Origins of Art: the Intersection of Cognitive and Cultural Evolution

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Abstract

In the field of cognitive archaeology, the origin of art has been recurrently explained as a result of the transition to a fully symbolic mind in our species, *H. sapiens*. Recent data is challenging that view as increasing evidence shows that the cognitive differences between 'premodern' and modern human populations are smaller than previously thought. Yet, possible cases of Neanderthal and other hominin art are few and far between, rendering artistic practices mainly a *H. sapiens* phenomenon. To explain this, it is necessary to redefine art and understand it not only as the product of cognitive operations, but as a behavior embedded in modern human social interactions.

Keywords: hominin cognition, human evolution, signaling, material culture, origins of art

Introduction

Anthropological data from across the globe show that some sort of visual art is present in every human culture (Anderson, 1992). Due to its wide-ranging presence, art is often defined as a universal human behavior (Davidson, 2012; Dissanayake, 2009). Similarly, every list of traits aimed at identifying the behavioral signature of *Homo sapiens* in the archaeological record invariably features art as a key, if not *the* key component that indicates modern human activity (Wadley, 2001).[1] For these reasons, origins-of-art theories have been an important element in human evolution research for over a century, particularly as a means to suggest and test hypotheses about human cognitive and cultural evolution (d'Errico *et al*., 2003).

Traditionally, the emergence of visual art had been coupled to the 'creative explosion' of the European Upper Paleolithic, some 40,00 years ago. Until the 1990s most of the examples of early art, specifically of representational imagery, came from that period, so it was assumed that it was then that modern humans acquired the capacity to 'think in symbols' and consequently to make art. This symbolic capacity, in turn, was usually associated with the emergence of syntax language, which purportedly marked the arrival of a new, 'modern' mode of cognition (Mithen, 1996). An outcome of 'creative explosion' models was the assumption that extinct hominins and even the earliest members of our own species lacked symbolic thought, language, and art-making abilities.

An increasing amount of recent archaeological finds, especially related to Neanderthals, now indicates that there is greater cognitive and behavioral continuity between 'premodern' and modern human populations than assumed by those models (Villa & Roebroeks, 2014). Besides having big brains, complex technologies, and intricate social lives (Roebroeks & Soressi, 2016), there is evidence that Neanderthals also had an array of behaviors that until recently were thought to be unique to modern humans. Among others, controlling fire (Henry, 2017), producing composite tools (Niekus et al., 2019), rope-making (Hardy et al., 2020), creating and visiting ritual spaces (Jaubert et al., 2016; Pitarch et al, 2021), exploiting ochre minerals (Roebroeks et al. 2012), and producing visual symbolism (Hoffmann et al., 2018; Leder et al., 2021; Rodriguez et al., 2014). In addition, a strong case is slowly building for the potential linguistic ability of extinct hominins, perhaps going back to the assumed last common ancestor of Neanderthals and *H. sapiens*, *H. erectus*, some half a million years ago (Barham & Everett, 2020; Conde et al., 2021; Dediu and Levinson, 2018). These finds have generated important questions about the pace and form of modern cognitive evolution, for example related to what cognitive traits are unique to *H. sapiens*, and which were shared with extinct hominins (Langbroek, 2012; Peeters & Zwart, 2020).

The Earliest Visual Art

Over the past twenty years, early *H. sapiens* occupations in Africa and the Levant have yielded the most significant evidence for art's origins since the discovery of European Paleolithic cave art. Finds of red ochre processing for pigment extraction and of personal ornament production dated to the African Middle Stone Age have pushed back the origins of art practices to at least 120,000 years BP (McDermott, 2021). Similarly, during the past decade several well-documented claims of Neanderthal art have come to light. Namely, involving personal ornaments (made

[1] See, for example: Bar-Yosef (2002); Gilman (1984); Henshilwood & Marean (2003); McBrearty & Brooks (2000); Mellars (1996); Roebroeks (2008).

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of shell, eagle talon, or feathers) and painted and engraved rock art (Hoffmann et al., 2018). But regardless of their interest, these finds have remained controversial, and if anything they still are few and far between. Admittedly, the same could be said for many of the symbolic artefacts associated with the early modern human populations of the MSA. So, what is needed are some criteria to determine whether those early finds should be interpreted as part of a systematic, culturally-transmitted visual art production.

A starting point could be that art, more than the result of a cognitive operation, is a cultural system. In addition to being socially shared, cultural traits are typically persistent, and variable within a population (van Schaik & Pradhan, 2003). So, if the artefacts in questions were part of a cultural system of art, they should appear as a recurrent practice in the archaeological record, and not only as an accumulation of isolated or 'one-off' cases. Therefore, continuity and/or recurrence in a constrained chrono-geographical span should work as inclusion criteria for early artworks. This would encompass, for example, forms occurring at more than one site within a limited time range (of at least 10,000 years for Pleistocene sites) and within a particular geographic region (suggesting widespread cultural practices); forms that occur at more than one archaeological level in one site (suggesting local transmission of cultural behavior over time); and, forms that are quantitatively significant at any given site or period (suggesting that they were used and/or produced by several individuals, i.e. a culturally shared behavior). When we apply these criteria to the earliest purported examples of visual art, most Neanderthal examples fall through. Prior to 40,000 BP most artistic output attributed to Neanderthal groups (up to now) are either more than 10,000 years apart or separated geographically by large distances (Zilhão et al., 2012). Whereas, there is slightly more temporal and spatial continuity in the early evidence associated to *H. sapiens* from 120,000 BP onwards.

This may indicate that even if extinct hominins, like the Neanderthals, were perfectly capable of creating visual art, it was *Homo sapiens* that consistently and systematically engaged in art-making. Of course it is possible that Neanderthals made art out of organic materials, painted their bodies, or created sand drawings, all of which would not have left any trace in the archaeological record. But based on the material evidence available to us, it seems that artistic traditions (as a culturally shared set of conventions and materials) remain to this point largely a *H. sapiens* phenomenon. Nevertheless, the traces of these practices among early modern humans are also somewhat discontinuous and even disappear from the record for extended periods of time (Straffon, 2019).

The paucity and slow spread of the earliest artworks within our own species presents a challenge for cognitive explanations which suggest that once the capacity for art-making evolves, it should become manifest quickly and abundantly throughout the record (Mithen, 1996). But this need not be the case. As Olga Soffer and Margaret Conkey pointed out, we must take into account the fundamental difference between the 'capacity for' and the actual 'performance of' a behavior (1997). What we need to find out is the contexts that make a behavior relevant. To achieve that, in this case, we should consider the possible function of art among Pleistocene human populations.

Art as Signaling

There are many different proposals about what the 'original' function of art might have been, e.g. pattern recognition (Zeki, 1999); mental problem-solving (Ramachandran & Hirstein, 1999); adaptive decision-making (Thornhill, 1998); increasing mating opportunities (Miller, 2000); supporting religious behavior (Irons, 2001); providing scenarios for action-planning (Tooby & Cosmides, 2001); social manipulation (Aiken 1998); social cohesion (Coe, 2003; Dissanakaye, 1992); and cognitive enhancement (Mithen, 2001), just to mention a few.

The only common element throughout all these different suggestions, as well as more 'traditional' views of art, is the idea that art is able to 'transmit', 'encode', 'store' or 'evoke' information, in other words, that art can serve for communication. The notion of art as communication has been a recurrent topic in anthropology, particularly within semiotic approaches which aim at decoding, measuring, or interpreting the 'messages' contained in art, which is seen as a medium of information or expression (Nowell, 2010). Often, the communicative function of art is presented either as self-evident (Lewis-Williams, 2002), or as a side-ffect of art media (Davidson, 2012). But why and how art communicates is something that should be explained, especially if it is championed as a uniquely-human behavior.

In order to understand what art does and how, rather than what it means, we can apply a biological communication approach. From the perspective of the ecology of communication, the focus is not on information and its exchange, but on how signals allow coordinating behavior between agents (Bunge, 1998). Communication is thus defined as a process that ultimately influences and guides the behavior of the organisms involved in it (Endler, 1993).

In previous work I have argued that, more than a cognitive operation, art in fact *is* a communication signal (Straffon, 2016). More specifically, a signaling system displayed in material culture or, signaling in artefact mode (Wobst 1977).

The effectiveness of communication systems is usually dictated by the fit between signal and response (Endler, 1993). To be effective, signals must be detectable, they must be in tune with the sensory and cognitive systems of emitter and receiver, and they must stand out in the signaling environment. Signals, therefore, are usually under selection to increase their detectability, discriminability, and memorability (Gilford & Dawkins, 1991), for which they often make use of the organism's pre-established perceptual capacities and biases (Krebs & Dawkins, 1984). Typical signal properties include redundancy, conspicuousness, stereotypy, contrast, pattern, novelty and exaggeration,

which incidentally are often listed among the core characteristics of artworks (Dissnayake, 2007; Dutton, 2009).

Art certainly is compatible with the definition of a communication signal. It is a stimulus intentionally emitted to convey information to others (about the sender or the environment) and influence their behavior. Furthermore, art is clearly coupled to human visual perceptive and affective systems (Verpooten & Nelissen, 2010). Furthermore, art manipulates the material properties of objects to stimulate bio-cultural biases that in turn make the objects increasingly detectable, discernible, and memorable, and thus effective as signals (Eibl-Eibesfeldt, 1988). Very possibly, visual art emerged out of the convergence of pre-existing behaviors in the hominin lineage like playful exploration, symbol use, and artefact production, innovatively exploiting aesthetic and affective resources for communication purposes.

Now I turn to the question of the context in which signaling through material culture would have been relevant for Pleistocene humans. Some clues may be found in ethnography. So far, the earliest forms of visual artistic behavior found in the archaeological record are the production of red pigment and the use personal ornaments, such as beads made of out of small shells. These beads have been found across the African continent and the Levant and their use may go back as far as 140,000 years ago (Sehasseh, 2021). Similar types of practices and ornaments are found among many present-day hunter-gatherers and small-scale societies, where they play an important role in mediating social interactions.

On this basis, various scholars have suggested that visual art originated as a means of expressing identity (Kuhn & Stiner, 2007; White, 1993), for instance membership to a certain group or class (e.g. age group, gender, position, status, occupation, etc.). But we still need to explain why signaling identity would have mattered at all, and how material culture became a medium for it. Many primates rely only on facial and vocal recognition to manage their complex social lives. Humans, in addition, can identify themselves through language, and have the ability to remember the faces and names of hundreds of other people (Haxby et al., 2002) so, why use artefacts to communicate identity? Moreover, if these were effective signals, why is their presence intermittent in the early record?

As a possible answer, I revisit the idea that signals of social identity help mediate cooperative interactions (Straffon, 2016; Wiessner, 1983).

The Context and Function of Early Art

Many aspects of modern human subsistence, resource exploitation, and reproduction, among others, depend on the successful collaboration between several (related and unrelated) individuals. Therefore it has been suggested that human survival, particularly over evolution, largely hinges on choosing the right cooperation partners and being chosen as a worthy partner (Tomasello & Vaish, 2013). This promotes the necessity to encode information about 'who did what' and to remember such knowledge over long periods of time (Aureli et al., 2008). Individual recognition is a key mechanism in cooperative interactions, as it allows to monitor and recall the behavior of various partners simultaneously (Crowley et al., 1996). However, this capacity is constrained by memory, so the number of cooperative relations one is able to keep track of is cognitively limited (Dunbar 1992; Gärdenfors et al., 2012; Rossano, 2010).

Even in contemporary industrialized societies, day-to-day exchanges still revolve around a small personal network (Emler, 1990). At the same time, people frequently interact and cooperate at a much larger scale (e.g. trade and exchange networks, information sharing networks, institutions, corporations, etc.). In the latter, contacts are often indirect, rather than face-to-face, which imposes pressure on memory, as in large groups it becomes hard to oversee the behaviour of every individual (Suzuki & Akiyama, 2005). The fact that, despite the constraints of memory and space, people are able to cooperate at such large scales, suggests that modern humans have developed strategies to economize cognitive processing and overcome its limitations. Some strategies may have been cognitive, such as thinking in 'categories' (Coward & Gamble, 2008), whereas others may have been cultural, like using social markers or emblems to denote group membership (McElreath et al., 2003).

Given that personal ornaments are known to convey identity in modern humans, it is likely that the earliest examples of visual art, such as the ancient shell beads, arose not as a product of increasing mental ability, but in fact as a cultural strategy to relieve human cognitive constraints when dealing with social networks beyond a certain threshold. Social markers such as dialects (Nettle & Dunbar, 1997) and material culture styles (Wobst, 1977) convey information about the identity of a person or a group, helping to recall social relations without having to keep track of each actor individually.

Social markers, however, have a minimum efficiency value. At the level of the intimate network they are unnecessary because in these small groups, identity is a constant (Dugatkin, 2002). In contrast, when network size grows and brief interactions with strangers increase, the group becomes too large for individuals to manage by direct personal interactions. It is in this context that social markers may become useful and necessary. As Wobst suggested (1977), social markers work best among strangers at a 'middle distance' of social relations, that is, individuals who share the same cultural 'codes', but do not know each other personally (Gärdenfors et al., 2012; Kuhn & Stiner, 2007). At this 'middle distance', social information becomes clearly important for deciding whether or not to interact and cooperate.

In this way, early visual art in the form of personal ornaments culturally extended human memory capacity, allowing Pleistocene groups to expand their cooperative

networks, and helping manage emerging social relations beyond the immediate familiar group.

A Material Culture Perspective

In her work with San hunter-gatherers, Polly Wiessner noticed that the items of material culture that effectively portrayed individual identity were visible personal utensils and body ornaments (Wiessner, 1983). In addition, she observed that the labor invested in 'artifying' an object not only added aesthetic appeal but also signaled the positive personal qualities of the maker, such as initiative and skill, which are traits that are sought-after in a cooperative partner. Therefore, displaying visually attractive items on the body, such as shell beads, would be highly suitable for the function of signaling one's identity while simultaneously advertising one's positive qualities to potential collaborators. Another advantage of signaling identity through visible social markers like body ornaments is that it reduces the risk of aggression from strangers, who are able to tell at a glance whether the unfamiliar individual is an ally or a foe, helping foresee and avoid potential conflict (Eibl-Eibesfeldt, 1988; Kuhn & Stiner, 2007).

The proposal that early personal ornaments arose as a cultural strategy to mediate relations in emerging cooperative networks beyond the intimate group seems to fit the observation that the appearance of beads correlates with increases in group sizes and the intensification of interactions throughout the Pleistocene. For most of human evolution, people interacted only in small networks, for example in a (extended) family unit, within which every member knew each other well, so there was no strong pressure for signaling identity. Consequently, we would not expect to find evidence for social markers. However, whenever these small groups started interacting more frequently and with more distant groups, the subtle signaling of individual identities through personal ornamentation became relevant, leaving a tangible trace in the archaeological record.

The evidence from the African Middle Stone Age indicates that personal ornaments were the earliest type of visual art to develop among Pleistocene modern humans and that, in turn, this development correlated with the establishment of extended cooperative relations beyond the small, local family group (Straffon, 2016).

As human populations turned larger and more expanded across the globe, more intensive interactions between social networks likely favored the emergence of collective identities and art forms. Eventually, these larger populations could support the specialization of art making practices, allowing for the development of complex artistic traditions like standardized image-making of the sort that we see in the rock art of the European Upper Paleolithic.

This renders a two-stage model for the development of visual art practices. The first arose when it became important to signal individual identity in order to establish and manage relations in a cooperative network larger than the (extended) family group. In the second stage, cooperative networks expanded in number and across space, creating a niche for collective identities displayed in regional material culture styles. This two-stage model for the evolution of art is consistent with the late Pleistocene record, where personal ornaments are the earliest predominant form, and more labor-intensive, collective forms such as representational art traditions appear only at a later moment (Straffon, 2019). Indeed, the emergence of collective forms of art such as regional styles of material culture and imagery do not appear until the Late Stone Age in Africa and the late Aurignacian in Europe, respectively, alongside growing population densities and traces of increased contact between distantly related groups.

Situating the emergence and development of art in the social interactions of modern humans can potentially explain the relative rarity of visual art behavior among the earliest members of *Homo sapiens* and also among our closest extinct relatives, the Neanderthals, without having to invoke substantial cognitive differences between them.

It is likely that both extinct hominins and the earliest *H. sapiens* lived in small communities where everyone knew each other and interacted on a regular basis. Even if signals of identity were present, these probably consisted of practices that did not require investing in durable materials and laborious techniques. Small group sizes would have acted as a behavioral (not cognitive) constraint on the development of a cultural system of art. Without regular interactions beyond the small network, there is little chance that signaling through aesthetic material culture would have been significant among either Neanderthal or early *Homo sapiens* populations. This may well explain why the systematic production of visual art is largely associated to our species, and only relatively late in our evolution.

Conclusion

In this paper I have attempted to clarify why, despite all the evidence pointing to the high cognitive and behavioral complexity of extinct hominins, visual art remains a behavior closely related to *H. sapiens*. The explanation, I suggest, need not invoke differences in cognitive ability but may in fact be found in the types of social interactions that characterize these populations and the role that visual artworks could have played in such relations. Up to now, the evidence indicates that during the late Pleistocene, modern humans started cooperating at scales that required the development of cultural strategies to identify and remember individuals beyond the familiar group. This likely created a new niche for artefacts as social markers, resulting in the emergence of personal ornaments, first, and of regional traditions of style and representational art, later. This is consistent with the idea that visual art can be understood as a human signaling system that exploits species-specific perceptual biases alongside our propensity to produce material culture to support communication.

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References

Anderson, R. L. (1992). Do Other Cultures Have "Art"? . *American Anthropologist, 94*(4), 926-929.

Bar-Yosef, O. (2002). The Upper Paleolithic Revolution. *Annual Review of Anthropology, 31*, 363-393.

Apicella, C. L., Marlowe, F. W., Fowler, J. H., & Christakis, N. A. (2012). Social networks and cooperation in hunter-gatherers. *Nature, 481*(7382), 497-501.

Aureli, F., Schaffner, C. M., Boesch, C., Bearder, S. K., Call, J., Chapman, C. A., et al. (2008). Fission-Fusion Dynamics. *Current Anthropology, 49*(4), 627-654.

Barham, L., & Everett, D. (2020). Semiotics and the origin of language in the Lower Palaeolithic. *Journal of Archaeological Method and Theory*, 1-45.

Bunge, M. (1998). Semiotic systems. *Systems: New Paradigms for the Human Sciences, Gabriel Altmann and Walter A. Koch (eds.)*, 337-349.

Coe, K. (2003). *The Ancestress Hypothesis: Visual art as adaptation*. New Brunswick, NJ: Rutgers University Press.

Conde-Valverde, M., Martínez, I., Quam, R. M., Rosa, M., Velez, A. D., Lorenzo, C., Jarabo, P., Bermudez de Castro, J.M., Carbonell, E. & Arsuaga, J. L. (2021). Neanderthals and Homo sapiens had similar auditory and speech capacities. *Nature Ecology & Evolution*, *5*(5), 609-615.

Coward, F., & Gamble, C. (2008). Big brains, small worlds: material culture and the evolution of the mind. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1499), 1969-1979.

Crowley, P. H., Provencher, L., Sloane, S., Dugatkin, L. A., Spohn, B., Rogers, L., et al. (1996). Evolving cooperation: the role of individual recognition. *BioSystems, 37*(1), 49-66.

d'Errico, F., Henshilwood, C., Lawson, G., Vanhaeren, M., Tillier, A.-M., Soressi, M., et al. (2003). Archaeological evidence for the emergence of language, symbolism, and music–an alternative multidisciplinary perspective. *Journal of World Prehistory, 17*(1), 1-70.

Davidson, I. (2012). Symbolism and becoming a hunter-gatherer. *Bull. de la Société Préhistorique Ariège-Pyrénées, 65*, 1689.

Dediu, D., & Levinson, S. C. (2018). Neanderthal language revisited: not only us. *Current Opinion in Behavioral Sciences, 21*, 49-55.

Dissanayake, E. (1992). *Homo Aestheticus: Where Art Comes From and Why*. New York: The Free Press.

Dissanayake, E. (2007). What Art Is and What Art Does: An overview of Contemporary Evolutionary Hypotheses. In C. Martindale, P. Locher & V. M. Petrov (Eds.), *Evolutionary and neurocognitive approaches to aesthetics, creativity, and the arts* (pp. 1-14): Baywood Pub. Co.

Dissanayake, E. (2009). The artification hypothesis and its relevance to cognitive science, evolutionary aesthetics, and neuroaesthetics. *Cognitive Semiotics, 5*(fall2009), 136-191.

Dugatkin, L. A. (1992). Sexual selection and imitation: females copy the mate choice of others. *The American Naturalist, 139*(6), 1384-1389.

Dunbar, R. I. (1992). Neocortex size as a constraint on group size in primates. *Journal of Human Evolution, 22*(6), 469-493.

Dutton, D. (2009). *The Art Instinct: Beauty, Pleasure and Human Evolution*. New York: Bloomsbury Press.

Eibl-Eibesfeldt, I. (1988). The biological foundation of aesthetics. *Beauty and the brain. Biological aspects of aesthetics*, 29-68.

Emler, N. (1990). A social psychology of reputation. *European review of social psychology, 1*(1), 171-193.

Kuhn, S. & Stiner, M. (2007). Body ornamentation as information technology: towards an understanding of the significance of early beads *Rethinking the human revolution* (pp. 45-54).

Endler, J. A. (1993). Some General Comments on the Evolution and Design of Animal Communication Systems. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 340*(1292), 215-225.

Gärdenfors, P., Brinck, I., & Osvath, M. (2012). The Tripod Effect: Co-evolution of Cooperation, Cognition and Communication *The Symbolic Species Evolved* (pp. 193-222): Springer.

Gilman, A. (1984). Explaining the Upper Palaeolithic Revolution. In M. Spriggs (Ed.), *Marxist Perspectives in Archaeology* (pp. 115-126): Cambridge University Press.

Guilford, T., & Dawkins, M. S. (1991). Receiver psychology and the evolution of animal signals. *Animal behaviour, 42*(1), 1-14.

Hardy, B. L., Moncel, M. H., Kerfant, C., Lebon, M., Bellot-Gurlet, L., & Mélard, N. (2020). Direct evidence of Neanderthal fibre technology and its cognitive and behavioral implications. *Scientific Reports, 10*(1), 1-9.

Haxby, J., Hoffman, E., & Gobbini, M. I. (2002). Human neural systems for face recognition and social communication. *Biological Psychiatry, 51*(1), 59-67.

Henry, A. G. (2017). Neanderthal cooking and the costs of fire. *Current Anthropology, 58*(S16), S329-S336.

Henshilwood, C. S., & Marean, C. W. (2003). The origin of modern human behavior. *Current Anthropology, 44*(5), 627-651.

Hill, R. A., & Dunbar, R. I. (2003). Social network size in humans. *Human nature, 14*(1), 53-72.

Hoffmann, D. L., Standish, C. D., García-Diez, M., Pettitt, P. B., Milton, J. A., Zilhão, Alcolea González, J.J., Cantalejo Duarte, P., Collado, H., de Balbín, R.,

Lorblanchet, M., Ramos Muñoz, J., Weniger, C.Chl, and Pike, A. (2018). U-Th dating of carbonate crusts reveals Neandertal origin of Iberian cave art. *Science*, *359*(6378), 912-915.

Irons, W. (2001). Religion as a hard-to-fake sign of commitment. *Evolution and the capacity for commitment*, *292309*.

Jaubert, J., Verheyden, S., Genty, D., Soulier, M., Cheng, H., Blamart, D., & Edwards, R. L. (2016). Early Neanderthal constructions deep in Bruniquel Cave in southwestern France. *Nature*, *534*(7605), 111-114.

Krebs, J. R., & Dawkins, R. (1984). Animal signals: mind-reading and manipulation. *Behavioural Ecology: an evolutionary approach*, *2*, 380-402.

Langbroek, M. (2012). Trees and ladders: A critique of the theory of human cognitive and behavioural evolution in Palaeolithic archaeology. *Quaternary International*, *270*, 4-14.

Leder, D., Hermann, R., Hüls, M., Russo, G., Hoelzmann, P., Nielbock, R., Bohner, U., Lehmann, J., Meier, M., Schwalb, A., Troller-Reimer, A., Koddenberg, T. & Terberger, T. (2021). A 51,000-year-old engraved bone reveals Neanderthals' capacity for symbolic behaviour. *Nature Ecology & Evolution*, *5*(9), 1273-1282.

Lewis-Williams, D. (2002). *The Mind in the Cave. Consciousness and the Origins of Art.* London: Thames & Hudson.

McBrearty, S., & Brooks, A. S. (2000). The revolution that wasn't: a new interpretation of the origin of modern human behavior. *Journal of Human Evolution*, *39*(5), 453-563.

McDermott, A. (2021) What was the first "art"? How would we know?. *Proceedings of the National Academy of Sciences*, 118 (44) e2117561118; DOI: 10.1073/pnas.2117561118

McElreath, R., Boyd, R., & Richerson, P. (2003). Shared norms and the evolution of ethnic markers. *Current anthropology*, *44*(1), 122-130.

Mellars, P. (1996). *The Neanderthal legacy: an archaeological perspective from western Europe*: Princeton University Press.

Miller, G. (2000). *The Mating Mind: How sexual choice shaped the evolution of human nature*. London: Heinemann.

Mithen, S.J. (1996). *The prehistory of the mind: the cognitive origins of art, religion and science*: Thames and Hudson.

Mithen, S.J. (2001). The Evolution of Imagination: An Archaeological Perspective. *SubStance*, *30*(94/95), 28-54.

Nettle, D., & Dunbar, R. (1997). Social Markers and the Evolution of Reciprocal Exchange. *Current Anthropology*, *38*(1), 93-99.

Niekus, M. J. T., Kozowyk, P. R., Langejans, G. H., Ngan-Tillard, D., van Keulen, H., van der Plicht, J., Cohen, K.M., van Wingerden, W., van Os, B., Smit, B.I., Amkreutz, L., Johansen, L., Verbaas, A., & Dusseldorp, G. L. (2019). Middle Paleolithic complex technology and a Neandertal tar-backed tool from the Dutch North Sea. *Proceedings of the National Academy of Sciences*, *116*(44), 22081-22087.

Nowell, A. (2010). Defining behavioral modernity in the context of Neandertal and anatomically modern human populations. *Annual review of anthropology*, *39*, 437-452.

Peeters, S., & Zwart, H. (2020). Neanderthals as familiar strangers and the human spark: How the 'golden years' of Neanderthal research reopen the question of human uniqueness. *History and philosophy of the life sciences*, *42*(3), 33.

Pitarch, A., Zilhão, J., d'Errico, F., Cantalejo-Duarte, P., Domínguez-Bella, S., Fullola, J. M., Weniger, G. & Ramos-Muñoz, J. (2021). The symbolic role of the underground world among Middle Paleolithic Neanderthals. *Proceedings of the National Academy of Sciences*, *118*(33).

Ramachandran, V. S., & Hirstein, W. (1999). The science of art: A neurological theory of aesthetic experience. *Journal of consciousness Studies*, *6*(6-7), 6-7.

Roberts, S. G., Dunbar, R. I., Pollet, T. V., & Kuppens, T. (2009). Exploring variation in active network size: Constraints and ego characteristics. *Social Networks*, *31*(2), 138-146.

Roebroeks, W. (2008). Time for the Middle to Upper Paleolithic transition in Europe. *Journal of Human Evolution*, *55*(5), 918-926.

Roebroeks, W., Sier, M. J., Nielsen, T. K., De Loecker, D., Parés, J. M., Arps, C. E., et al. (2012). Use of red ochre by early Neandertals. *Proceedings of the National Academy of Sciences*, *109*(6), 1889-1894.

Roebroeks, W., & Soressi, M. (2016). Neandertals revised. *Proceedings of the National Academy of Sciences*, *113*(23), 6372-6379.

Rodríguez-Vidal, J., D'Errico, F., Pacheco, F. G., Blasco, R., Rosell, J., Jennings, R. P., Queffelec, A., Finlayson, G., Fa, D.A., Gutiérrez López, J.M., Carrión, J. S., Negro, J.J., Finlayson, S., Cáceres, L.M., Bernal, M.A., Fernández Jiménez, S. and Finlayson, C. (2014). A rock engraving made by Neanderthals in Gibraltar. *Proceedings of the National Academy of Sciences*, *111*(37), 13301-13306.

Rossano, M. J. (2010). Making friends, making tools, and making symbols. *Current Anthropology*, *51*(S1), S89-S98.

Sehasseh, E. M., Fernandez, P., Kuhn, S., Stiner, M., Mentzer, S., Colarossi, D., Clark, A., Laone, F., Pailes, M., Hoffmann, D., Benson, A., Rhodes, E., Benmansour, M., Laissaqui, A., Ziani, I. Vidal, P. Morales, J., Djellal, Y., Longet, B., Hublin, J.J., Mouhddine, M., Rafi, F., Worthley, K.B., Sanchez, I., Ghayati, N. & Bouzouggar, A. (2021). Early Middle Stone Age personal ornaments from Bizmoune Cave, Essaouira, Morocco. *Science Advances*, *7*(39), eabi8620.

Soffer, O., & Conkey, M. W. (1997). Studying ancient visual cultures. *Beyond art: Pleistocene image and symbol*, 1-16.

Straffon, L. M. (2016). Signaling in style: On cooperation, identity and the origins of visual art. In *Understanding cultural traits* (pp. 357-373). Springer, Cham.

Straffon, L. M. (2019). Evolution and the origins of visual art: an archaeological perspective. In *Handbook of Evolutionary Research in Archaeology* (pp. 407-435). Springer, Cham.

Suzuki, S., & Akiyama, E. (2005). Reputation and the evolution of cooperation in sizable groups. *Proceedings of the Royal Society B: Biological Sciences*, *272*(1570), 1373-1377.

Tomasello, M., & Vaish, A. (2013). Origins of human cooperation and morality. *Annual review of psychology*, *64*, 231-255.

Tooby, J., & Cosmides, L. (2001). Does Beauty Build Adapted Minds? Towards an Evolutionary Theory of Aesthetics, Fiction and the Arts. *SubStance*, *94/95*, 6-27.

van Schaik, C., & Pradhan, G. (2003). A model for tool-use traditions in primates: Implications for the coevolution of culture and cognition. *Journal of Human Evolution*, *44*(6), 645-664.

Verpooten, J., & Nelissen, M. (2010). Sensory exploitation and cultural transmission: the late emergence of iconic representations in human evolution. *Theory in Biosciences*, *129*(2), 211-221.

Villa, P., & Roebroeks, W. (2014). Neandertal demise: an archaeological analysis of the modern human superiority complex. *PLoS one*, *9*(4), e96424.

Wadley, L. (2001). What is cultural modernity? A general view and a South African perspective from Rose Cottage Cave. *Cambridge Archaeological Journal*, *11*(2), 201-221.

Wiessner, P. (1983). Style and Social Information in Kalahari San Projectile Points. *American Antiquity*, *48*(2), 253-276.

White, R. (1993). Technological and Social Dimensions of 'Aurignacian-age' Body Ornaments across Europe. In H. Knecht, A. Pike-Tay & R. K. White (Eds.), *Before Lascaux: The Complex Record of the Early Upper Paleolithic* (pp. 277-299): CRC Press.

Wobst, H.M. (1977). Stylistic Behavior and Information Exchange. In C. E. Cleland (Ed.), *For the Director: Research essays in honor of James B. Griffin*. Ann Arbor, MI: Museum of Anthropology, University of Michigan.

Zeki, S. (1999). *Inner vision: an exploration of art and the brain*: Oxford University Press.

Zilhão, J. (2012). Personal ornaments and symbolism among the Neanderthals. In *Developments in Quaternary Sciences* (Vol. 16, pp. 35-49). Elsevier.