Editorial

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Art and the Brain: Archaeological Perspectives on Visual Communication

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Abstract: This issue of the journal developed from interest generated around a conference held in Cambridge entitled Art and the Brain, which examined how human neurophysiological capacities are exemplified by early art. This is a theme of great interest today, with attention focused on the ability to produce art as one of the defining characteristics of fully modern human beings, since their emergence in Africa 100,000 years ago, and the desire to understand the role of art in the story of human evolution.

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> 'Art stimulates this mental synthesis within the viewer. The memory process is engaged as the painting elicits the viewer's stored, long-term unconscious memories and puts them into dialogue with conscious short-term memory. This actualisation is to some extent open-ended and polysemic, also dependent on the cultural identity of its audience and its recourse to long-term cultural memory' (Nalbantian, 2008, pp. 359–360).

The creative processes that lead to the production of visual communication are based on two main aspects: first, the capacities of our modern human bodies and brains; and second, the cultural contexts that impact on how these capacities are utilised in the creation of visual art.

Definitions of art, like art itself, are often in the eye of the beholder. For the purposes of this collection of papers on archaeological case studies of visual communication, we propose the following: art is a creative process resulting in productions regarded as appealing sometimes beautiful, maybe even sometimes ugly, that challenge the viewer to think about their place in the world.

This issue of the journal developed from interest generated around a conference held in Cambridge entitled Art and the Brain, which examined how human neurophysiological capacities are exemplified by early art. This is a theme of great interest today, with attention focused on the ability to produce art as one of the defining characteristics of fully modern human beings, since their emergence in Africa 100,000 years ago, and the desire to understand the role of art in the story of human evolution (cf, Janik, forthcoming; Onians, 2010; Renfrew, 2008). Some of the contributions to this special issue are based on papers presented at the conference and others were specially commissioned to ensure as wide a range as possible of specifically archaeological approaches to early art.

Rather than asking our authors to focus on what part of the brain is responsible for the creation of art and the communication of visual messages, themes already covered in a number of books and papers

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(cf. Livingstone, 2002; Shimamura, 2013; Zeki, 1999; Wagemans et al., 2012), we suggested that they address how particular attributes of visual cognition were used by our ancestors, and in what contexts these attributes were engaged. Discussion at the Cambridge conference highlighted the need to understand the role of cultural context in the creation of art, given what is known of the neuroscientific capacities that are drawn on by artists. Seeing is dependent on the way light enters the human eye and the stimulation of particular parts of the brain by electrical impulses. But how we make sense of what we see is based on knowledge generated through our life histories, and that knowledge that is culturally constituted. This allows us to set similar images in different contexts, including social, religious or economic, where the creation of visual communication is the basis for the cultural categorisation of the world by artists.

Visual communication and expression are responses to impulses/influences experienced by artists, including in ancient times: 'I am conscious of my body via the world' (Merleau-Ponty, 2002, p. 82). We know, however, that experiencing the world is not a passive process: the world influences us and we, by living, influence the world we live in (Bourdieu, 1977, 1992). By acknowledging this recursive relationship, we recognise that each context is unique and specific to particular communities and cultures. Therefore, despite the use of similar neurophysiological capacities in the creation of images that appear to look similar, their meaning differs because they are made in different worlds, at different times and places (Janik, 2013, 2014). In this way we hope to build an awareness of how human neurophysiological capacities were used in the context of the creation of ancient art. To do this we concentrate on two aspects: colour and line.

Each of our brains are unique, but at the same time they are all structured in the same way. As Ratey explains:

> 'the hind-brain at the top of our spinal cord, which controls sensation and movement of the muscles of our face and throat; the mid brain, farther into the centre of the head, which deals with some movement of the eyes and some rudimentary hearing and vision; and the forebrain, which achieves its most glorious development in human beings and which contains cerebral matter fibres connecting neurons of the cortex with each other and with other neurons, as well as those areas deep in the centre of the brain that coordinate automatic sensory and motor functions' (Ratey, 2002, p. 22).

The area of the brain responsible for vision is located in the back, and is indicated by scientists by the letter V (Fig. 1). This region is divided into a number constituent parts responsible for distinguishing colour, shape, motion, object and facial recognition. The capacity for *making sense* of what we see is located in other parts of the brain, for example in the areas responsible for memory or emotions.

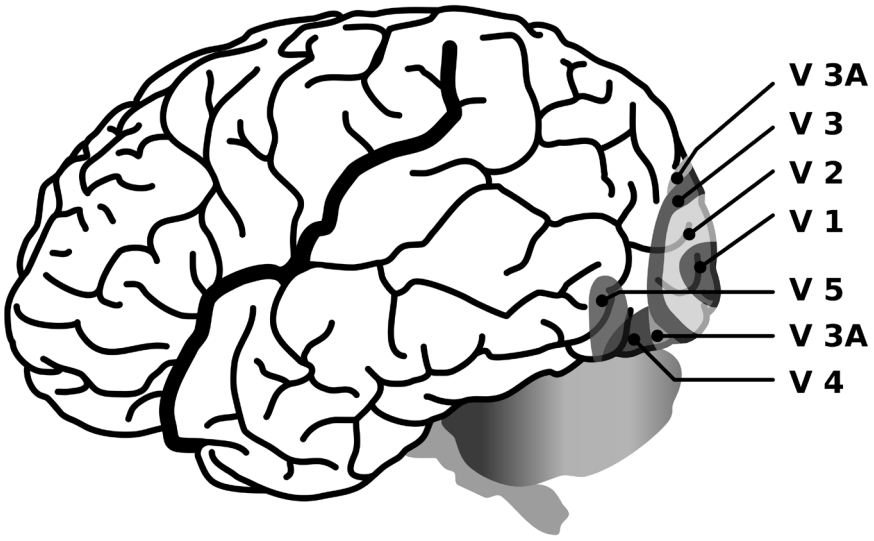

Figure 1. Areas of the brain relating to visual cognition.

1 Colour

Colour is of primary importance in allowing humans to make sense of what we see. Distinguishing colours begins with the process whereby light reflected from objects enters our eyes, in the form of waves that vary depending both on the area reflecting it and the area itself. The colours we see are determined by the length of these waves of light while moving through the photoreceptors, cones located in the eye's retina. Humans respond to light with wavelengths between 4000 and 7000 nanometres, and these six million or so cones distinguish between long, medium and long wavelengths, determining what colour we see: as humans we respond best to the range from yellow to red (Livingstone, 2002). Interestingly, this is the colour spectrum widely used by our ancestors a hundred thousand years ago (Barham, 2002; McBrearty & Brooks, 2000; Morris-Kay, 2010; Watts, 2016). It is difficult to say if the use of these colours resulted from cultural preferences or from biological sensitivity to the light spectrum – but this is comparable to the question of which came first, the chicken or the egg. We suggest that one reinforced the other, i.e. red was favoured because it was most the visible colour. But we must remember about the characteristics of blue, a colour not employed by Palaeolithic artists. Humans see blue best in low light conditions, due to the way rods located alongside the cones in the eye play a role in luminescence, responding to the brightness of light (Livingstone, 2002).

If we follow arguments that give priority to neurophysiological capacities in the choice of particular colours, and then link specific colours to other cultural categories, for example red and danger (Gage, 2006; Shimamura, 2013; Zarkadi & Schnall, 2013), we face something of a conundrum over why blue was not used by prehistoric artists. It could be argued that blue pigment was not easily available to communities in prehistory. Unlike red, yellow, black or white, blue is a difficult colour to generate since its source is mainly mineral based and it is not widely available, as are ochre (red) or charcoal (black). The paper by Bedford et al. shows how some blue effects can be achieved through the use of 'optical blue', for example by mixing a grey pigment such as clay or gypsum, mixing it with charcoal and placing it alongside yellow or red, generating an effect perceived by the human eye as blue (Campbell, 2007). So there was a way for prehistoric artists to create blue.

While visibility was important to the prehistoric artists who placed images on the dark spaces of cave walls, so were the meanings captured in the designs and use of specific colours. Through the development of image making and visual communication, did how these images look and the meanings they were intended to convey take priority for these artists, or was it of greater significance just to ensure that they were visible in the gloom, however constrained by our neurophysiological capacities. The way in which 'optical blue' was used by the Emigdiano Chumash at the site of Three Springs in South Central California (late 1700s to early 1800s AD) as suggested by Bedford et al., shows how the Chumash chose to use 'optical blue', despite having access to minerals that could be used in production of real blue. This study indicates the importance of cultural preferences, the meaning and ways colour was produced by placing grey with yellow or red.

In a similar vein, Strong approaches the topic of how choices of colour were made in her study of the use of pigments in tomb paintings in ancient Egypt (c. 4,500–2,030 BP). She uses a variety of methods to examine the perception and choices of colours in the spectrum most visible to the human eye during the day, namely yellow and orpiment, made from ochre and arsenic sulphate respectively. Orpiment in particular had the luminous and sparkling properties of a rich gold colour. The colour yellow in ancient Egypt had divine connotations, and so seeing yellow/gold suggested underlying meanings of special importance.

A particularly interesting aspect of Strong's work are the experiments she carried out to establish what was used to light the space where the yellow/gold paintings were made. The best results were accomplished by the use of animal fats that produced a bright light with a flame without smoke, and practically no smell. Similarly, animal fat was used in illuminating the images of Palaeolithic caves such as Altamira and Lascaux (Aujoulat, 2005; Bahn, 2016; Perez-Seoane et al., 1999). Strong's experiments lead to the conclusion that the use of animal fat as a lighting source, itself yellowish-red, enhanced the parts of images painted in yellow/gold as if focusing the gaze of the viewer on this part of the composition. Furthermore, although the yellow painted surfaces were located in dark spaces, when illuminated, their visibility was heightened, over being seen in fluorescent or natural light. This is perhaps one reason why blue was not used in Palaeolithic cave

art, since illumination allowed the yellow-ochre painted images to communicate their visual messages in the strongest way. Strong's research and its possible extension to understanding aspects of Palaeolithic cave art show how human neurophysiological capacities influenced the development of visual communication through the millennia.

Two articles in this issue focus on the use of the colour red: Wolf et al. discuss the mineral substances used to achieve the desired effect, while Matsumoto addresses the earliest use of red colour, which involved mixing red pigment with a plant-based substance. Wolf et al. consider the spectrum from yellow to red, the light wavelength best seen by humans. Their paper presents some of the latest analyses of Palaeolithic art from the Swabian Jura, Germany, one of the richest regions in Europe for Palaeolithic visual representations, including anthropomorphic and zoomorphic figurines and musical instruments, dating back to over 30,000 years ago. Before presenting the archaeological data, Wolf et al. show how ochre, the key material used, was sourced. The use of ochre facilitated the production of the spectrum of colours ranging from yellow to red, the potential of which was first exploited by ancestors in Africa who used ochre as a pigment to paint marine shells worn as beads. The African cases prove the use of ochre prior to the occupation of Europe by Homo sapiens. Wolf et al. also present evidence for the early use of ochre in European contexts by Neanderthals as early as from between 250,000 and 200,000 years ago, indicating the widespread use of the yellow to red colour spectrum by different species of humans.

The Swabian material (c. 18,000 to 16,000 years BP) discussed is of great interest since it shows the visual power of contrasting colours. Red pigment, often in the form of lines made from multiple dots, is placed on a white background of white/lime based stones, thus increasing the red colour visibility and the responsiveness of the brain, which in turns makes the visual communication based on the stones decorated with red pigment a powerful visual signifier of the message the prehistoric artist intended to convey.

Matsumoto presents important information from prehistoric Japan relating to the use of both plant-based and mineral pigments in prehistory. The use of red colour based on substances extracted from plants and pigment obtained from iron oxide/ochre (northeastern Japan) and cinnabar (Hokkaido Island) was recorded for the first time during the Jomon period (c. 14,000–300 BP). Matsumoto's article presents the knowhow behind the extraction of plant substances (in this case the *urushi* or lacquer tree – *Toxicodendron vernicifluum*) and which are then mixed with coloured pigments, resulting in what is known to us as red lacquer (first recorded around 9,000 BP). What we see here is the choice to use a similar spectrum of colours as in the Swabian Jura. Matsumoto suggests that there might be independent origins for the exploitation of the *urushi* tree in Japan and in China. In Japan the earliest lacquer was used to colour threads and combs, objects of personal ornamentation, while in China lacquer was used to decorate hunting tools such as bows and parts of eating and drinking sets. Lacquer was used with objects made of both organic (wood, plant threads) and inorganic (clay pots and figurines) materials, very thin layers of lacquer being applied to their surfaces, sealing them against water penetration. This increased their survival chances in the archaeological record, and provides archaeologists with exceptional opportunities to see and experience these objects and the colours used, for example, in bodily adornment, all traces of which are normally lost. The red achieved by mixing modified resin coming from the *urushi* tree with iron oxide/ochre is a colour that in neurophysiological terms produces the strongest stimuli in our colour recognition abilities. Matsumoto offers a further intriguing suggestion that in the Jomon period in prehistoric Japan red was used as a form of visual communication in the context of symbolic artefacts. Red thus takes on a meaning that plays a particularly important role in social and ritual contexts.

2 Line

More important than seeing colour as a response to the notion of 'I am conscious of my body via the world' (Merleau-Ponty, 2002, p. 82) is the recognition of lines, since all shapes are created by a single line or putting a number of lines together. From the visual viewpoint every object we see distinguishes itself from other objects by its outline. We acknowledge these orders between things when making sense between visual noise and silence, when different elements 'compete' to be comprehended. The vital role in this process is

played by areas of the brain marked V1, V2 and V3. Four articles in this issue focus on lines and the ways they have been put together and interpreted. While they differ in terms of region, period and context of meaning, the uses of the line by prehistoric artists is very significant in understanding the relationship between neurophysiological capacities and the contexts of prehistoric art.

We often ask who were the artists who created the unforgettable images we encounter in the archaeological record. The answer, in most cases, is that we do not know and have no means to know. Cooney-Williams and Janik present one the few examples where we can trace artists, from the Palaeolithic cave art of France and Spain (c. 31,000–12,000 BP). By analysing finger flutings (marks on the cave walls made by fingers) they explore the idea of art being created through a process of 'situated learning', whereby through executing 'decorating of the walls', younger members of the community, even those of a very young age who were unable to understand the meaning of the flutings, took part in creative processes involved in the production and expression of biographical and social memory engaging the whole community. Furthermore, the evidence presented by Cooney-Williams and Janik suggests that young individuals were encouraged in this practice by being carried on the shoulders of taller community members to reach areas otherwise inaccessible to them. In this way, children were part of a 'community of practice' composed of different gender and ages, united by the acts of finger fluting.

Cooney-Williams and Janik also argue that traditional understanding of the role of 'special individuals', such as shamans, as creators of Palaeolithic art needs to be questioned, since children of all ages produced a variety of imagery, even in the deepest recesses of the caves. There were no 'private' spaces in the caves, but Cooney-Williams and Janik suggest that certain caves were 'private', entered by only a few people, in contrast to more 'public' caves that were frequented by higher numbers of individuals. This use of analysis of 'the line' provides visual clues going beyond neurophysiological human capacities, and allows us to examine early 'community art': who created it, where it was located and who looked at it.

Similarly, the article by Chisena and Delage considers the prehistoric artist, but the focus here is not on who was the artist but instead, what skills they had. They examine engravings considered to date from c. 14,500 BP made on limestone blocks from the rock shelter of La Marche, Lussac-les-Châteaux, Vienne, France, and analyse the skill employed in the execution of human imagery there. The engravings of humans from La Marche are fascinating from a number of perspectives: they offer a very rare opportunity to look at the prehistoric faces of the engraved – the depictions of faces were possibly inspired by members of the community the artists belonged to; and in addition to faces, these images depict clothing and body adornment.

It has been previously proposed that there were possibly three workshop groups employing lines in carving the images and defining individual artists. Chisena and Delage, however, suggest that it is unlikely that we can define such details in the images. What they propose instead is the idea of a workshop, where by examining the execution of lines it is possible to describe stages of skill and proficiency of the engravers. They conclude that overall sixteen people of different levels of skill created the images of humans: five were good engravers; skills of a further nine individuals could be categorised from medium to low; the final two individuals were young learners and their skills were very low. This innovative analysis shows how following lines can give clues about the skills of prehistoric artists, but also the ratio of skilled to unskilled engravers, which in turn can tell us about the way the community and the execution of tasks was organised many thousands of years ago.

Spikins et al. argue for the need to go beyond the community into the realm of broader society by examining the lines of Upper Palaeolithic (c. 50,000–10,000 BP) images and proposing that they were made by talented artists with autism. They suggest that realistic imagery such as the frieze of lions at Chauvet Cave was created by someone who was able to execute realistic depictions of animals, and was the result of work by an individual with a 'local processing bias'. This suggestion contradicts previous interpretations advocating the use of drugs in helping artists produce highly realistic and detailed depictions of animals. Through considering contemporary artists with similar conditions on the autistic spectrum, they conclude that this is most likely explanation for some of Palaeolithic art. This does not mean that individuals with such skills were categorised in a similar way as they would be today, but by taking into account the creative process and accomplishments of people with autistic traits, we need to consider the variety of people making

the most accomplished imagery in the past, just as we do in contemporary art. Once again, it is the notion of the line that provides clues as to not only who were the artists, but also to see people with particular cognitive skills that today would be characterised as those with 'autistic traits'. This paper thus provides a particularly apt analytical turn given the overall aim of this collection, namely through studying imagery we can learn about the brain, revealing aspects of the hypo-connectivity/enhanced functional connectivity between different brain network regions (Conti et al., 2015; Hillary & Grafman, 2017).

The final article in this special issue is also based on analysing lines. Batarda addresses the images located in the open air rock art sites at Côa Valley, Portugal, which contain art dating from c. 25,000 to 18,000 years BP. He develops a theoretical perspective based on the question of what is the role of rock art in negotiation, tension, subversion and ambiguity as forces in visual communication. Batarda focuses on the ways the carvings are interpreted in archaeology and how the engraved lines inform narratives, arguing for a diversity of interpretations and the need to be open to this diversity.

The Cambridge conference provided the opportunity to consider a range of themes relevant to understanding the complex interplay between art and the human brain. We are grateful to the McDonald Institute for Archaeological Research for providing the venue and for financial support, and we also acknowledge the support of the Sainsbury Institute for the Study of Japanese Arts and Cultures which allowed us to bring Dr Naoko Matsumoto to the conference. The papers in this special issue do not represent all the presentations made during two very stimulating days, and thank all of those who participated in the conference, and in particular Professor Emir Zeki and Professor Dana Arnold for their stimulating contributions on the day. Lastly, we would like to thank the editorial team at Open Archaeology for all of their encouragement, patience and assistance with this issue, and all of the reviewers for their insightful suggestions. We hope that this edited collection of papers will encourage further investigations in this fascinating field.

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