Changes in Raw Material Selection and Use at 400,000 Years BP: A Novel, Symbolic Relationship between Humans and Their World. Discussing Technological, Social and Cognitive Arguments

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Approximately 400,000 years BP, *novel technological behaviours appeared in the archaeological record, attested by evidence of the exploitation of previously unused resources and the production of new tools. I have reviewed such innovations, and I discuss them in the frame of the anthropological, palaeoneurological, genetic and behavioural changes that appeared in the Middle Pleistocene. I propose that at this chronology humans started to see the resources as 'other-than-human' sentient co-dwellers. The technological innovations expressed this novel cognitive complexity and the possible new things–things, human–things and environment–things relationships. Artefacts and technologies acquired multiple semiotic meanings that were strongly interconnected with the functional value. Ethnoarchaeological evidence suggested the possible symbolic acting beyond these innovations in material culture. This perspective has relevant implications in the archaeology of the ancient Palaeolithic. It suggests the need for a new view of material culture, one that goes beyond the classical list approach in the definition of modern symbolic mediated behaviour. Further, it allows one to overcome the traditional juxtaposition between ancient cultures and* Homo sapiens *in terms of complexity. The evidence discussed in this paper suggests that the ontological hypothesis could change our view of Middle Pleistocene hominids and the origin and definition of modern behaviour, and test the archaeological visibility of cognition in prehistory.*

Introduction

It has been repeatedly argued that Acheulean techno-complexes are the reflection of a technological and behavioural stagnation that lasted hundreds of millennia (Klein 1999; Whiten *et al.* 2003, 102). Acheulean industry is characterized by the production of large flake-based, bifacial tools, including handaxes, cleavers and picks, and had appeared in East Africa at approximately 1.75 million years ago, which is close chronologically to the appearance of *Homo erectus/ergaster* (Beyene *et al.* 2013). This cultural stillness is usually set against the great dynamicity registered in the archaeological contexts at the rise of modern humans in Africa (Brown *et al.* 2012; McBrearty & Brooks 2000). The onset of *Homo sapiens* has recently been dated at perhaps 300,000 BP (Hublin *et al.* 2017). Richter *et al.* (2017) present a complex discussion about the origin of *Homo sapiens* and the Middle Stone Age (MSA) cultural complex. In association with technological innovation and creativity, the emergence of new capacities in *Homo sapiens* is usually taken for granted with the appearance of symbolic ways to process information.

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New technological patterns—bone technology along with spears and projectile weapons—and symbolic artefacts and behaviours, such as ornaments and the use of coloured pigments (see Somel *et al.* 2013, 113 and bibliography), are usually viewed as proxies for acting symbolically since the MSA. Several recent works have shown changes in Acheulean technocomplexes, including giant-core technology, the appearance of new forms of artefacts and techniques and the diversified life-cycle of handaxes (Baena Preysler *et al.* 2018; Sharon 2009; Stout 2011). Beyond the possible cultural variation within the Late Acheulean industry, the conventional focus on novel capacities of *Homo sapiens* has not taken proper account of a previous period in which several behavioural changes suggest a complex cultural dynamism out of Africa before the advent of our species.

In this paper, I review the technological changes of this period, looking at the new forms of resources exploitation. Starting from approximately 400,000 BP, it is possible to recognize the inclusion in the archaeological record of productive resources that were previously considered waste or rejected for tool production. I argue that this novel technological creativity is the expression of changes in the way hominins looked at their world. In other words, I suggest that at approximately 400,000 BP, ancient humans built new relationships with their environs through raw materials. This idea is discussed within the framework of anthropological, palaeoneurological, genetic and general behavioural changes at that time. This ancient technological dynamism has implications for the study and understanding of behavioural modernity. The scenario that can be drawn is still patchy, with non-homogeneous evidences on wide geographical areas. However, the discussion in a global view suggests, to my mind, an interesting research line that could open a fruitful discussion and future research perspective in the understanding of what defines *Homo sapiens* behaviours and how we can comprehend our evolutionary success.

Material culture, meanings and relationships: an integrated, multi-layer perspective on raw materials

The aim of archaeology is to understand human behaviours over a large timespan. Archaeology is a science that primarily studies objects. The approach is to look at the relationships between material culture, which has been a fundamental dimension of human life for more than three million years, and the social and environmental contexts in which these objects have been produced and used. The specific contexts weave the meanings of material culture (Hamilakis & Jones 2017). Reconstructing the social context is extremely difficult. This is especially true in ancient prehistory, when humans differed from us in terms of biology, economic strategies and technologies, and lived in a largely dissimilar environment. Furthermore, a part of their material culture has disappeared due to the decomposition of organic materials, other post-depositional disturbances and the decreasing amount of evidence the further back in time we go. Thus, the picture is always quite incomplete and puzzling, making the study of material culture a complex matter (Romagnoli *et al*. 2018a).

The approach that is generally used in Western archaeological tradition conceptualizes the natural environment as a passive container from which to extract what we need in a materialistic perspective. Therefore, as archaeologists, we are used to interpreting ancient technologies in terms of techno-economy: we invest effort in, for example, the identification of production sequences, the quantification of the productivity of a knapping method, the calculation of the time and energy costs of the supply distance and speculation on the efficiency of tool design. In this paper, I attempt to determine whether artefacts were, and are, solely passive, functional tools. What Harris and Robb (2012) applied to the anthropological interpretation of the human body through history is also true for material culture: multiple ontologies exist and include materiality, but also sensoriality and affectivity (Hamilakis & Jones 2017). An object is a means of communication and conveys something that words cannot express. It has a surplus of meaning that t is not necessarily intentional and widely socialized but can be unambiguously shared by a certain group of people.

According to Guarinello (2005), it is possible to reduce the meaning of artefacts to three different fields. The *functional* field is the most concrete and easiest to understand. The raw material and the shape of an object are strictly related to its function and operating mode. The *social* field is how objects create and express identities. They are social classifiers: gender division of labour, social classes, and so on. The *expressive* field is the most complex to understand and is strictly related to the semiotics of the cultural material.

The focus of this article is on raw materials, and I have applied this analysis to technological changes at 400,000 BP. Technology is a basic component of an artefact. Each artefact certainly had a functional goal and was created by past humans to realize a technology-mediated task. I propose that each artefact also had surplus meanings reflecting new possible thing–thing, human–thing and environment–

thing relationships. I argue that these different layers of meanings were strongly interconnected in the human populations at approximately 400,000 BP. Hominids started to see land resources as something different from merely effective means to meet their needs. They started to be engaged with materials and the world in a novel, symbolic way, thanks to novel cognitive capacities and social dynamics. These meanings were codified and socially shared within the human group. The identification of a Palaeolithic object as an expression of identity and as signalling social practices is very hard to determine. However, according to economic analysis, the process of innovation is both an individual and collective phenomenon (Saxenian 1994). Furthermore, the capacity to adapt to a changing environment, as expressed by technological changes, cannot be explained simply through individual problem-solving; it implies cultural learning, social organization and social dynamics. Finally, seeing the elements in a dynamic and flexible way, relationships between humans and 'other-than-human' elements could be understood primarily as social in nature.

Increasing the range of exploited resources at approximately 400,000 bp: The archaeological records

Independently from the label we gave to the techno-complex and to the *Homo* species associated with it, at approximately 400,000 BP we can show the appearance in the archaeological record of new technological behaviours. They can be identified according to the type of raw material being exploited as a new resource and the way in which humans accessed it.

Rocks

In the case of abiotic resources, the main changes involved new strategies for acquisition. An example is the intensification of lithic recycling. Almost systematically, humans transformed the functional life history of a tool in diversified and complex ways that can be categorized according to the aim of the recycling: (i) the production of short flakes and (ii) the configuration of a new tool (giving new life to waste). In the first category, we can include the exploitation of a previous tool that is later used as a core and the transformation of an Acheulean handaxe into a core, as has been shown in the lower layers at Tabun Cave (Shimelmitz 2015). In the second category, we can include the collection of previously abandoned blanks, usually identified in the archaeological assemblage by the presence of double patination, and the transformation of a core into a retouched flake (Barkai *et al.* 2015). Until now, specific studies on recycling strategies in the Middle Pleistocene have been carried out in Europe and the Levant, showing that this technological behaviour was widespread in these regions and persisted there in the Middle Palaeolithic with several different economic values (Romagnoli 2015; Romagnoli *et al.* 2018b with bibliography).

Another example is the novel exploitation of chert quarries, as specific primary locations in the Levant attest (Verri *et al.* 2005). This new strategy was associated with the collection of previously known surface-level secondary sources. Some authors suggested that this new behaviour was due to the diversified production of specific tool types (Boaretto *et al.* 2009). The exploitation of underground sources implies the frequentation of a new geographical space and all the possible novel perceptions of the landscape that could be associated with it. These activities also involve specific extraction knowledge and its inter-generational transmission because of the persistence of this new behaviour for approximately 200 years beginning at 400,000 BP. It is also relevant that in the Levant, this change is associated with a general technological shift and the appearance of the new Acheulo-Yabrudian cultural complex (AYCC), including novel tools such as the Quina scrapers with stepped, scaled retouching. These artefacts are probably most related to new forms of human mobility and planning of tasks, because they are transported items usually characterized by complex and long use, re-sharpening and a recycling life-cycle (Lemorini *et al.* 2016). It has been suggested that some aesthetic concerns have been expressed in this novel context. They are reflected in the systematic collection of several small coloured flint pebbles, less than 50 g in weight and mostly reddish, which do not present any trace of functional/productive use (Assaf 2018).

Wood

Organic material is usually not preserved and its recovery is quite exceptional. Evidence of wood artefacts has been reported in few Middle Palaeolithic European sites, attesting to wood technology in Neanderthal groups (Aranguren *et al.* 2018; Carbonell & Castro-Curel 1992; Rios-Garaizar *et al.* 2018). To date, the most ancient and complete wood artefacts have been found at Schöningen in northern Germany. The site was previously dated at approximately 400,000 years ago, according to models of sedimentations and biostratigraphical

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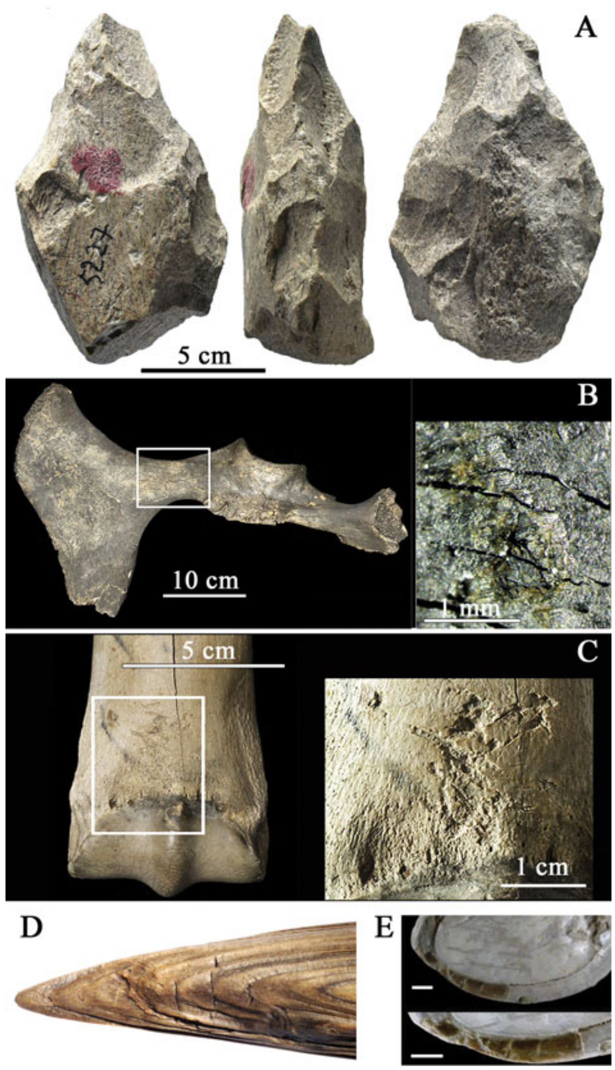

Figure 1. *(A) Castel di Guido site (Italy): a handaxe made of an elephant bone. (Modified from Zutovski & Barkai 2016); (B) Schöningen site (Germany): a horse bone used as an anvil; (C): Schöningen site (Germany): a horse metacarpal with knapping damage (B & C modified from Kolfschoten* et al. *2015); (D) Schöningen site (Germany): detail of a spearhead. (Modified from Schoch* et al. *2015); (E) Trinil site (Java): shell tool. Scale bar 1 cm. (Modified by Joordens* et al. *2015.)*

correlations. Recently, thermoluminescence dating suggested a maximum age of the level of wood technology at Marine Isotope Stage (MIS) 9, at approximately 330,000–300,000 years ago (Richter & Krbetschek 2015). Highly skilled horse hunters repeatedly occupied the open-air site (Julien *et al.* 2015). The site is well known for the exceptional degree of conservation of the archaeological records, including several botanical macro-remains of aquatic and lakeshore plants, shrubs and trees. Ethnobotanical studies have shown that most of the species yielded at the site are used for subsistence and as raw material by hunter-gatherers living in similar environments; several of the species also have medicinal effects (Bigga *et al.* 2015).

Wood technology at Schöningen was attested by nine almost complete spears, one lance, one double-pointed rod and one worked wooden stick. These artefacts were archaeologically associated with the remains of at least 35 butchered horses. Humans selected thin trunks of spruce (in one case, pine) and removed the bark, scraping and smoothing the surface of the tools. The traces of these activities are still clearly visible. One spear shows clear evidence of several resharpening activities, suggesting repeated use. The tip was always sharpened away from the central axis of the trunk (Fig. 1D; Schoch *et al.* 2015). Technological analysis and experimental archaeology suggested that the spears, with weights and dimensions similar to modern championship javelins, were well balanced and effective in the hunting of large animals from a distance of several metres. Furthermore, their technological characteristics prevented the spears from breaking, making them long-lasting tools (Smith 2003). There is other evidence suggesting the control of wood technology in hunting activities by hominins in this period. At Clacton-on-Sea, in southern England, a tip of a yew spear was dated at approximately 400,000 BP (Oakley *et al.* 1977).

Bones

Since 2.5 million years BP, ancient humans fractured animal bones to obtain the highly caloric marrow. Bone fragments were then thrown away as waste. Between 400,000 and 300,000 BP, animal bones were first used as raw material in tool production. Two types of bone artefacts are known in this chronology (Fig. 1A–C): functional tools and bone artefacts that were used to modify stone tools (retouchers). Bone retouchers became usual in Late Pleistocene Neanderthal sites (see bibliography in Hutson *et al.* 2018) and have recently been identified in the same chronology in northern China (Doyon *et al.* 2018). Within the most ancient evidence known today, there is a distal epiphysis of a red deer humerus at Boxgrove from MIS 13 associated with several retouchers made of red deer antler (Roberts & Parfitt 1999). Between MIS 12 and 11, these objects were used in France at Caune de l'Arago, La Micoque and Terra Amata. In MIS 9, in several sites in northern and western Europe, including Schöningen (see bibliography in Daujeard *et al.* 2018, 94) and in

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the Levant at Qesem Cave, they possibly represent local, convergent development (Blasco *et al.* 2013a). Between MIS 12 and 9, bone retouchers were variously associated with bifacial, AYCC and pre-Mousterian technology.

Bone tools became basic elements in the culture of *Homo sapiens* in Europe. They firstly appeared around 400,000 BP in the Levant at Revadim Quarry, in three sites in central-western Italy (where a later fourth site was dated as MIS 7), at Vértesszőlős in Hungary and at Bilzingsleben in Germany (see bibliography in Gaudzinski *et al.* 2005; Zutovski & Barkai 2016). They were large bifacial handaxes made of proboscidean bones and produced with the same procedures applied to shape the similar Acheulean lithic tools (Villa & d'Errico 2001). At Bilzingsleben, other tools have been found, including an elephant bone used as an anvil and five splinters on which a regular series of parallel and convergent cut marks were engraved. Authors have suggested that the regularity in the patterns of lines has to be interpreted as an abstract meaning, a way of communicating, rather than the accidental production of cut marks (Mania & Mania 2005). A horse bone anvil has also been identified at Schöningen (Kolfschoten *et al.* 2015). Two other bone tools, similar to lithic retouched tools, have been found in the TD10 layer at the Gran Dolina site in Atapuerca dated to MIS 10/9 (Rosell *et al.* 2015). The strong predominance of proboscidean bones for Acheulean organic handaxes is not surprising. In these techno-complexes, humans were strongly dependent on these animals for subsistence. Finally, at Qesem Cave, some indirect evidence of early bone-working activities has been identified within AYCC assemblages. They are residue and use-wear traces on two chert scrapers and a mark on a fallow deer tibia not linked to butchering tasks (Zupancich *et al.* 2016).

An antecedent of Middle Pleistocene bone technology could be seen in the use of fragments of bones and a horn by South African *Paranthropus* to dig into the soil for the collection of termites for consumption (d'Errico & Backwell 2009). However, in this case, hominins 'used' bones but did not modify them before use. Middle Pleistocene bone retouchers are conceptualized differently because they imply the use of a bone fragment to modify another raw material to shape artefacts. Thus, it is a novel technology-related behavioural pattern. Researchers have continued to demonstrate bone technology in the Late Middle Palaeolithic as well. Neanderthals frequently used animal and, to a lesser extent, human skull fragments and long bone retouchers, especially within Quina techno-complexes (Hutson *et al.* 2018; Rougier *et al.* 2016). Sporadically, they also used animal and human bones to produce specialized tools and to express symbolic communication (Burke & d'Errico 2008; Majkić *et al.* 2017; Soressi *et al.* 2013).

Shells

The origin of the exploitation of coastal resources stepped into the spotlight latterly because of its implication in human evolution. European Neanderthals exploited molluscs and marine mammals for consumption (see bibliography in Álvarez-Fernández 2015). At Cueva de los Aviones and Cueva Antón in Spain and Fumane Cave in Italy, shells have been found associated with mineral pigments, suggesting a role of marine shells in Neanderthal symbolically mediated behaviour (Peresani *et al.* 2013; Zilhão *et al.* 2010). Neanderthals' use of shell technology also shows that it was well integrated into the techno-economic behaviour of the human groups (Romagnoli 2018; Romagnoli *et al.* 2016; 2017). It included the systematic selection of *Callista chione* valves, their configuration as tools using specific techniques and deep knowledge of the constraints imposed by this organic resource.

At present, the most ancient evidence of the use of marine shells as raw material has been identified in a *Homo erectus* context in Southeast Asia at Trinil and is dated by luminescence at a minimum age of 0.43 ± 0.05 million years. Within several consumed *Pseudodon* specimens, one showed anthropogenic modifications of the ventral margin associated with smoothing and polishing due to use (Fig. 1E). Furthermore, one valve showed an engraving on the central part of the external surface. A zigzag line was associated with a set of parallel lines and was probably made on the brown periostracum of a fresh valve (Joordens *et al.* 2015).

Other changes in the same chronological period and their implications for the appearance of novel communication codes in human evolution

These new technologies and varieties of raw materials appeared in the Middle Pleistocene alongside other major behavioural and anthropological changes.

The control and regular use of fire in Europe were first attested at this time (Roebroeks & Villa 2011). Fire control, attested less frequently since at least about 800,000 BP (Alperson-Afil 2008; see Berna *et al.* 2012 for the oldest evidence), has affected new social and semiotic relationships among humans, and wood resources could have acquired additional meanings reflecting them.

New stone tool technologies and toolkits appeared. Evidence is found in the shift to AYCC in the Levant (Barkai & Gopher 2011) with Quina scrapers and laminar technology and in Africa and Eurasia with the appearance of predetermined Levallois core strategies. Levallois production methods were used in some areas in tandem with previous bifacial technology, most probably due to evolutionary processes based on a common technological ancestry (Adler *et al.* 2014; Moncel *et al.* 2011). MSA assemblages appeared in eastern and southern Africa in this period of global cultural dynamism.

New economic strategies were demonstrated at this chronology in the accumulated first evidence of a decrease in pachyderm eating, the active communal hunting of large ungulates (Rodríguez-Hidalgo *et al.* 2017), standardized carcass processing (Blasco *et al.* 2013b) and a diversification in diet. The diversification included an ever-increasing consumption of small game (e.g., tortoises and birds) and marine resources (see bibliography in Blasco *et al.* 2016), as well as plants for nutrition and medication (Hardy 2018). These new subsistence strategies imply novel, flexible and complex relationships between humans, plants, animals and specific ecological niches with which humans would have had few previous interactions. Active communal hunting could also have driven novel relationships with weapon technology. Furthermore, these economic strategies imply reorganization and new social human relationships, including the social division of labour, food sharing and the transmission of knowledge of plants and animals. These strong and complex social relationships could explain the social assistance that would have supported the survival of pathological individuals (Trinkaus 2018). Changes in the socioeconomy could have driven novel meanings within the additional value of resources and technologies related to a new perception of the landscape and the novel relationships humans built with it.

Ethnoarchaeology gives several pieces of evidence regarding how technology is fully integrated into the ontological perception of landscape. Australian Aborigines construct complex relationships with their territory according to the belief that rocks can listen and oversee human activities (Povinelli 1995). The North American Ojibwe look at animals, plants, inanimate objects and natural forces as 'persons' with whom humans maintain social relationships (Hallowell 1960). South Indian Nayaka hunter-gatherers looked at plants, animals and rocks in different ways—as 'other-than-human' sentient co-dwellers or objects—not on the basis of the inherent essence of these 'entities' or their location in the landscape, but by when, why and which people dealt with them (Naveh & Bird-David 2014). This dynamic and living perception of entities in the landscape declined when Nayaka became producers and started to perceive plants, animals and stones as means to acquire something else. According to Naveh and Bird-David (2014), this transition to a more pragmatic, static and unique conceptualization was due to socio-economic changes and the delayed use of these resources by anonymous consumers rather than to changes in human social relationships. All of this suggests that it might be unduly restrictive to interpret ancient changes in material culture only in terms of economic rationality—production sequences, effectivity, transportability, etc.—according to a modern, Western, consumer conception of tools and land resources.

From a palaeoanthropological viewpoint, the Middle Pleistocene is characterized by a great diversity of human species, and all of them are in different ways associated with some of these novel behaviours. Thus, we see a complex mosaic that make it impossible to link a human species linearly to a specific technology and behavioural set. Looking at anatomical and genetic traits that can support the capacity for creating novel and more complex semiotic meanings in material culture, current data suggest that all these hominins shared such traits. At the latest, they appeared at the emergence of the speciation events occurring around 600,000 BP, long before the advent of modern humans.

Within a progressive process of encephalization, hominins species who lived in the Middle Pleistocene shared some genetic mutations that are relevant when speaking about behaviours. The GADD45G and DUF1220/NBPF genes (probably leading to brain size expansion) and the HAR1 mutation (related to cortical expansion) were already present within Neanderthal features (O'Bleness *et al.* 2012; Somel *et al.* 2013) that first appeared in the European fossil record at approximately 400,000 BP (see bibliography in Hublin 2009). The FOXP2 amino acid mutation was already present at this point in Neanderthals, Denisovans and Heidelbergensis, suggesting that changes in brain connectivity linked with the motor controls of fingers and language were already present not only in these hominin species (Somel *et al.* 2013, 113 and bibliography) but most probably also in their common ancestor. Palaeontological and archaeological evidence also supports complex linguistic capacity and codes in

Neanderthals (Dediu & Levinson 2018). Semiotically complex ways of communicating novel perceptions of the landscape could fit within these new communication codes and could be the result of the complex process of anatomical and cognitive reorganization attested in hominins since approximately 600,000 BP.

I propose that the changes in the archaeological record presented in this paper are the expression of a novel, complex, dynamic conceptualization of the world, similar to what is attested in ethnoarchaeological contexts where resources were viewed as 'other-than-human' sentient co-dwellers. These innovations in technology and the selection of production resources are the expression of a novel, symbolic way in which humans related with materials and the land.

This hypothesis is based on several arguments. The changes in material culture presented in this paper appeared in a short time interval, associated with different human species, and across different and unconnected regions, each characterized by specific cultural traits. Thus, they were most probably due to a cognitive shift, rather than being novel technological or economic strategies. Furthermore, in these innovations there are some semiotic aspects that I find particularly significant. The first is that some of the resources that are introduced in the production process from this moment were previously seen as waste, as in the case of animal bones. This change implies a novel conceptualization of the raw material where it goes from being disregarded to being the focus of repeated and systematized human interactions and a novel element of human culture. Moreover, these resources are not isolated but are part of a whole. The use of bone as raw material could be related to a novel, holistic conceptualization of the animals, which were fundamental entities for human survival. Ethnoarchaeological literature offers several forms of evidence for the possible complex way of meaning of human–animal interactions in hunter communities. On one hand, the animal must be dominated, while on the other, dependence on the animal for livelihood engages humans in a series of reciprocal relations with it, including a specific treatment of each part of the animal carcass (see Nadasdy 2007 and bibliography). The vision of raw materials as part of a whole, with consequent novel semiotics and possible novel cognitive human–whole interactions, could be also applied to underground resources (as part of the soil on which we stand and move), of wood (as part of the forest) and shells (as part of the sea and being themselves animals). More generally, these resources are all part of the landscape and their novel exploitation could be related to a novel conceptualization of land. Recycling could be a further component of the novel semiotics of technology. The recycling of tools enlarges the life-cycle of an artefact. This could be an economic advantage, reducing the energy and time costs of searching for the raw material and modifying it up to get the final, functional product (Romagnoli 2015). At the same time we cannot exclude that the recycled object is gaining importance as container of external memories, as happens with our contemporary objects handed down for generations. Finally, some of these resources could have had a value in relation to their aesthetic appearance. Shells, for example, are characterized by an external shiny and coloured surface; and we cannot exclude that lithic resources were also selected according to their colour and the combination in the recycled tool of the patinated, older surfaces and the original colour of the matrix, revealed by the latest retouching.

All these arguments suggest that the technological innovations presented in this paper could have been the expression of novel meanings of raw materials and tools, and novel modalities in which humans interpreted the land and engaged with it. This behavioural complexity needed a larger working memory capacity, a cognitive system that allows abilities in learning and reasoning (Baddeley 2012) and higher language processing with increased ability to create and comprehend signs and meanings. An increase in these neuronal functions is expected to be correlated with a larger cerebellar volume (Kochiyama *et al.* 2018, 4). Furthermore, the novel conception of land I propose in this paper would have needed a higher visual cognition and, in particular, the 'semantic' processing of visual information (Jeannerod & Jacob 2005). This capacity implies the perception of spatial relations between objects, that is to say the identification of an isolated object seen in a complex, multiple disposition, and the codification of that object according to the conceptual information and knowledge of it that are stored in our long-term memory. An increase in visual cognition, including the enhancement of multi-step manipulation of spatially presented information, could have allowed humans to get around more safely in the land, know better the different geographical areas and, thus, exploit a larger range of resources. Furthermore, it could have modified the conception humans had of a whole as composed by different parts. This understanding of their realm could also have led to a different conception of the individual as part of a community, as expressed in the care of the aged and infirm people (Trinkaus

2018) and, at the end of the Middle Pleistocene, to intentional human burials (e.g. Pomeroy *et al.* 2020). Finally, the improvement in processing spatial information could have enhanced the 2D and 3D manipulation capacities that allowed for the creation of novel technologies and tools. Visual cognition is stored in the parietal lobule of the human brain (Jeannerod & Jacob 2005).

Some studies suggested that cerebellar volume and the parietal lobule were larger in *Homo sapiens* than in Neanderthals (Bruner & Iriki 2016; Kochiyama *et al.* 2018; Neubauer *et al.* 2018), suggesting higher cognitive and social capacities in our species. However, there are some limits in the ontological interpretation of the use of new raw materials based on morpho-anatomical and palaeoneurological studies. The first is that we still do not know the exact relationship between dimension, morphology and functional capacities in the human brain, genetics, and cognitive performance. The second is that the argument used in these studies to sustain the lower level of cognitive complexity in pre-*sapiens* is usually the lack of complexity in the archaeological record. However, the pre-*sapiens* cultural inferiority is usually defined by a European Upper Palaeolithic perspective and is based on a traditional list approach, which is anachronistic and untrustworthy according to the novel multidisciplinary data. Thus, this is a flawed, circular argument that risks becoming self-referenced and limiting our understanding of pre-*sapiens* cognitive and social capacities and behaviours. Furthermore, my hypothesis is based on the comparison between the Middle Pleistocene populations and their predecessor and we know little about the cognitive capacities of pre-600,000 BP hominids (Pearson *et al*. 2020). Finally, these studies mentioned that the origin of the modern brain morphology did not necessary coincide with the origin of our lineage (Bruner & Iriki 2016, 104) and that there were no significant differences in the relative size of the parietal regions between Neanderthal and Early *Homo sapiens* (Kochiyama *et al.* 2018, 5). This evidence suggests that Middle Pleistocene populations shared similar palaeoneurological and cognitive traits and that there are still many unknown data about cerebrocranial organization and its palaeoneurological implications in extinct humans.

Hypotheses in cognitive archaeology are speculative and need to be discussed with a multidisciplinary approach. The notion of the brain–artefact interface (Malafouris 2010) suggests that brain, material culture and environment are integrated in a complex manner. According to this idea, technologically mediated cultural behaviours are a part of the human cognitive architecture, and interaction with cultural objects and the material world may remodel brain anatomy and function. Based on functional neuroimaging and evolutionary neurosciences, even early stone tools should be capable of extending human cognition, being not merely a passive aid for humans to realize a specific task (see Malafouris 2010, 266–7 and bibliography). As Bruner and Iriki pointed out (2016, 107), we still ignore how the relationships between brain, material culture and environment could affect ‘intelligence’ and ‘creativity’. I propose to change the traditional archaeological hypothesis about the conceptualization of the material world at 400,000 BP and to test the possible cognitive interpretations we can generate combining palaeoneurology, genetics, psychology, archaeology, ethnoarchaeology and cognitive archaeology.

Assuming my hypothesis is true, there is a delay compared to the appearance of the anatomical and genetic traits supporting this cognitive capacity in the fossil record. To be identifiable in archaeological records, human behaviours must be repeated over time. This implies a standardized conduct shared by the human group. Looking at the innovative exploitation of resources at 400,000 BP, their *additional* values and means of relationships humans maintained with these objects and raw materials should have been unambiguously shared. For this to happen, specific demographic, social and cultural conditions are needed to foster the collective codification of the means of communication that these new objects expressed. They were most probably driven by the socio-economic changes that appeared at this time in the diet, collective hunting and hearth-related organization of the living space. A similar argument can be used concerning the occurrence of graphic symbols and personal ornaments. There is a delay between the appearance of *Homo sapiens* and the recurrent presence of these evidences in the archaeological records, dated at approximately 100,000 BP and independently associated with modern humans and Neanderthals (e.g. Henshilwood *et al.* 2011; Hoffmann *et al.* 2018; Radovčić *et al.* 2015) and it was most probably related to novel social and demographic dynamics.

The behavioural dynamism highlighted at 400,000 BP was restricted neither to a specific human species and hominin lineage nor to an ecological niche or geographical area, and predates the emergence of modern humans in Africa. The appearance of complex conduct is a matter of both higher cognitive capacities and social/cultural context. Symbolic behaviour is usually assumed for ornaments, graphic signs and complex technologies. Although between 600,000 and 100,000 BP several human species shared the cognitive capacities to produce a cultural modernity as defined by the presence of symbolic mediated behaviour, it makes its appearance in the archaeological records only much later than the emergence of modern humans and most probably independently within *sapiens* and Neanderthal communities. I propose that we need to rethink the definition of symbolic behaviour beyond our contemporary, Western conception. Ethnoarchaeology suggests that symbolic mediated behaviours could be less evident than the use of colour and personal ornaments. They can also be expressed by a shared perception of the landscape that was represented symbolically in communication and in the relationships humans built with objects that became the expression of social and ontological factors (Arthur 2018; Weedman 2006). Thus, a different view of the study of past material culture, going beyond economic and technological perspectives to include *additional* meanings, may enlarge the narrative of ancient archaeology and open new paths in the understanding of *Homo sapiens* cultural and cognitive records.

The idea discussed in this paper must now be tested through an analysis of the degree of technological complexity with a multidisciplinary approach and an in-depth study of the intensity of the novel behaviours on a scale from episodic to systematic, to verify whether these aspects have led to real adaptations with evolutionary implications. Furthermore, we still disregard the flexibility and versatility of most of the technological and economic strategies within their cultural contexts, and we still lack adequate in-depth knowledge of pre-*sapiens* cultural evolution. My goal is to open the reader's mind to new possibility in the way in which we look at and interpret the Pleistocene archaeological records. The evidence I discuss in this paper suggests that the ontological hypothesis I have proposed here could be relevant to change our view of Middle Pleistocene hominids and the origin and definition of modern behaviours, and test the archaeological visibility of cognition in ancient prehistory. It deserves to be seriously tested. Social and symbolic complexity in *Homo sapiens* seem not to have been abrupt novelties, and we have to investigate the possible exaptation of some traits that we have perhaps uncritically taken for granted in ourselves and regarded from a limited, distorted and flawed perspective.

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