or groups with specific approaches and research interests will affect overall trends. Similarly, the journals sampled publish exclusively in English (although researchers based at institutions in non-English speaking countries are well represented). In terms of chronology, it is necessary to note that the draft of the Neanderthal genome was published in May 2010. While the database includes articles published

throughout 2010, those published before May do not belong to the genomic era in the strictest sense. Given publication lags, it is likely that some papers published >1 year after this date did not consider these genetic findings in the interpretation and discussion of their data (although such papers would be difficult to identify with certainty). Despite these limitations, the analysis presented here is for the most part systematic and suitable for the examination of the main trends in the use of ethnographic data in recent Neanderthal archaeological research.

2.2 Key trends in the use of ethnographic data in genomic era Neanderthal research

Of the 241 articles identified through the literature search, slightly over one third drew on ethnographic data in some way in their analysis (n=88, 36%). The rest of the results refer primarily to these eighty-eight articles and are summarised in Table 1. The key trends are:

- The behavioural focus of each article was identified according to the categories listed in Table 1, with each article assigned to up to three categories (ie the categories are not mutually exclusive, so that while n=88 many articles would have been counted two or three times in the resultant tabulation). As shown in Figure 1, archaeologists use ethnographic data in research on a wide range of Neanderthal behaviours, most commonly subsistence. While at first glance, it appears that ethnographic data are also commonly used in articles concerning lithic technology, a closer probing of the data indicates that the overall large number of the 241 articles in the database which focus on lithic technology (n=117) is driving this trend; as a percentage of the total number of articles which are concerned with this behaviour, lithic technology is the behavioural domain least frequently discussed with reference to ethnographic data. Overall, the use of ethnographic data (as a percentage of the number of articles in the overall database assigned to that behavioural category) is highest for the behaviours with the lowest archaeological visibility (symbolism/modern behaviour) and lowest for that with the highest (lithic technology) (Figure 1)
- Ethnographic data are most commonly used for comparative purposes to substantiate or justify a claim (along the lines of ‘often hunter-gatherers do/ethnographic data show that [...] so Neanderthals should’) or for narrative purposes, taking the form of illustrative examples to ‘fill in the gaps’ of the archaeological record. The use of ethnographic data as a starting point for testing ideas based on the archaeological data cited is

rare. However, in many cases, it was difficult to confidently characterise the use of ethnographic data according to the categories listed in Table 1 (which are not mutually exclusive), especially in the many instances where references to ethnographic data were not integral to the article and were limited to ‘throwaway’ comments

- In most cases, engagement with ethnographic data is restricted to unspecified references to ‘the ethnographic record’ or ‘ethnographic data’. Where data on specific groups or populations are cited, researchers draw on a broad range of examples from across four continents including Inuit groups (eg Romagnoli 2015), Aboriginal Australians (eg Vaquero et al 2015), the Hadza (Tanzania) (eg Henry 2017), the Ju/’hoan !Kung (Botswana) (eg Rosell et al 2012), and the Ache (Paraguay) (eg Cochard et al 2012)

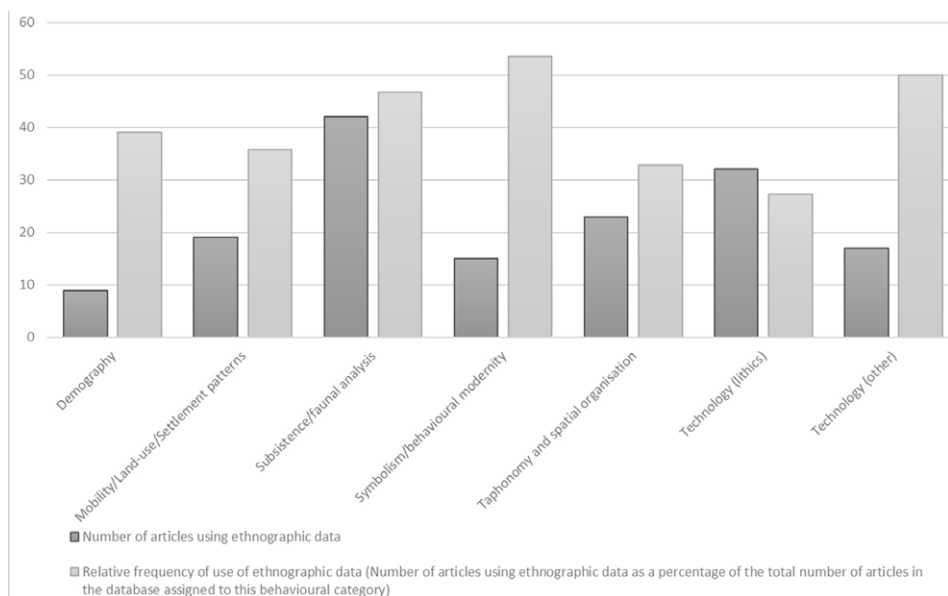


Figure 1 Breakdown of the Neanderthal behaviours studied by Palaeolithic archaeologists in articles which draw upon ethnographic data in their analysis and discussion. The behavioural categories are not mutually exclusive, and each article (n=88) was assigned up to three categories (meaning that it may appear more than once in the overall counts). The breakdown of Neanderthal behaviours is shown here as both the total number of articles in each behavioural category which drew upon ethnographic data, and as a percentage of the total number of articles in the database concerned with that behaviour. Data from articles published in *Journal of Archaeological Science*, *Journal of Human Evolution*, *Journal of Anthropological Archaeology*, *Current Anthropology* and *Quaternary International* between 2010 and 2017. For complete data, see Appendix: supplementary data

- It is rare for researchers to provide an explicit justification for the relevance to their Neanderthal data of any ethnographic data drawn upon beyond the shared classification of both populations as ‘hunter-gatherers’. Where some justification is provided, the most common reason is the occupation of similar environments. Other reasons included comparable diets (Germonpré et al 2014), and the simple availability of data on specific ethnographic groups (Bocquet-Appel & Degioanni 2013)
- It is rare for researchers to acknowledge the potential problems or limitations of the use of ethnographic data to interpret Neanderthal archaeological data.

Table 1 Summary of the results of the analysis of the frequency and use of ethnographic data in published articles on Neanderthal archaeology in five key international journals between the years 2010–2017. The results of questions 2–5 are limited to those articles which draw upon ethnographic data in their analysis or discussion (n=88). The categories presented are not always mutually exclusive. For complete data, see Appendix: supplementary data

	Number of articles
Q1: Do the authors draw on ethnographic data?	
No	153
Yes	88
Q2: What aspects of Neanderthal behaviour are the focus? (up to three classifications per article)	
Demography	9
Mobility/land-use/settlement patterns	19
Subsistence/faunal analysis	42
Symbolism/behavioural modernity	15
Taphonomy and spatial organisation	23
Technology (lithics)	32
Technology (other)	17
Q3: How are ethnographic data used?	
Illustrative (ie neat ethnographic examples to ‘fill in the gaps’, often for narrative purposes)	27
General comparative – substantiation (ie used to substantiate a claim or justify a method)	48
General comparative – hypothesis testing/search for differences (ie used as starting point for explicit testing or examination of archaeological data)	23

Q4a: How specific is the authors' reference to ethnographic data?	
Unspecified reference to 'ethnographic record' or 'ethnographic data'	67
Use of Binford's (2001) Frames of Reference dataset	5
Reference to specific ethnographic groups	28

Q4b: How is the relevance of their choice and use of ethnographic data justified?	
Shared classification of 'hunter-gatherers' (either implicit or explicitly stated)	65
Environment (similarities in prevailing climatic/environmental conditions)	14
Subsistence (similarities in diet)	2
Availability of data	2
Other	5

Q5: Are the difficulties and limitations of the use of ethnographic data acknowledged?	
No	75
Yes	13

3. Discussion

The use of ethnographic data is not ubiquitous in Neanderthal archaeological research, and, if the sample analysed here is representative, the majority of articles published in the genomic era do not draw explicitly upon data from recent hunter-gatherers in their analysis. Nonetheless, the use of ethnographic data to interpret the Neanderthal archaeological record has a long and influential history (eg Binford 1973), and the results of this study show that analogies (as defined in the broadest sense) with recent hunter-gatherers are employed by a sizable number of Neanderthal researchers (cf Spikins et al 2017:132).

Overall, this use of ethnographic data is uncritical, and contra to prevailing recommendations which advocate their use as a source of hypotheses for testing ideas and models with archaeological data, rather than to simply 'fill in the gaps' or compensate for an impoverished archaeological record (eg Binford 2001; Kelly 2013). There are several reasons why it might be rare for Neanderthal researchers to use ethnographic data in this way. The frequent lack of the relevant

archaeological data and resolution in the Middle Palaeolithic with which to test hypotheses are likely partly responsible. However, there are two other factors which I suggest are at play. The first of these is the lack of engagement by many Neanderthal researchers with the wider field of hunter-gatherer studies. This lack of engagement is not unique to Middle Palaeolithic archaeologists, but is likely compounded by the spatial and temporal distance between Neanderthals and ethnographically documented populations: Neanderthals lived too long ago for any type of direct historical analogy to be applicable and there are no recent forager societies in their Eurasian range. In terms of the data presented here, this lack of engagement is best reflected in the overwhelming lack of critical discussion on the limitations of, or potential problems with, the ethnographic data cited, and the limited consideration given to why the data were relevant to the Neanderthal case ('source-side' issues: Stahl 1993:235). More broadly, compared to both the later Palaeolithic and the Mesolithic (eg Porr 2001; Jordan 2006; Warren 2017), there is little literature dedicated to critical reflection on the use of analogy and ethnographically derived models in Middle Palaeolithic archaeology.

The second reason is specific to the study of Neanderthals in the genomic era. One outcome of the finding of interbreeding between Neanderthals and early *Homo sapiens* – bolstered by new archaeological evidence for symbolic and artistic behaviours amongst Neanderthals (Hoffman et al 2018; Peresani et al 2013; Romandini et al 2014), and for new technologies (Hardy et al 2013; Kozowyk et al 2017) – is a current research trend which emphasises the similarities between the two groups (see also Spikins et al 2017). At its extreme, this view claims for the archaeological 'indistinguishability' (Wynn et al 2016) of Neanderthals and early *Homo sapiens* (eg Hayden 2012; Villa & Roebroeks 2014; Zilhão 2014; see Wynn et al 2016 for a refutation). Assuming such strong behavioural similarities arguably reduces the need to articulate the relevance of recent foragers to Neanderthals, and takes for granted the appropriateness of analogues with recent foragers (although as noted earlier, several scholars place the emergence of the 'modern forager adaptation' at the end of the Pleistocene/Early Holocene, also excluding the early Upper Palaeolithic *Homo sapiens* with whom Neanderthals are most frequently compared). However, an investigation of directionality is beyond the scope of this study, and it is therefore difficult to state both how the use of ethnographic data which characterises the current decade differs from past research, and the extent to which recent findings are driving this trend.

Regardless of why, the fact remains that the current use of ethnographic data in Neanderthal archaeology frequently falls into the traps discussed in the

introduction which largely replicate the ethnographic record in the past, and do not allow for the possibility of differences between the archaeological and ethnographic cases. These results support those of Spikins et al (2017), who argued for a similar scenario based on the close reading of several research papers, most notably Hayden (2012). This practice is particularly problematic for Neanderthals as it brushes aside some notable differences in biology (and, to a lesser extent, presumably cognition) between Neanderthals and *Homo sapiens*. These differences likely had an important impact on the social and cultural behaviours we seek to understand. Before considering the impact of biological and cognitive differences between Neanderthals and *Homo sapiens* on both our interpretation of the Middle Palaeolithic archaeological record and inferences drawn from recent foraging populations, it is necessary to review briefly the evidence for these differences.

3.1 Biological and cognitive differences between Neanderthals and *Homo sapiens*

Neanderthals evolved in Europe during the Middle Pleistocene following the divergence of their lineage with that which led to *Homo sapiens*. Genetic estimates place this divergence between ~765 and 550 ka (Prüfer et al 2014), with the earliest fossils which show Neanderthal-like features dated to ~430 ka (Arsuaga et al 2014). The identity of the last common ancestor of Neanderthals and *Homo sapiens* is unclear. *Homo heidelbergensis* is typically considered the most likely candidate (Stringer 2012), although the young age of several presumed *Homo heidelbergensis* fossils weaken this hypothesis (Harvati 2016; Manzi et al 2010). The species status of Neanderthals is also debated; whether they are a separate species (*Homo neanderthalensis*), or a sub-species of *Homo sapiens* (*Homo sapiens neanderthalensis*). Here, I follow the lead of recent reviews by Churchill (2014) and White et al (2014) to consider Neanderthals a separate species. Regardless of the position taken on the Neanderthal species question, the fact remains that Neanderthals are both closely related to *Homo sapiens*, and experienced millennia of a distinct evolutionary trajectory.

Morphologically, the constellation of Neanderthal craniofacial features best distinguishes them from other closely related hominins (Churchill 2014:14). Estimates of Neanderthal endocranial volume suggest brain size (relative to overall body mass) comparable to *Homo sapiens* as well as larger absolute brain sizes (Robson & Wood 2008). Key cranial differences between Neanderthals and *Homo sapiens* include the shape of the cranial vault (with Neanderthals characterised by a long and broad shape, compared to the upright and rounded

cranial vault of *Homo sapiens*; Bruner et al 2003), and the robust Neanderthal supraorbital and orbital tori (brow ridges), pronounced mid-face prognathism and corresponding lack of chin. Post-cranially, Neanderthals were on average shorter and stockier than *Homo sapiens*, with features including a wide trunk, barrel-shaped chest, large muscle attachment sites, and short distal extremities (forearms and legs) (see summary in Harvati 2007); a morphology variously attributed to adaptation to cold glacial conditions (Holliday 1997; Steegman et al 2002) or extremely high activity levels (Franciscus & Churchill 2002; Weaver 2009).

One much contested potential area of biological difference between Neanderthals and *Homo sapiens* is their respective patterns of growth and development (life history), particularly whether Neanderthals experienced a long childhood phase comparable to that of *Homo sapiens*. The results of a comparative review suggest that the life history of Neanderthals was consistent with that of *Homo sapiens*, based on data on body size, brain size, and dental development (Robson & Wood 2008); a finding supported by a recent analysis of the growth pattern of the El Sidrón Neanderthal child (Rosas et al 2017). However, other studies suggest a Neanderthal growth pattern both faster (Hublin et al 2015; Ramírez Rossi & Bermúdez de Castro 2004; Smith et al 2007) and potentially slower (Ponce de León et al 2008) than those of *Homo sapiens*. Some of these contradictions can likely be explained by using different measures of development (eg dental vs cranial evidence) (Guatelli-Steinberg 2009).

Another area of potential difference is energetic requirements. The large and muscular body mass of Neanderthals has led many researchers to suggest that they had a higher Basal Metabolic Rate (BMR) (the minimum amount of energy required to sustain basic biological functions) than *Homo sapiens*. This increased BMR – in combination with the increased energetic requirements of combating cold stress, the consumption of high protein diets and inferred high activity levels and higher energetic travel costs (Weaver & Steudel-Numbers 2005) – results in estimates of adult Neanderthal daily total energy expenditure (TEE) up to 10% higher than those for both Upper Palaeolithic and present-day *Homo sapiens* (Churchill 2014; MacDonald et al 2009; Snodgrass & Leonard 2009; Sorensen & Leonard 2001; cf Heyes & MacDonald 2015).

Data on possible cognitive differences between *Homo sapiens* and extinct hominins are more elusive. Inferences of Neanderthal cognition based on factors such as brain size and shape are difficult to make, but, when combined with archaeological information on behaviour, provide the most direct data (see Wynn & Coolidge 2012 for a review). Wynn and colleagues (2016) identify

several domains of likely cognitive difference between Neanderthals and *Homo sapiens* as implied by their cranial morphologies, including those relating to motor learning, creative thinking and memory. These differences were likely subtle and are difficult to quantify. Furthermore, as Wynn et al (2016), stress, these differences do not imply value judgement as to which cognitive characteristics are 'better' or 'worse'. Given both the difficulty of assessing cognitive differences, and the historical use of assumptions of inferior Neanderthal cognition (compared to *Homo sapiens*) as a 'fall back' position in archaeology to explain perceived limitations to their behaviour, the rest of this discussion will focus on other aspects of Neanderthal biology. This is not to deny, however, the importance of cognition for our understanding of hominin behaviour, adaptation and evolution. Here I consider briefly the implications of these biological differences between Neanderthals and *Homo sapiens* with reference to two interrelated domains: demography and mobility.

3.2 The relationship between Neanderthal biology and behaviour

3.2.1 Neanderthal demography

The study of Neanderthal demography is notoriously difficult. Nonetheless, most researchers agree that Neanderthals lived in small groups and at low population densities compared to both Upper Palaeolithic *Homo sapiens* and recent hunter-gatherers (eg Bocquet-Appel & Degioanni 2013; Holliday et al 2014; Mellars & French 2011). One possible explanation for this pattern is taphonomic loss through time. Many archaeological estimates of population sizes and densities rely on the quantification of proxies such as numbers of sites and quantities of material culture, which *a priori* are less likely to survive the further back in time one goes. Nonetheless, this pattern is consistent enough across multiple lines of evidence (archaeological, genetic, osteological) to suggest that it is at least partly real, and that Neanderthals were indeed characterised by small living groups, overall small population sizes and low population densities.

What role did the Neanderthal biology play in this? Although culture and behaviour are also important, biology is fundamental to all demographic processes. Researchers have long hypothesised as to the impact of the robust Neanderthal physiology and their high energetic demands on their group size, population density, and in particular, their fertility (Snodgrass & Leonard 2009). At the heart of these arguments is the idea that reproduction is energetically expensive and requires additional calories above normal metabolic

requirements both to support the pregnancy and the subsequent lactation required to feed the child (Butte & King 2005). The overall energy balance of a woman also plays an important role in her ability both to become pregnant, and to complete a successful pregnancy (Ellison 2001). In combination with already high energetic requirements, these additional constraints would likely have resulted in low Neanderthal fecundity (ability to conceive) and low fertility levels (Churchill 2014). The evidence also suggests high Neanderthal mortality rates (Trinkaus 1995) and possibly also low life expectancy (Caspari & Lee 2004). This combination of low fertility and high mortality – driven by physiological constraints and life history traits – means that Neanderthals had difficulty maintaining viable populations, let alone experiencing population growth. The result would have been overall small population sizes, low population densities and high susceptibility to local extinctions (see calculations by Caspari et al 2017; Nakahashi et al 2018; Sørensen 2011).

3.2.2 *Neanderthal mobility and land use*

How might Neanderthal biology have influenced their land use and mobility patterns? Verpoorte and colleagues' (Verpoorte 2006; MacDonald et al 2009; Roebroeks & Verpoorte 2009) model of the effect of the robust Neanderthal morphology on these elements of behaviour provides one example. Assuming foraging from a central place across a homogenous environment, the higher energetic requirements of Neanderthals would have reduced their effective foraging radius (the distance from camp to the location of the food resource at which the required amount of energy is equal to the net return of resources at that distance). All other things being equal, the same site would be a feasible place of residence for Neanderthals for a shorter time than *Homo sapiens*, meaning more residential moves (but of a shorter distance) per year for Neanderthals. A comparative study of the land-use strategies of Neanderthals and early *Homo sapiens* in the Levant provides broad support for this model, with Neanderthal site exploitation territories (foraging ranges) up to 20% smaller than those of *Homo sapiens* (Henry et al 2017). Neanderthal high energetic costs might also have influenced overall mobility strategies. Churchill (2014:Chapter 10; Churchill et al 2016) suggests that these costs, in combination with other aspects of Neanderthal dietary ecology (heavy reliance on meat) and technological repertoire (lack of transportation technology), would have favoured a primarily residential (moving people to resources) rather than a logistical (moving resources to people) mobility and settlement pattern.

More broadly, aspects of biology may explain divergences between the Neanderthal archaeological record and expectations based on cross-cultural

patterns seen in recent hunter-gatherers. Ethnographic foragers display clear cross-cultural patterning across a range of behaviours driven by adaptations to environmental conditions. Mid-to-high latitude hunter-gatherers, who most closely approximate Neanderthals in terms of environments inhabited, are characterised by an emphasis on hunted rather than gathered resources, large home ranges and predominantly logistical mobility strategies, a reliance on storage, and diverse and complex toolkits (see, for example; Binford 2001; Roscoe 2003; Torrence 1989). Neanderthals do not adhere to these cross-cultural expectations (Bocquet-Appel & Tuffreau 2009; Hardy & Moncel 2011; Hoffecker 2002:131–137; Kuhn 2011). One possible explanation for this is the lower population density of Neanderthals which caused them to adapt differently to prevailing environmental conditions. Churchill (2014:53–54) postulates that the lack of complex Neanderthal subsistence technology (an adaptation designed to mitigate the increased levels of risk in resource acquisition at higher latitudes, both in terms of reduced encounters and severity of resource failure) means that, unlike ethnographic foragers, they responded to the challenges of obtaining food in these ecological conditions in other, non-technological ways (eg altering the size and composition of their foraging groups, and/or foraging ranges). However, both the plausibility of these adaptations and the extent to which biological differences are an adequate explanation is unclear; Middle Palaeolithic *Homo sapiens* also do not correspond to these latitudinally-driven patterns (Kuhn & Stiner 2001), which may be exclusive to Holocene environments (Osborn 1999).

3.3 Implications for ethnographic analogy

The interactions between Neanderthal biology and behaviour discussed above have clear implications for the use of ethnographic analogy in Neanderthal archaeological research. Alongside the important social and behavioural effects of vastly different historical trajectories between recent and prehistoric hunter-gatherers, the possible effects of these interactions need to be recognised and taken into account. This is rarely the case: only four articles included in the database implicitly addressed the complicating factor of biological differences between Neanderthals and recent foragers (Browne & Wilson 2011; Castel et al 2017; Henry et al 2017; Nicholson 2017).

Translating this recognition into direct recommendations for how archaeologists should use ethnographic data differently in Neanderthal contexts is difficult. As discussed above, one recommendation which applies more broadly is using these data as a starting point to test hypotheses about prehistoric

foragers; a practice which is often conducted with the paradigm of Human Behavioural Ecology (Humphreys 2007; Kelly 2013). Frustratingly, the archaeological data required to use ethnographic analogy in this way are rarer the further back in time one goes, where both the necessity and benefit of such a strategy is arguably greatest. Nonetheless, several articles included in this database used ethnographic data in this way (eg Dusseldorp 2012; Henry et al 2014; Hockett 2012; Salazar-García et al 2013) indicating that the challenges of archaeological data resolution and availability are not insurmountable in all Middle Palaeolithic contexts.

The overall recommendation presented here is more critical engagement with the ethnographic data used. One immediate concern is the direct transplant of absolute values from the ethnographic record to Neanderthal contexts. Continuing with the example of demography, as the evidence suggests that Neanderthals likely lived in smaller groups than recent hunter-gatherers, the transference of group size estimates from recent foragers to Neanderthals (eg Hayden 2012) should be questioned, at least without additional justification. One response to this has been the use of data from those ethnographic groups living at the lowest observed densities and/or minimum group size estimates when generating expectations for Neanderthal populations (eg Binford 2007). Similarly, the explicit application of criteria of suitability to the ethnographic data selected, and the removal of cases deemed anachronistic or otherwise unsuitable, should also be considered. Of the articles included in the dataset analysed here, only four applied such criteria. The idea that certain features of a recent hunter-gatherer group's adaptation could be removed to reveal the 'pure' hunter-gatherers is difficult to justify, implying (incorrectly) that forager cultures are essentially static in the absence of outside influences (Sassaman & Holly 2011; Layton 2001:292). However, the acknowledgement that some data are more relevant than others is warranted. For example, when addressing Neanderthal demography and/or mobility, recent foragers who are primarily sedentary are likely to be of reduced comparative value (see Holliday et al 2014; Pearce & Moutisou 2014).

Critical use of ethnographic data also involves engaging more with the specifics of how these data were collected. While it is often tempting to defer to ethnographic data, we need to bear in mind the many assumptions, limitations and possible sources of error involved in both their collection and analysis. For example, both Howell (1979), and Hill and Hurtado (1996) discuss at length the challenges of accurate demographic data collection in ethnographic contexts. More broadly, Bird-David (2018) argues that anthropologists have considered inadequately the effects of the small size of hunter-gatherer societies on both

other elements of forager cultures and their interpretation of these societies, effects which were likely more pronounced in the smaller societies of prehistory and which archaeologists should take into account. Along these lines, Spikins and colleagues (2017:137) suggest that the implications of Neanderthal biology to their demography and settlement patterns combine to result in an ‘intimate scale of Neanderthal sociality’, in which the local focus of Neanderthal social structures and interactions contrasts with that of both archaic *Homo sapiens* and recent hunter-gatherers.

Neanderthal demography and mobility are two domains where models and data from ethnography are particularly prevalent. They are also domains where we might expect interactions between biology and behaviour to be particularly important in generating the patterns seen, and in which the biological differences between Neanderthals and *Homo sapiens* (including recent foragers) mean that the uncritical use of ethnographic analogy may be especially problematic. What about other behaviours, including those (discussed in the introduction) which characterise foragers in the present day? One such example is the gendered division of labour seen among most ethnographic foragers (men hunt, women gather). Whether or not Neanderthals shared the gendered division of labour is an ongoing debate (Kuhn & Stiner 2006). While the direct evidence for or against the presence of this division is ambiguous, small Neanderthal group size may have played a key role. If technological and economic skills are transmitted culturally between individuals, the division of tasks by gender, and the maintenance of this division, requires twice as many people to ensure the successful transmission of cultural knowledge. This division might have been unfeasible if group sizes were too small and/or mortality was high (Nakahashi 2017), factors which, as discussed above, are strongly influenced by Neanderthal biology. In terms of lithic technology, while fracture mechanics of flint adhere to uniformitarian principles, the interplay between Neanderthal cognition, biology and behaviour (including the effect of these on social structures and interactions) undoubtedly affected the important processes of manufacture, use and discard. Ultimately, when considering archaic hominins, behaviour and biology should not be separated (particularly the impact of differing biology and cognition on behaviour: Foley 2002), nor subsumed under broad ethnographic analogies.

I do not mean to imply that there are no benefits to the prevailing use of ethnographic data in Neanderthal archaeological research. The Middle Palaeolithic record is undoubtedly patchy, and analogies are good tools to think with, both in terms of interpreting our evidence, and in reminding us that people created it. Furthermore, the use of ethnographic analogies and frameworks

is largely inevitable and firmly embedded in Palaeolithic research traditions. Binford's (1980) model of residential and logistical hunter-gatherer mobility which was referenced in twenty-five of the papers analysed, is a case in point. Warren (2017:153) argues that this model is often treated as 'received wisdom' in hunter-gatherer archaeology, and the irony of my uncritical use of the residential/logistical mobility continuum to describe Neanderthal mobility practices, while simultaneously discussing the shortcomings of such use, is not lost. The embeddedness of such models demonstrates the importance of ongoing critical evaluation of our engagement with ethnographic data for both Neanderthal and wider prehistoric hunter-gatherer research.

4. Conclusion

This analysis of the use of ethnographic data in recent Neanderthal archaeological research was designed to be expository, not accusatory. Furthermore, the results might appear unsurprising to many archaeologists, and the recommendations here are not new. However, it continues to be the case that 'one of the greatest challenges in Palaeolithic archaeology is imagining ways of being human that are not like those of recent hunter-gatherers [...] it is important to avoid [...] imagining early hominin groups as essentially recent foragers lacking a few key elements' (Kuhn & Clark 2015:15). It is difficult to categorically state whether (and to what extent) the prevailing use of ethnographic data results in a weakening of our understanding of Neanderthals. The use of ethnographic data in ways which serve to replicate the present in the past does, however, serve to weaken our understanding of the diversity of hunter-gatherers. Remaining forager populations are declining, and if we seek to examine the diversity of people who live in small-scale societies and subsist primarily on wild resources, we need to turn to the archaeological record, and the greater geographical coverage and insight into long-term adaptations which it provides. Neanderthals represent an intriguing aspect of this diversity and have the potential to offer new insights into what it means to be a hunter-gatherer.

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Supplementary Material

The data analysed here are available in the [Appendix: supplementary data](#).

References

- Arsuaga, JL, Martínez, I, Arnold, LJ, Aranburu, A, Gracia-Téllez, A, Sharp, WD, Quam, RM, Falguères, C, Pantoja-Pérez, A, Bischoff, J, Poza-Rey, E, Parés, JM, Carretero, JM, Demuro, M, Lorenzo, C, Sala, N, Martínón-Torres, M, García, N, Alcázar de Velasco, A, Cuenca-Bescós, G, Gómez-Olivencia, A, Moreno, D, Pablos, A, Shen, CC, Rodríguez, L, Ortega, AI, García, R, Bonmatí, A, Bermúdez de Castro, JM & Carbonell, E 2014. Neandertal roots: cranial and chronological evidence from Sima de los Huesos. *Science* 344:1358–1363.
- Barnard, A 2002. The foraging mode of thought. In Stewart, A, Barnard, A & Omura, K (eds) *Self- and other images of hunter-gatherers*. Senri Ethnological Studies 60. Osaka, Japan: National Museum of Ethnology:5–24.
- Barnard, A 2014. Defining hunter-gatherers. Enlightenment, romantic and social evolutionary perspectives. In Cummings, V, Jordan, P & Zvelebil, M (eds) *The Oxford handbook of the archaeology and anthropology of hunter-gatherers*. Oxford: Oxford University Press:43–54.
- Binford, LR 1973. Interassemblage variability: the Mousterian and the ‘functional’ argument. In Renfrew, C (ed) *The explanation of culture change: models in prehistory*. London: Duckworth:227–254.
- Binford, LR 1980. Willow smoke and dogs’ tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45(1):4–20.
- Binford, LR 2001. *Constructing frames of reference: an analytical method for archaeological theory building using ethnographic and environmental data sets*. Los Angeles: University of California Press.
- Binford, LR 2007. The diet of early hominins: some things we need to know before ‘reading’ the menu from the archaeological record. In Roebroeks, W (ed) *Guts and brains: an integrative approach to the hominin record*. Leiden: Leiden University Press:185–222.
- Bird-David, N 2018. Size matters! The scalability of modern hunter-gatherer animism. *Quaternary International* 464:305–314.

- Bocquet-Appel, JP & Degioanni, A 2013. Neanderthal demographic estimates. *Current Anthropology* 54 (S8):S202–S213.
- Bocquet-Appel, JP & Tuffreau, A 2009. Technological responses of Neanderthals to macroclimatic variations (240,000–40,000 BP). *Human Biology* 81(2–3):287–307.
- Browne, CL & Wilson, L 2011. Resource selection of lithic raw materials in the Middle Palaeolithic in southern France. *Journal of Human Evolution* 61(5):597–608.
- Bruner, E, Manzi, G & Arsuaga, JL 2003. Encephalisation and allometric trajectories in the genus *Homo*: evidence from the Neanderthal and modern lineages. *Proceedings of the National Academy of Sciences USA* 100:15335–15340.
- Butte, NF & King, JC 2005. Energy requirements during pregnancy and lactation. *Public Health Nutrition* 8(7a):1010–27.
- Caspari, R & Lee, SH 2004. Older age becomes common late in human evolution. *Proceedings of the National Academy of Sciences USA* 101(30):10895–10900.
- Caspari, R, Rosenberg, KR & Wolpoff, MH 2017. Brother or other: the place of Neanderthals in human evolution. In Marom, A & Hovers, E (eds) *Human paleontology and prehistory. Contributions in honor of Yoel Rak*. Dordrecht: Springer:53–271.
- Castel, JC, Discamps, E, Soulier, MC, Sandgathe, D, Dibble, HL, McPherron, SJ, Goldberg, P & Turq, A 2017. Neanderthal subsistence strategies during the Quina Mousterian at Roc de Marsal (France). *Quaternary International* 433:140–156.
- Churchill, SE 2014. *Thin on the ground. Neanderthal biology, archeology, and ecology*. Oxford: Wiley Blackwell.
- Churchill, SE, Walker, CS & Schwartz, AM 2016. Home-range size in large bodied carnivores as a model for predicting Neanderthal territory size. *Evolutionary Anthropology* 25:117–123.
- Cochard, D, Brugal, JP, Morin, E & Meignen L 2012. Evidence of small fast game exploitation in the Middle Paleolithic of Les Canalettes Aveyron, France. *Quaternary International* 264:32–51.
- Currie, A 2016. Ethnographic analogy, the comparative method, and archaeological special pleading. *Studies in History and Philosophy of Science* 55:84–94.
- Dusseldorp, GL 2012. Studying prehistoric hunting proficiency: applying optimal foraging theory to the Middle Palaeolithic and Middle Stone Age. *Quaternary International* 252:3–15.
- Ellison, PT 2001. *On fertile ground*. Cambridge, MA: Harvard University Press.
- Finlayson, B & Warren, G (eds) 2017. *The diversity of hunter-gatherer pasts*. Oxford: Oxbow.
- Foley, R 1988. Hominids, humans, and hunter-gatherers: an evolutionary perspective. In Ingold, T, Riches, D & Woodburn, J (eds) *Hunters and Gatherers: History, Evolution, and Social Change*. Vol 1. London: Berg:207–221.
- Foley, R 2002. Parallel tracks in time: human evolution and archaeology. In Cunliffe, B, Davies, W & Renfrew, C (eds) *Archaeology: the widening debate*. Oxford: Oxford University Press:3–42.
- Franciscus, RG & Churchill, SE 2002. The costal skeleton of Shanidar 3 and a reappraisal of Neanderthal thoracic morphology. *Journal of Human Evolution* 42(3):303–356.

- Germonpré, M, Udrescu, M & Fiers, E 2014. Possible evidence of mammoth hunting at the Neanderthal site of Spy (Belgium). *Quaternary International* 337:28–42.
- Gould, RA 1980. *Living archaeology*. Cambridge: Cambridge University Press.
- Gould, RA & Watson, PJ 1982. A dialogue of the meaning and use of analogy in ethnoarchaeological reasoning. *Journal of Anthropological Archaeology* 1:355–381.
- Green, RE, Krause, J, Briggs, AW, Maricic, T, Stenzel, U, Kircher, M, Patterson, N, Li, H, Zhai, W, Fritz, MHY, Hansen, NF, Durand, EY, Malaspinas, AS, Jensen, JD, Marques-Bonet, T, Alkan, C, Prüfer, K, Meyer, M, Burbano, HA, Good, JM, Schultz, R, Aximu-Petri, A, Butthof, A, Höber, B, Höffner, B, Siegemund, M, Weihmann, A, Nusbaum, C, Lander, ES, Russ, C, Novod, N, Affourtit, J, Egholm, M, Verna, C, Rudan, P, Brajkovic, D, Kucan, Z, Gušić, I, Doronichev, VB, Golovanova, LV, Lalueza-Fox, C, de la Rasilla, M, Fortea, J, Rosas, A, Schmitz, RW, Johnson, PLLF, Eichler, EE, Falush, D, Birney, E, Mullikin, JC, Slatkin, M, Nielsen, R, Kelso, J, Lachmann, M, Reich, D & Pääbo, S 2010. A draft sequence of the Neanderthal genome. *Science* 328:710–722.
- Guatelli-Steinberg, D 2009. Recent studies of dental development in Neandertals: implications for Neandertal life histories. *Evolutionary Anthropology* 18:9–20.
- Hardy, BL & Moncel, MH 2011. Neanderthal use of fish, mammals, birds, starchy plants and wood 125–250,000 years ago. *PLoS One* 6:e23768.
- Hardy, BL, Moncel, MH, Daujeard, C, Fernandes, P, Béarez, P, Desclaux, E, Navarro MGC, Puaud, S & Gallotti, R 2013. Impossible Neanderthals? Making string, throwing projectiles and catching small game during Marine Isotope Stage 4 (Abri du Maras, France). *Quaternary Science Reviews* 82:23–40.
- Harvati, K 2007. The Neanderthals and their contemporaries. In Henke, W & Tattersall, I (eds) *Handbook of paleoanthropology*. Berlin: Springer:1717–1748.
- Harvati, K 2016. Paleoanthropology in Greece: recent findings and interpretations. In Harvati, K & Roksandic, M (eds) *Paleoanthropology of the Balkans and Anatolia*. Dordrecht: Springer:3–14.
- Hayden, B 2012. Neanderthal social structure? *Oxford Journal of Archaeology* 31(1):1–26.
- Headland, TN & Reid, LA 1989. Hunter-gatherers and their neighbours from prehistory to the present. *Current Anthropology* 30 (1):43–66.
- Henry, AG 2017. Neanderthal cooking and the costs of fire. *Current Anthropology* 58(S16):S329–S336.
- Henry, AG, Brooks, AS & Piperno, DR 2014. Plant foods and the dietary ecology of Neanderthals and early modern humans. *Journal of Human Evolution* 69:44–54.
- Henry, DO, Belmaker, M & Bergin, SM 2017. The effect of terrain on Neanderthal ecology in the Levant. *Quaternary International* 435:94–105.
- Heyes, P & MacDonald, K 2015. Neanderthal energetics: uncertainty in body mass estimation limits comparisons with *Homo sapiens*. *Journal of Human Evolution* 85:193–197.
- Hill, K & Hurtado, AM 1996. *Ache life history. the ecology and demography of a foraging people*. New York: Aldine de Gruyter.
- Hockett, B 2012. The consequences of Middle Paleolithic diets on pregnant Neanderthal women. *Quaternary International* 264:78–82.

- Hoffecker, JF 2002. *Desolate landscapes. Ice-age settlement in Eastern Europe*. New Brunswick, NJ: Rutgers University Press.
- Hoffmann, DL, Standish, CD, García-Diez, M, Pettitt, PB, Milton, JA, Zilhão, J, Alcolea-González, JJ, Cantalejo-Duarte, P, Collado, H, De Balbín, R & Lorblanchet, M 2018. U-Th dating of carbonate crusts reveals Neandertal origin of Iberian cave art. *Science* 359(6378):912–915.
- Holliday, TW 1997. Postcranial evidence of cold adaptation in European Neanderthals. *American Journal of Physical Anthropology* 104:245–258.
- Holliday, TW, Gautney, JR & Friedl, L 2014. Right for the wrong reasons: reflections on modern human origins in the post-Neandertal genome era. *Current Anthropology* 55(6):696–724.
- Howell, N 1979. *Demography of the Dobe !Kung*. New York: Academic Press.
- Hublin, JJ, Neubauer, S & Gunz, P 2015. Brain ontogeny and life history in Pleistocene hominins. *Philosophical Transactions of the Royal Society B* 370:20140062.
- Humphreys, AJB 2007. Behavioural ecology and hunter-gatherers: from the Kalahari to the Later Stone Age. *South African Archaeological Bulletin* 62(186):98–103.
- Ingold, T 1987. *The appropriation of nature: essays on human ecology and social relations*. Manchester: Manchester University Press.
- Jordan, P 2006. Analogy. In Conneller, C & Warren, G (eds) *Mesolithic Britain and Ireland: new approaches*. Stroud: History Press:83–100.
- Kelly, RL 2013. *The lifeways of hunter-gatherers. the foraging spectrum*. Cambridge: Cambridge University Press.
- Kent, S 1992. The current forager controversy: real versus ideal views of hunter-gatherers. *Man (NS)* 27:45–70.
- Kozowyk, PRB, Soressi, M, Pomstra, D & Langejans, GHJ 2017. Experimental methods for the Palaeolithic dry distillation of birch bark: implications for the origin and development of Neandertal adhesive technology. *Scientific Reports* 7(1):8033.
- Kuhlwilm, M, Gronau, I, Hubisz MJ, de Filippo, C, Prado-Martinez, J, Kircher, M, Fu, Q, Burbano, HA, Lalueza-Fox, C, de la Rasilla, M, Rosas, A, Rudan, P, Brajkovic, D, Kucan, Ž, Gušić, I, Marques-Bonet, T, Andrés, AM, Viola, B, Pääbo, S, Meyers, M, Siepel, A & Castellano, S 2016. Ancient gene flow from early modern humans into Eastern Neanderthals. *Nature* 530:429–435.
- Kuhn, SL 2011. Neandertal techno-economics: an assessment and suggestions for future development. In Conard, NJ & Richter, J (eds) *Neandertal lifeways, subsistence and technology: one hundred fifty years of Neandertal study*. Dordrecht: Springer:99–109.
- Kuhn, SL & Clark, AE 2015. Artifact densities and assemblage formation: evidence from Tabun Cave. *Journal of Anthropological Archaeology* 38:8–16.
- Kuhn, SL & Stiner, MC 2001. The antiquity of hunter-gatherers. In Panter-Brick, C, Layton, RH & Rowley-Conwy, P (eds) *Hunter-gatherers: an interdisciplinary perspective*. Cambridge: Cambridge University Press:99–129.
- Kuhn, SL & Stiner, MC 2006. What's a mother to do? The division of labor among Neandertals and modern humans in Eurasia. *Current Anthropology* 47(6):953–980.
- Kusimba, SB 2005. What is a hunter-gatherer? Variation in the archaeological record of eastern and southern Africa. *Journal of Archaeological Research* 13(4):337–366.

- Lane, PJ 2014. Hunter-gatherer-fishers, ethnoarchaeology, and analogical reasoning. In Cummings, V, Jordan, P & Zvelebil, M (eds) *The Oxford handbook of the archaeology and anthropology of hunter-gatherers*. Oxford: Oxford University Press:104–150.
- Layton, R 2001. Hunter-gatherers, their neighbours and the nation state. In Panter-Brick, C, Layton, RH & Rowley-Conwy, P (eds) *Hunter-gatherers: an interdisciplinary perspective*. Cambridge: Cambridge University Press:292–321.
- Lee, RB 1992. Art, science, or politics? The crisis in hunter-gatherer studies. *American Anthropologist* 94(1):31–54.
- MacDonald, K, Roebroeks, W & Verpoorte, A 2009. An energetics perspective on the Neandertal record. In Hublin, JJ & Richards, MP (eds) *The evolution of hominin diets: integrating approaches to the study of Palaeolithic subsistence*. Dordrecht: Springer:211–220.
- Manzi, G, Magri, D, Milli, S, Palombo, MR, Margari, V, Celiberti, V, Barbieri, M, Barbieri, M, Melis, RT, Rubini, M, Ruffo, M, Saracino, B, Tzedakis, PC, Zarattini, A & Biddittu, I 2010. The new chronology of the Ceprano calvarium (Italy). *Journal of Human Evolution* 59:580–585.
- Mellars, P & French, JC 2011. Tenfold population increase in Western Europe at the Neanderthal-to-modern human transition. *Science* 333:623–627.
- Nakahashi, W 2017. The effect of trauma on Neanderthal culture: a mathematical analysis. *HOMO- Journal of Comparative Human Biology* 68:83–100.
- Nakahashi, W, Horiuchi, S & Ihara, Y 2018. Estimating hominid life history: the critical interbirth interval. *Population Ecology* 60(1–2):127–142.
- Nicholson, CM 2017. Eemian paleoclimate zones and Neanderthal landscape-use: A GIS model of settlement patterning during the last interglacial. *Quaternary International* 438:144–157.
- Osborn, AJ 1999. From global models to regional patterns: possible determinants of Folsom hunting weapon design, diversity, and complexity. In Amick, DS (ed) *Folsom lithic technology: explorations in structure and variability*. Ann Arbor, MI: International Monographs in Prehistory:188–213.
- Pearce, E & Moutisou, T 2014. Using obsidian transfer distances to explore social network maintenance in late Pleistocene hunter-gatherers. *Journal of Anthropological Archaeology* 36:12–20.
- Peresani, M, Vanhaeren, M, Quaggiotto, E, Queffelec, A & d’Errico, F 2013. An ochered fossil marine shell from the Mousterian of Fumane Cave. *PloS One* 8(7):e68752.
- Pettitt, P 2014. The European Upper Palaeolithic. In Cummings, V, Jordan, P & Zvelebil, M (eds) *The Oxford handbook of the archaeology and anthropology of hunter-gatherers*. Oxford: Oxford University Press:279–309.
- Ponce de León, MS, Golovanova, L, Doronichev, V, Romanova, G, Akazawa, T, Kondo, O, Ishida, H & Zollikofer, CPE 2008. Neanderthal brain size at birth provides insights into the evolution of human life history. *Proceedings of the National Academy of Sciences USA* 105(37):13764–13768.
- Porr, M 2001. Between Nyae Nyae and Anaktuvuk- some remarks on the use of anthropology in Palaeolithic archaeology. *Ethnographisch- Archäologische Zeitschrift* 42:159–173.

- Porter, CC & Marlowe, FW 2007. How marginal are forager habitats? *Journal of Archaeological Science* 34(1):59–68.
- Prüfer, K, Racimo, F, Patterson, N, Jay, F, Sankararaman, S, Sawyer, S, Heinze, A, Renaud, G, Sudmant, PH, de Filippo, C, Li, H, Mallick, S, Dannemann, M, Fu, Q, Kircher, M, Kuhlwilm, M, Lachmann, M, Meyer, M, Ongyerth, M, Siebauer, M, Theunert, C, Tandon, A, Moorjani, P, Pickrell, J, Mullikin, JC, Vohr, SH, Green, RE, Hellmann, I, Johnson, PLF, Blanche, H, Cann, H, Kitzman, JO, Shendure, J, Eichler, EE, Lein, ES, Bakken, TE, Golovanova, LV, Doronichev, VB, Shunkov, MV, Derevianko, AP, Viola, B, Slatkin, M, Reich, D, Kelso, J & Pääbo, S 2014. The complete genome sequence of a Neanderthal from the Altai Mountains. *Nature* 505:43–49.
- Ramírez Rossi, FV & Bermúdez de Castro, JM 2004. Surprisingly rapid growth in Neanderthals. *Nature* 428:936–939.
- Richerson, PJ & Boyd, R 2013. Rethinking paleoanthropology: a world queerer than we supposed. In Hatfield, G & Pittman, H (eds) *Evolution of mind, brain, and culture*. Philadelphia, PA: Pennsylvania University Press:263–302.
- Robson, SL & Wood, B 2008. Hominin life history: reconstruction and evolution. *Journal of Anatomy* 212(4):394–425.
- Roebroeks, W & Verpoorte, A 2009. A ‘language-free’ explanation for differences between the European Middle and Upper Palaeolithic record. In Botha, R & Knight, C (eds) *The cradle of language*. Oxford: Oxford University Press:150–166.
- Romagnoli, F 2015. A second life: recycling production waste during the Middle Palaeolithic in layer L at Grotta del Cavello (Lecce, Southeast Italy). *Quaternary International* 361:200–211.
- Romandini, M, Peresani, M, Laroulandie, V, Metz, L, Pastoors, A, Vaquero, A & Slimak, L 2014. Convergent evidence of eagle talons used by late Neanderthals in Europe: a further assessment of symbolism. *PloS One* 9(7):e101278.
- Rosas, A, Ríos, L, Estalrich, A, Liversidge, H, García-Taberno, A, Huguet, R, Cardoso, H, Bastir, M, Lalueza-Fox, C, de la Rasilla, M & Dean, C 2017. The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain). *Science* 357:1282–1287.
- Roscoe, P 2003. Latitudinal trends in hunter-gatherer diets and the ‘tropical exception’. *Before Farming* 2004/3 <http://dx.doi.org/10.3828/bfarm.2004.3.4>.
- Rosell, J, Cáceres, I, Blasco, R, Bennàsar, M, Bravo, P, Campeny, G, Esteban-Nadal, M, Fernández-Laso, MC, Gabucio, MJ, Huguet, R, Ibáñez, N, Martín, P, Rivals, F, Rodríguez-Hidalgo, A & Saladié, P 2012. A zooarchaeological contribution to establish occupational patterns at Level J of Abric Romani (Barcelona, Spain). *Quaternary International* 247:69–84.
- Salazar-García, DC, Power, RC, Serra, AS, Villaverde, V, Walker, MJ & Henry, AG 2013. Neanderthal diets in central and southeastern Mediterranean Iberia. *Quaternary International* 318:3–18.
- Sassaman, KE & Holly, DH 2011. Transformative hunter-gatherer archaeology in North America. In Sassaman, KE & Holly, DH (eds) *Hunter-gatherer archaeology as historical process*. Tucson: University of Arizona Press:1–13.

- Smith, TM, Toussaint, M, Reid, DJ, Olejniczak, AJ, & Hublin, JJ 2007. Rapid dental development in a Middle Paleolithic Belgian Neanderthal. *Proceedings of the National Academy of Sciences USA* 104(51):20220–20225.
- Snodgrass, JJ & Leonard, WR 2009. Neandertal energetics revisited: insights into population dynamics and life history evolution. *PaleoAnthropology* 2009:220–237.
- Sørensen, B 2011. Demography and the extinction of the European Neanderthals. *Journal of Anthropological Archaeology* 30:17–29.
- Sorensen, MV & Leonard, WR 2001. Neandertal energetics and foraging efficiency. *Journal of Human Evolution* 40:483–495.
- Spikins, P, Hitchens, G & Needham, A 2017. Strangers in a strange land? Intimate sociality and emergent creativity in Middle Palaeolithic Europe. In Finlayson, B & Warren, G (eds) *The diversity of hunter-gatherer pasts*. Oxford: Oxbow:132–147.
- Stahl, AB 1993. Concepts of time and approaches to analogical reasoning in historical perspective. *American Antiquity* 58(2):235–260.
- Stegman, ATJ, Cerny, FJ & Holliday, TW 2002. Neanderthal cold adaptation: physiological and energetic factors. *American Journal of Physical Anthropology* 14:566–583.
- Stringer, C 2012. The status of *Homo heidelbergensis* (Schoetensack 1908). *Evolutionary Anthropology* 21:101–107.
- Torrence, R 1989. Retooling: towards a behavioural theory of stone tools. In Torrence, R (ed) *Time, energy, and stone tools*. Cambridge: Cambridge University Press:57–66.
- Trinkaus, E 1995. Neanderthal mortality patterns. *Journal of Archaeological Science* 22:121–142.
- Vaquero, M, Bargalló, A, Chacón, MG, Romagnoli, F & Sañudo, P 2015. Lithic recycling in a Middle Palaeolithic expedient context: evidence from the Abric Romaní (Capellades, Spain). *Quaternary International* 361:212–228.
- Verpoorte, A 2006. Neanderthal energetics and spatial behaviour. *Before Farming* 2006 (3):1–6.
- Villa, P & Roebroeks, W 2014. Neandertal demise: an archaeological analysis of the modern human superiority complex. *PloS One* 9(4):e96424.
- Warren, G 2017. Making the familiar past: northwest European hunter-gatherers, analogies and comparisons. In Finlayson, B & Warren, G (eds) *The diversity of hunter-gatherer pasts*. Oxford: Oxbow:148–162.
- Weaver, T 2009. The meaning of Neanderthal skeletal morphology. *Proceedings of the National Academy of Sciences USA* 106(38):16028–16033.
- Weaver, TD & Steudel-Numbers, K 2005. Does climate or mobility explain the differences in body proportions between Neanderthals and their Upper Palaeolithic successors? *Evolutionary Anthropology* 14:218–223.
- White, S, Gowlett, JAL & Grove, M 2014. The place of the Neanderthals in hominin phylogeny. *Journal of Anthropological Archaeology* 35:32–50.
- Wobst, HM 1978. The archaeo-ethnology of hunter-gatherers or the tyranny of the ethnographic record in archaeology. *American Antiquity* 43(2):303–309.
- Wylie, A 1985. The reaction against analogy. *Advances in Archaeological Method and Theory* 8:63–111.

- Wynn, T & Coolidge, FL 2012. *How to think like a Neandertal*. Oxford: Oxford University Press.
- Wynn, T, Overmann, KA & Coolidge, FL 2016. The false dichotomy: a refutation of the Neandertal indistinguishability claim. *Journal of Anthropological Sciences* 94:1–22.
- Zilhão, J 2014. The Neanderthals: evolution, palaeoecology, and extinction. In Cummings, V, Jordan, P & Zvelebil, M (eds) *The Oxford handbook of the archaeology and anthropology of hunter-gatherers*. Oxford: Oxford University Press:191–213.