Cognitive and Cultural Diversity in Human Evolution

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Abstract
Most well-accepted models of cognitive evolution define the modern human mind in terms of an amalgamation of species-specific cognitive mechanisms, many of which are described as adaptive. Likewise, these models often use the rich archaeological record of Homo sapiens to illustrate how ‘uniquely human’ mental abilities gave our species an evolutionary advantage over extinct hominins. Recent evidence from various fields, however, indicates that closely related species, particularly Neanderthals and Denisovans, likely had cognitive capacities very similar to ours, and that several key aspects of ‘modern’ cognition are not exclusive to our lineage. The sum of these data therefore requires a timely revision of human cognitive evolution models. On the one hand, claims of species-specific cognitive mechanisms have been weakened. On the other hand, there are tangible differences among extinct and extant humans that call for an explanation. One way to accommodate these differences is to understand cognition as shaped by sociocultural and environmental factors, and to argue for culture-specific rather than species-specific cognition over the course of human evolution.

Keywords: hominin cognition, human evolution, cognitive archaeology, culture, cognitive diversity

Introduction
For decades, scholars have warned against the implicit biases that span interpretations in palaeoanthropology and particularly in cognitive archaeology, such as those implying that modern humans embody the pinnacle of evolution (Cartmill, 1990; Corbey & Roebroeks, 2001; Gould, 1990; Landau, 1993). Despite increasing awareness of these issues, recent reviews have found that the field of human cognitive evolution is still largely dominated by narratives which ultimately propose that our species has been endowed with certain abilities that gave it an evolutionary edge and allowed it to survive and outcompete extinct hominins (Barham & Everett, 2020; Breyl, 2020; Langbroek, 2012).

Those supposedly advantageous abilities, often referred to as ‘species-specific’ behavioural or cognitive adaptations (Tooby & Cosmides, 1992), include among others, imitation, pedagogy, language, theory of mind, and symbolic thinking. Namely, traits which are thought to underlie much of modern human complex culture and sociality. Accordingly, their emergence has been assigned a late evolutionary date, with or after the appearance of H. sapiens, between 200 and 100,000 years ago (McBrearty & Brooks, 2000).

The timing of the origin of such adaptations is sometimes estimated on the basis of indirect archaeological evidence, for example by using art or personal ornaments as proxies for language and symbolic thought (d’Errico et al., 2005), and other times just by inferring that due to their current universality these traits must have been in place by the time H. sapiens migrated out of Africa, minimally 100,000 years ago (Mellars, 2006). This in turn has fuelled ongoing discussions of whether the modern human mind and body evolved gradually together (McBrearty & Brooks, 2000) or if there was a lag between anatomical and cognitive/behavioural modernity, with the latter evolving much later than the former (Tattersall, 2017).

However, a growing number of archaeological finds suggest that many of the allegedly species-specific adaptations evolved neither with nor after the emergence of our species, but prior to it. In fact, they were likely shared with other ‘archaic’ humans, in particular Neanderthals and perhaps Denisovans, whose cognitive capacities appear to have been not too dissimilar to ours (Breyl, 2020; Shea 2011). Therefore, such traits can no longer be held as unique to H. sapiens and cannot by themselves explain our ‘success’ as a species.

1Following the phylogenetic species concept, a species is here understood as a lineage of organisms, distinguished from other lineages by its evolutionary trajectory, bound in time by its origin in a speciation event and its eventual disappearance by further speciation or extinction (Sterelny & Griffiths, 1999). Accordingly, Neanderthals, Denisovans and Homo sapiens are considered separate species (Stringer, 2012). This means that whether these other human groups were absorbed by modern African populations or died out, they constitute separate lineages by virtue of their own particular evolutionary paths, which diverged for at least 400,000 years, since the split from a last common ancestor (Hublin, 2013). Therefore, in this paper ‘our species’ refers to all individuals classified as H. sapiens (aka modern humans), from the Jebel Irhoud fossils c.300,000 BP (Hublin et al., 2017) to contemporary populations.
Hominin Brains and Complex Behaviour

Although several researchers have long argued for the cognitive and behavioural complexity of Neanderthals and other extinct hominins (Villa & Roebroeks, 2014), a series of discoveries over the past few years have lent strong support to those appeals. In addition to long-known facts such as the Neanderthal’s big brains, complex hunting strategies and technologies, and high social skills (Roebroeks & Soressi, 2016), it has now been confirmed that they were able to control fire (Henry, 2017), made adhesives and produced composite tools of wood and stone (Niekus et al., 2019), made rope and perhaps textiles out of vegetal fibres (Hardy et al., 2020), created and frequented ritual spaces (Jaubert et al., 2016), made and used pigments and created some visual symbols (Hoffmann et al., 2018; Rodriguez et al., 2014). It is argued that many of these behaviours entail higher cognitive abilities (but see Tennie et al., 2016) as well as cultural strategies for information transfer such as pedagogical instruction and potential ‘funds of knowledge’ (Moll et al., 1992).

As far as Denisovans are concerned, not yet much is known but the fact that they interbred with both Neanderthals and modern humans may be used as an indicator of the probable abilities of those mysterious hominins (Reich et al. 2010). Furthermore, they seem to have produced visual symbols similar to those made by Neanderthals and early modern humans (Li et al., 2019).

The issue of the chronology of language in our lineage is still open to debate (Fitch, 2017). Nevertheless, a large corpus of (indirect) evidence supports the presence of complex linguistic capacities among extinct hominin species (Barham & Everett 2020; Dediu and Levinson, 2013). In any case, all the adaptations required for complex vocalization were already in place by the time of the assumed last common ancestor of Neanderthals and H. sapiens, H. erectus, some half a million years ago, if not earlier (de Boer, 2017). In addition, many of the hominin behaviours mentioned above, like making composite tools, may require verbal instruction (Ambrose, 2010). Finally, the genetic contribution of extinct hominins to current populations is another clue that they were probably capable of communicating and sharing information with modern humans through language (Mafessoni 2019; Villanea & Schraiber, 2019).

Because Neanderthals had brains as big or even bigger than H. sapiens, but were long portrayed as less cognitively sophisticated, a frequent argument for explaining modern cognitive abilities has been that it is not brain size that matters, but brain structure (Klein, 1995; Mithen 1996). The unexpected recent discovery of H. naledi has become problematic to such claims. This small-sized, small-brained hominin lived in South Africa between 335,000–236,000 years ago, which means that at some point it coexisted with the earliest members of our species (Hawks et al., 2017). Brain endocasts of the fossil specimens show that even though H. naledi’s brain volume was on the lower side, within the range of Australopithecenes (450-600 cubic cm vs. 1,450 cubic cm in H. sapiens), their brain structure was more similar to ours. That is, naledi had a relatively well-developed frontal cortex, related to sociality, and presented an occipital petalial asymmetry, related to language ability (Holloway et al., 2018). Because naledi is a distant relative, these data suggest that current brain structure may have featured since the beginning of the hominin clade and that behaviours characteristic of Homo like tool-making, sociality, and hunting may not be the result of the evolution of cognition but might themselves have acted as selective pressures for brain organization (Holloway et al., 2018).

H. naledi thus demonstrates that, a) encephalization was not a generalized trend in Homo (Montgomery, 2018) as it has been assumed (Bruner et al., 2003); b) that the Pleistocene African environment did not select strictly for big brains (Dusseldorp & Lombard, 2021); and c) that a large brain may not be a prerequisite for (rudimentary) language ability (Holloway et al., 2018). It also suggests that key neurological aspects of cognition, such as general brain size and structure, and likely behavioural ones too, may be traced back to the very start of the Homo genus (Stade, 2020).

Modern Human Cognition and Culture

So, what, if anything, could be unique about modern human cognition? Given the previous discussion, it has become clear that any hypotheses of species-specific cognitive or behavioural adaptations must either be supported by evidence or predicted by it. Clearly, we can no longer provide lists of traits presumed to be exclusive to modern humans and then simply reverse-engineer multiple likely functions (which often leads to unfalsifiable ‘just-so stories’). If we propose that a trait evolved only in H. sapiens, we need to back the argument with data preferably from different fields, and put forward possible selective contexts that would have led to the emergence of such trait in our species and not in other related hominins (a testable prediction). That is, we need to argue why the trait appeared when it did (within the evolutionary range of our species, over the past 300,000 years) and how it may have yielded an advantage to H. sapiens populations in particular. Preferably, such explanations should also incorporate archaeological data, as this is the only empirical evidence we have of the actual evolution of human cognition and behaviour (Mellers & Gibson, 1996).

To illustrate this, visual art invariably features in lists of uniquely modern human behaviours (Roebroeks, 2008). Cognitive explanations have often linked the origins of (visual) art to the emergence of symbolic capacity (Coolidge and Wynn 2009; Deacon 1997; Mithen 1996), that is, the ability to use one thing or situation to stand for another. Because prior to 100,000 years ago evidence for ‘symbolic’ objects (e.g. aesthetic or non-utilitarian) is scarce, researchers have often assumed that the ability to think symbolically was also absent until then. Conversely, it has been proposed that once symbolic thought was acquired, it at once allowed for all sorts of behavioural and
technological innovations, including art (Mithen, 2005). Thus, the hypothesis of a sudden, late emergence of symbolism predicts that the earliest visual art will co-occur with an increase in tool complexity and diversity, of the sort expected among modern humans. But as the findings discussed above show, many putative symbolic artefacts as well as other markers of ‘modern’ cognition (e.g. artefact diversity, specialized tool types, visual symbols) were produced by pre- and early modern humans as well, and show a gradual, mosaic-like pattern of development in which innovations appeared and disappeared as needed and often did not co-exist (McBrearty & Brooks, 2000). Moreover, there are modern human populations whose output of visual art would not leave an archaeological print greater than those of many early MSA or Middle Palaeolithic sites (e.g. the historical Tasmanians and Californians, or the contemporary Pirahà). This means that the archaeological absence of symbolic objects, such as visual artworks, cannot be prescriptive of either the presence or absence of symbol-based (modern) cognition, because their relationship is not causal.

In addition, studies in comparative psychology indicate that symbolic cognition might be more widespread across lineages than assumed. By now it is well accepted that great apes are able of successfully learning and using gestural, graphic, and language-based symbols, and even if they do not create or use them in the wild, this points to an incipient symbolic capacity (de Waal 2001; Gillespie-Lynch et al. 2011; Matsuzawa 2009). Similarly, animal signalling systems such as the alarm calls of vervet monkeys allude to symbol-based communication (Ribeiro et al. 2007). So, symbolic abilities may be shared with other primates and certainly with hominins (Shea 2011). In addition to symbolism, other aspects of human cognition that have been traditionally thought of as ‘unique’ have been reported (not without controversy) in non-human animals as well. For example, ‘true’ imitation in great apes and dogs (Bates & Byrne, 2010), theory of mind in apes, monkeys, and corvids (Krupenye & Call, 2019), metacognition in dolphins, apes, and monkeys (Kornell, 2014), and vocal learning in birds, seals, and cetaceans (Fitch, 2000). In brief, some of the key capacities which underlie human cognition, such as symbolic understanding, complex problem-solving, and language-like communication, likely evolved in other lineages, under different selection pressures (Bräuer et al., 2020). We must then confront the possibility that there may be nothing fundamentally different about modern human cognition compared to that of other recently extinct humans, or even in general.

**Diversity over Human Evolution**

Established models of cognitive evolution are based on the hypothesis that all non-African modern humans stem from a single population of *H. sapiens* that migrated out of Africa some 100,000 years ago. This single-origin, single-migration hypothesis expects low cognitive and behavioural diversity and supports the notion of a universal species-specific mental architecture (Tooby & Cosmides, 1992). This ‘cognitive unity’ model, which has predominated over the past three decades in cognitive evolution studies (Heyes, 2012), explains the observed variability in human culture and behaviour as a response to environmental input, but assumes that the cognitive mechanisms underlying it are the same in all living humans, and have been so since the beginning of our species.

That view, however, has been changing in accordance to recent research which suggests that cognitive diversity is actually prevalent among modern human populations and it comes about not only through environmental factors but from culture as well. That is, cultural practices and objects (e.g. languages, symbols, artefacts) are not simply the products of a uniform species-wide cognitive architecture, but in fact can generate different cognitive architectures in different populations (Bender, 2019; Henrich et al., 2010; Levinson, 2012).

There are many examples of how people perceive and process information distinctively across cultures, including optical illusions (Ahlulwala 1978; Henrich et al., 2010), numerical cognition (Bender & Beller, 2013), spatial cognition (Bender et al., 2012), emotion processing (Beller & Bender, 2018), and memory (Schwartz et al., 2014), just to mention a few. Much of this variability hinges on cultural and linguistic diversity (Henrich et al., 2010; Majid et al., 2004), but individual cognitive differences can also arise over a lifetime through learning and experience (Muguiro et al., 2000). Network accounts of cognition, for instance, propose that the neural connections that guide brain function emerge in ontogeny and remain somewhat plastic over a lifetime (Luria, 2002; Spoorns, 2010). This means that cultural and environmental input can actually shape how those connections are formed and amount to actual qualitative differences in cognition (Mithen & Parsons, 2008). This has highlighted the importance of considering brain plasticity and ontogenic processes, alongside phylogeny, in explanations of human cognition and its evolution (Levinson, 2012).

Current research in palaeoanthropology also suggests that there is no reason not to expect a similar level of cognitive and behavioural diversity among pre- and early modern human groups as well. Contrary to the single-origin hypothesis, it now seems that the emergence of our species can be traced back to several small, widespread populations. In recent years, the oldest *H. sapiens* specimens have been found in Morocco (Hublin, 2017), and Israel has yielded fossil remains of a similar age as the oldest modern humans from sub-Saharan Africa (Hershkovitz 2018; Trinkaus 2005; White et al. 2003). This indicates that from early on, there were enclaves of *H. sapiens* spread out through Africa and the Levant. Likewise, the morphometric analyses of the crania of some of the earliest modern human fossils has shown that these groups were as diverse as current human populations (Gunz et al., 2009). Such variation means that soon after the origin of our species, there were intra-African dispersals that ended up creating small isolated communities.
that later expanded and mixed in and out of Africa at different times (Gunz et al. 2009). The higher genetic diversity of living African peoples also supports the hypothesis of several small founder populations of modern humans scattered over that continent (Bergström et al., 2020; Campbell & Tishkoff, 2010). If early *H. sapiens* groups were genetically and anatomically diverse and widespread, then we should expect them to have been culturally diverse too (McBrearty & Brooks, 2000).

Moreover, if we accept the possibility that extinct and early modern humans had spoken language, as discussed above, then they must have had linguistic diversity as well. Given that language and culture generate cognitive variability, i.e. different ways of perceiving, knowing, doing, and thinking, we may infer that these hominins were cognitively diverse.

We could argue, then, that like today, human cognition over evolution was not species-specific but culture-specific. If that is the case, to explain cognitive evolution we should focus more on environmental, social, and information transmission processes and contexts (Bender 2019; Heyes 2018). And to reconstruct past cognition we must take into account brain size and structure we must also take into account ecology, diet, demography and social structure, for instance. This means that insights from anthropology, developmental psychology, cross-cultural studies, and artificial learning, among other fields, are needed to understand what aspects of culture shape different cognitive mechanisms and how (Bender, 2019). Only then will we be able to explain the tangible differences between and within the archaeological records of different hominin populations.

To go back to the visual art example, figurative art, specifically image-making, developed relatively recently and, as far as we know, was systematically practiced only at the end of the Pleistocene by members of our species. However, we now have evidence of mark-making behaviour (a precursor of visual art) among *H. erectus* (Joordens et al., 2015), Neanderthals (Rodriguez et al., 2014), early *H. sapiens* (d’Errico et al., 2001), and perhaps Denisovans (Li et al., 2019). Research into the psychology of art has shown that mark-making minimally requires shared intentionality and perspective-taking (Callaghan, 2008). So if we assume that those archaeological examples of geometric patterns were purposefully made by hominins, we can hypothesize on the one hand, that these capacities were in place at least since the time of *H. erectus*, and that the mark-makers possessed social cognition skills related to collaborative action and communication, on the other. So, to account for the actual development of figurative art-making, it would not suffice to invoke the cognitive uniqueness of our species or attribute it with special symbolic or mark-making abilities; but we would need to attend to the culture-specific contexts of the groups that actually undertook figurative art practices (Straffon, 2016). Cognitive evolution studies will move beyond mere character lists and conjectures when hypotheses about the evolution of particular cognitive or behavioural traits are rooted in both archaeological data and empirical studies of (present-day) cognition.

**Conclusion**

Because cognition is shaped by the specific circumstances of socialization, learning, way of life, and environment, we may say that it is culture-specific. At the same time, we could argue that diversity is what characterizes human, and possibly hominin, cognition (Levinson, 2012). To explain human cognitive evolution, a comprehensive study of hominin cultures and ecologies could therefore contribute towards more accurate accounts than the models available to date. Additionally, differences between extant and extinct humans may be understood in terms of cultural diversity instead of cognitive ability, allowing us to do away with implicit superiority arguments in favour of our species. In sum, by understanding not only how cognition impacts culture, but also how different aspects of culture shape cognition, we should become better equipped to work out well-informed inferences and put forward much-needed falsifiable hypotheses and testable predictions about the origins of the modern human mind. To that aim we must keep in mind that ‘the evolutionary questions about cognition are both of the evolution of cognition and the effects of cognition on evolution’ (Lewontin, 1998).

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