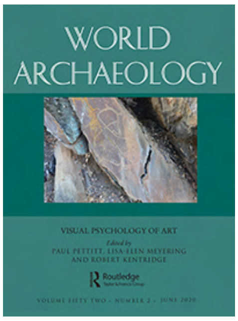

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ARTICLE

Prehistoric art as a part of the neurophysiological capacities of seeing. Examples from prehistoric rock art and portable art

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ABSTRACT
Colour, line, movement and face are discussed here as a part of the neurophysiological capacities of seeing. They are all integral parts of seeing and visual interpretation a part of the world we live in. Visual narratives conveyed via depictions allow imagery not only to represent things but also play active roles in story-telling. Prehistoric art surviving in caves and on rock surfaces, carved figurines, and the installation of the viewer into these are explored in terms of a joint relationship between the image/s and the way our brains work.

KEYWORDS
Sculpture; rock and cave art; contemporary art; neurophysiological capacities

In recent years the interest in the relationship between art and human cognition has increased significantly in prehistoric archaeology, based on a steady stream of new discoveries and advances in neuropsychology, research into the brain, and the cognitive sciences. Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and Positron Emission Tomography (PET) provide means to examine the brain, particularly with a view to establishing how particular visual stimuli affect particular parts of the brain. These advances provide archaeologists with a new means of understanding prehistoric visual imagery from its origins and the subsequent development of the creative process over the last 100,000 years or more.

The imagery of African visual culture, considered to be some of the oldest known, follows the general psychological principles involved in the creation of visual images, which encourage a focus on particular aspects of the composition, dependent on the brain processing visual stimuli in creating visual narratives. We can now interpret for the first time prehistoric art as a set of tangible visual expressions based on similar neurophysiological capacities shared by ourselves and our ancestors. We have to remember however, that the neuro/brain research perspective refers to both how and what we see as human beings, and the way different artists reflect the visual preferences of the cultures they live in.

Seeing as a process combines two essential elements; the neurophysiological capacities of our bodies, and the cultural preferences that give particular form to visual culture and which can be studied archaeologically as a part of the non-verbal communication employed by *Homo sapiens* and our cousins the Neanderthals. The combination of both creates the 'magic of art' from its earliest form to the contemporary world. Visual stories and visual-story telling became a major medium for keeping social, religious and symbolic narratives alive for and by the communities who produced them or who experienced them through physical proximity to their creators. Over time, I suggest,

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visual culture acted as an agent of change, by being part of the narratives and by creating them as an active medium of communication.

This paper is divided into three parts, each dedicated to particular aspects of prehistoric art: cave art, rock art and the so-called Mid-Upper Palaeolithic 'Venus figurines'. I will present neuroaesthetics in 'action' as an integral part of visual storytelling and the narrative itself through these examples. Although I concentrate on the art of prehistoric fisher-gatherer-hunters, this approach, focused as it is on the neuroaesthetics of seeing, can be applied to any period in any part of the world.

Seeing

Distinct regions of the brain react to different sensory stimuli, e.g. touch each responsible for making sense of what we do, hear, see or otherwise sense. *Seeing* is a response to electrical stimuli created by the light that enters our eyes and travels to the brain via the optic nerve. The image arrives upside-down due to the eye's round shape, and in simple terms the brain turns the image the right way around. The cerebral visual cortex – the area responsible for seeing in the brain – is to the rear (occipital) region of the brain, and is composed of two primary areas, V1 and V2, and number of smaller regions responsible, for example, for the perception of colour, face or movement (V3, V3a, V4, V5, V5a). The information mainly travels along two distinct routes: the 'how' pathway of the parietal lobe and the 'what' pathway of the temporal lobe. Vision, as with most brain functions, is distributed -sent to various brain regions to be processed- and then somehow bound together again as 'seeing' (Ratey 2002, 100).

Seeing is to make sense; interpreting what we see is linked to our previous experiences that are locked in our memory, and is related to the dorsal and ventral pathways. Memory is essential to the process of seeing, and it is unique to each of us, whether in the present or in the deep past. Memory is generated through learning, experiences and cultural preferences: these 'start in the area of V1 from where the ventral pathway travels to V4 and the temporal cortex, and deals with the fundamental question of "what" we see: faces, objects and colours. The second dorsal pathway travels to V5 and the parietal cortex and is responsible for the spatial location, "where": movement, the organization of space and the separation between objects and their background. As pointed out by Shimamura (2013), the recent discovery of the posterior parietal cortex allows us to understand the integrated role of both pathways that meet in this part of the brain, making sense from the regions responsible for auditory and haptic information, which in turn allow us to plan our actions while at the same time interpreting the world around us' (Janik 2020, 18). The whole process, from when light enters our eyes to making sense of what we see, takes only few milliseconds, hence to the individual it 'feels' instantaneous.

Cave art

Turning to Upper Palaeolithic Franco-Cantabrian figurative cave art (~37,000–12,000 years ago) we see that images are clearly defined depictions on the walls and ceilings of caves, produced by artists through the process of relaying elements of the neuroaesthetics of seeing, e.g. colour, line and motion, into a creative process of visual story-telling. Images were created using three principle colours; red, black and white, each made either stronger or weaker by the addition of contrasting pigment e.g. red darkened by the addition of black pigment. The brain region responsible for analysing colour is V4.

The three cones responsible for responding to light of short (S), medium (M) and long (L) wavelengths are situated in our eyes. The medium wavelength cones focus on green, and the long wavelength on red, producing the strongest physiological response to 'the yellow-to-red range of light spectrum' (Livingstone 2002, 27). This means that we are most visually alerted – i.e. respond most strongly to depictions made with colours within the yellow-to-red spectrum, which were commonly used in cave art and achieved by modifications to mineral pigments containing oxidized iron. The deliberate use of red pigment can be recognized as early as ~300,000 years ago in Africa (Barham 2002; McBrearty and Brooks 2000; Morris-Kay 2010) and ~250,000 years ago in Europe (Roebroeks et al. 2012). Recent dating of figurative rock art at Leang Bulu' Sipong 4, Sulawesi, Indonesia to ~43,900 years ago (Aubert et al. 2019) shows the use of red for a hunting scene in which pigs and a small bovid are apparently being hunted with spears and ropes by therianthropes (animal-like humans). The same colours were commonly utilized in Franco-Cantabrian Palaeolithic art e.g. at Lascaux, Chauvet and Altamira cave.

An opposite aspect of colour implementation is to place black pigment on white walls, relying on colour contrast to produce a visual opposition between the image and its setting. The colour white – 'a mixture of all wavelengths of visible light, or from a combination of appropriate quantities of red and cyan (a greenish blue) yellow and blue green, purple, or many other mixtures of appropriate light' (Livingstone 2002, 30) – reflects light, while by contrast black absorbs it. Hence the combination of both creates the perfect visual setting for *focusing* our gaze on an image, (as proven by this white page with black text printed on it), in accordance with the Gestalt principle. We see such contrasts very well. This relates to our neuroaesthetic capacity of seeing, utilized well by both prehistoric and contemporary artists as a means of capturing the attention of viewers, in the past and today.

It is particularly visible, for example, in the process of creating art on the Panel of Horses and Panel of Lions in Chauvet Cave, Ardèche (~32,000 years ago: Clottes 2003). Here, the surface of the wall was removed by scraping, for no reason but to provide a sharp white background on which to draw with charcoal bovines, horses and lions' heads, and hence to increase the their visibility by maximizing the contrast between figure and background (Figure 1).

As we see, prehistoric artists not only used the pigments most visible to us, but additionally utilized the contrast between colours as part of the neuroaesthetic capacities of seeing in order to produce the visual clues that alert viewers' brains to visually *focus* on the images of concern. As an interaction between the brain and cultural process, it is a way to guide attention.

What is striking however, is the apparent lack of the colour blue in the pallet of cave art. Blue is the colour we see the best in dark, due to the way that 'the cones are linked in distinguishing colour, the second photoreceptors located in our eyes are rods, of which each of us has around twelve million. They are responsible for defining the luminescence of light, understood as the brightness/lightness of light, which determines how we see colour in darkness. Rods do not follow the cones' ratio of responding 1 = S; 5 = M;10 = L wavelengths in allowing particular light to enter our brain. Instead they favour short wavelengths, allowing greater entry of light in the spectrum of blue (S) and green (M), which in practice means that we see blue better than red in the dark' (Janik 2020, 21).

If one imagines dark caves and our capacity to see blue best in the dark, we would expect that the obvious choice of colour to use in making images in caves would be blue. It can be argued that there were no suitable compounds available to derive the blue colour from, but I suggest that this is too simple an explanation. We know that the technological know-how of pigment modification possessed by early humans was extensive (Henshilwood and Dubreuil 2011), so the argument that blue

Figure 1. Panel of Lions, Chauvet Cave, (Ardèche, France). https://commons.wikimedia.org/wiki/File:Lions_painting,_Chauvet_Cave_(museum_replica).jpg.

pigment was simply not available is insufficient. Furthermore, we can see that a blue effect can be achieved without the use of specifically blue pigments, as seen for example in North American rock art (Bedford et al. 2018). XRF analysis of the pigments employed in producing the rock painting at Three Springs in the Wind Wolves Preserve in South Central California, US, allowed the authors to distinguish between the pigments use to create an optical – if not 'real' – blue. This optical blue was created by mixing black, white and other pigments to produce a grey. Placing this grey on the wall next to red or yellow colour (Campbell 2007) created the visual illusion of blue. All of these pigments – white, black, yellow and red – were available to the artists of Palaeolithic Europe, but they appear not to have utilized this particular trick.

To explain this lack of use of blue despite our physiological predisposition to see blue best in the dark, I suggest that a cultural preference of not using blue overwrote the physiological demands of seeing clearly in the dark. Cave art was of course only to be seen with the use of lit torches, lamps and hearths, animated light sources which cause the image to disappear with increasing distance from illuminating it. If the image was blue it would 'linger in the background' and the viewer would still see it in the distance.

From the perspective of the neuroaesthetic capacities of modern art we could say that prehistoric artists were Fauvists, the movement in modern art popular in early 20th century Paris characterized by the use of synthetic colours, often seen, for example, in paintings by Henri Matisse or André

Derain. The mammoth at Chauvet Cave created as a collage of red hand prints, red hyenas or the red bear create a response in: 'the V4 complex – apparently only concerned with constructing colours to any particular objects – is active. But there any similarity between this and the preceding experiments ends. In the Fauvist experiment there is no hippocampal activity and the activity in the frontal cortex in not located in the same zone as that produced when we view natural colours; instead it is located in the middle frontal convolution. This is not to imply that the middle frontal convolution is given over exclusively to the perception of objects when they are invested with unnatural colours, and certainly not to the Fauvist works of art. It is more likely that it is the element of the unnatural that is activating a different part of the frontal lobe – often referred as a monitoring station . . . ' (Zeki 1999a, 201). By understanding the way the brain works today we are able to learn about the brains of prehistoric artists and Palaeolithic imagery. *Seeing the colour red focuses our attention of particular image or part of the composition, while the wall provides the contrasting background for seeing 'better', what makes the images stand out to be seen very well with the use of artificial light of a torch* (Figure 2).

Although the red pigment was used to create images of mammoth, hyena or bear, we do not really know if it was the preferred colour of the individual artist or if it signified cultural meaning (Lackoff and Johnson 1999; Gage 2006; Shimamura 2013; Zarkadi and Schnall 2013), or it related to neurophysiological capacity of seeing.

The line is an integral element of cave art, as is another part of our neurophysiological capacity of seeing. We see lines all around us, not simply as visual trajectories connecting two points in space

Figure 2. Hyenas. Chauvet Cave, (Ardèche, France). https://commons.wikimedia.org/wiki/File:20,000_Year_Old_Cave_Paintings_Hyena.png.

but as outlines of all physical items (e.g. chairs, tables, iPhones and pillows) and also elements of the natural world (e.g. clouds, hills, rivers and trees). Lines have been used extensively in art, for example by Pablo Picasso conveying the horrors of Guernica, by David Hockney in his Yorkshire landscapes, or by Julian Opie in his figure of a human (Figure 3).

We see lines as edges, demarcating particular shapes and defining them against their background. The regions of the brain responsible for this are V1 + V2 + V3 and V4; 'The regions of the brain including the parietal, prontoparietal, temporo-occipitoparietal, interoparetal, optical thalamic, and basal ganglia are all involved in determining different angles of the lines' (Calamia et al.

Figure 3. Julian Opie, LED Artwork in Dublin, Ireland, 2008. https://commons.wikimedia.org/wiki/File:Julian_Opie_Darstellung.JPG.

Figure 4. Fragment of ochre (haematite), Blombos Cave, South Africa. https://en.wikipedia.org/wiki/Blombos_Cave#/media/File:Blombos_Cave_-_3.jpg.

2011; Charras and Lupiáñez 2010; Treccani and Cubelli 2011; Urbanski and Bartolomeo 2008). If we compare the work of contemporary British artist Andy Goldsworthy, the *Icicle star*, and a marked (engraved) fragment of ochre from the Middle Stone Age of Blombos Cave, South Africa (~100,000 and ~75,000 years ago) we see how the lines interrelate in the shape of an X (Figure 4); by so doing our brains trigger us focus in on the centre of the X (Charras and Lupiáñez 2010).

Lines in cave art are used to show the whole or partial shape of the animal depicted. Incomplete shapes can be explained in variety of ways; one proposal is that cave walls can be understood as a membrane between the real world and the world of spirits from where animals emerge (Clottes 2009, 2010; Lewis-Williams 2002, 2009). In such interpretations, I suggest that the animals depicted with incomplete lines *indicate the direction of movement in the caves*. By placing animals in particular locations in the caves the artist/s created particular *encounters in time and space*, and by following certain routes (that are not contemporary) one meets animals; they are places indexing the visual narrative as a part of the story. The viewer, by moving through the cave, encounters the other world, and in this way the image and its construction form the *active part of the story-telling*. While creating imagery in caves the prehistoric artists used the brain capacity of seeing colour and movement in implicit ways giving their audiences strong visual stimuli in non-verbal communication.

As I have stated above, seeing constitutes not only the physiological response to light but is also a culturally-based interpretation as a part of making sense of the world around us (Janik and Kaner 2018; Roldan Garcıa et al. 2016; Thavapalan and Warburton 2019; Velliky, Porr, and Conard 2018). Since we all have distinct experiences and cultural contexts our interpretation of what we see on the cave walls vary considerably, resulting in different interpretations of the lines and images. Interpretations often reflect the prevailing social, ideological and spiritual status quo of the interpreter. Hence, ideas differ and are often based on the exclusion and inclusion of specific members of the community centred for instance, on their sex or gender. It has been postulated for example by Breuil (1949), that men created cave art (holy men and/or male shamans) while women were the auxiliary helpers who mixed the paint. We have to remember that Breuil was a Catholic priest for whom male supremacy in administering, painting, and communicating with the supernatural was dogmatic, and the role of women was secondary. Furthermore, some 'umbrella' interpretations of cave art rely on the importance of shamans (the gender is nowadays not defined) and still argue for restrictions on different community members and controlled limited access to particular parts of the cave (Lewis-Williams 2002, 2009). Children and youths are not mentioned in the majority of interpretations, or their inferred presence is limited to the entrances of the caves, Clottes (2009) suggested that the presence of youth in the front of the cave was part of the initiation ritual. Such interpretations are based on the way we see visual information through our cultural bias relating to current experiences and socio-economic and ritual contexts shared through time and space through the neurophysiological capacities of seeing. The challenges of interpreting this imagery demonstrate both strength of the prehistoric artists in exploiting the neurophysiological capacity of seeing and how they transcended the constraints on their artistic process.

By analysing the fingers used in making images in two French caves (Rouffignac and Gargas) and four in Northern Spain (El Castillo, Las Chimeneas, El Cudón, and Hornos de la Peña) previous interpretations of Franco-Cantabrian art have been questioned (Cooney–Williams and Janik 2018). By concentrating on lines dragged on soft cave walls by fluting, wherein the age of the 'artist' can be estimated (Sharpe 2004, Sharp and Van Gelder e.g., 2006a, 2006b, 2006c, 2009; Van Gelder 2015), we suggested community-based cave art creation that involved the young and old without restriction. Children and young adults were clearly present actively in all parts of these caves that were previously thought to be restricted to the adult few. Hence we suggested that cave art must be seen as a community-based endeavour: 'Children, as analysis of the data suggests, were participatory members of the Palaeolithic community of practice, encouraged to become involved in the social and possibly symbolic aspects of society before they cognitively understood the full implications and meanings of their actions. We suggest the aim was not only to develop artistic motor skills but also to participate in the social memory regardless of comprehension level' (Cooney-Williams and Janik 2018, 234). Considering the different interpretations I have mentioned above the need to remember that making sense of visual imagery is an integral part of seeing, where there is no clear distinction between the neurophysiological capacities and interpretation we make of what we see. Our experiences and cultural preferences matter.

The way one encounters the images placed on walls leads me to consider another important part of our neurophysiological capacity of seeing; motion. This can be divided into two aspects of seeing: one related to the primary motor cortex and part of visual cortex in the V5 area of the brain; and another whereby the information can take another path in the brain via V1 (Zeki 1999a). This shows us that seeing motion is possibly more complex than seeing colours. The second aspect of seeing motion relates to the V3 and V3a regions as a response to the movement of the eyes. What is also essential in perception of movement is the orientation of lines (Hughes et al. 2017; Palmer 2002) which serve to 'direct' seeing in a particular direction. Furthermore, if we add to this the Gestalt principle where the whole image is more than the sum of elements that constitute it, we can start to interpret the visual narrative. Palaeolithic open air rock art and cave art sites are full of such depictions. In Chauvet Cave (Figure 5), for example, we see multiple horse heads used to create the impression of the movement of the animal's head, or the repetition of the tusks of woolly rhinoceros to create the impression of movement. Similarly, the creation of multiple legs in combination with the use of the moving light source creates the sense of movement, e.g. in the case of an otherwise eight-legged bison on the wall of Chauvet Cave. It is important here to return to colour and line. if we can imagine moving along the wall from using a flickering light to illuminate only part of the drawing or painting at any one time, this will create *seeing a concurrent sequence of lines, and hence movement*.

Figure 5. Panel of Horses, Chauvet Cave, (Ardèche, France). https://www.ancient.eu/Chauvet_Cave/. Original image by Claude Valette.

Another interesting aspect of prehistoric art interpretation is arguably the notion of seeing movement, as a human response to still images. The objects or activities related to motion (Kourtzi and Kanwisher 2000; Proverbio, Riva, and Zan 2009) activate our brains to make us aware of what happened before and after the specific form of the visible image presents itself. We also physiologically respond to scenes in which physical activity is performed; 'Increased activity was noted in the extrastriate body area (EBA, located at the posterior inferior temporal sulcus and the temporal gyrus), superior temporal gyrus, a promoter area of the brain involved in the visual comprehension of static pictures of images representing action' (Janik 2020, 37). This is akin to seeing someone who is standing at the road crossing; we implicitly know that this individual has walked from somewhere to stand on the pavement, and that when the lights change he/she will cross the road. Our neurophysiological capacities once again rely here on our long term memory, hence there is no need to draw or paint either the beginning or the end of this sequence or story like a comic book. As long as we have experienced the event, either directly or by participating in its storytelling, we are able to start and finish the story ourselves simply by seeing the visual clue. I therefore suggest that *prehistoric cave or rock art was not a form of cartoon in the way the visual narrative is constructed, but that it is visual story-telling relying on visual clues that are strongly embedded in the neurophysiological capacities of seeing*.

Creating imagery with neurophysiological capacities of seeing as a part of story-telling

The relationship between colour, line, movement and prehistoric art as constituents of the neuropsiological capacities of seeing were explored in an art installation in the Ryōsokūin Temple area of the Kenninji Temple, Kyoto, for the World Archaeological Congress in 2016. Focusing on a skiing scene from the White Sea petroglyphs (~4600 years old) Katarzyna Szczęsna and I (2018) created the installation to incorporate the neuropysiological capacities of seeing in a particular context (Figure 6).

Summer in Kyoto is very hot; almost everyday one encounters temperatures in the mid 30°s centigrade and higher, with humidity over 70%, and where the only escape from these oppressing surroundings are air-conditioned places. The Japanese additionally employ various additional means to alleviate the heat, e.g. running water shown to suggest cool air behind TV news presenters, as imagery linked to 'cooling down'.

Figure 6. *Cooling Japan: exploring the neuroaesthetic of prehistoric and contemporary art*, Katarzyna Szczęsna and Liliana Janik, 2016.

Our installation was a contribution to 'cooling down' Japan. It was based on the juxtaposition of different elements that work on different levels of comprehension/recognition by temple visitors. It provided the opportunity to cool viewers via non-verbal communication based on visual clues. Temple visitors came from different countries, hence the symbols we used needed to be understood without any verbal or written commentary, evoking the neurophysiological response to visual stimuli. By doing so we were relying on long term memory as knowledge we are always able to use (Brady, Konkle, and Alvarez 2011). 'Visual processing begins with the establishment of a neural representations in the visual context. Later this information moves on to the temporal lobe for additional ordering. The resulting internal representation remains stable over time even though we are presented daily with innumerate perspectives' (Ratey 2002, 207). We know that particular images are associated with specific contexts; this neurophysiological capacity of seeing is linked with structures of the medial temporal lobe which are very important in long term memory, alongside those of the inferior temporal cortex, prefrontal cortex, V2 and V4 visual cortex areas (Bar 2004). This means that if we look, for example, at an umbrella, we relate this to events involving rain, and that this allows us to predict that the presence of an umbrella in someone's hand is part of the preparations for avoiding getting wet through rain predicted to fall in the future. Hence, our use of the kimono (traditional dress) as a shape for the installation, to situate everyone in Japan; our further use of snowflakes (to indicate winter, a cold season). The specific shape of snowflakes was derived from Edo period (1603 – 1868) kimonos in order to create a visual conversation with the traditional Japanese art form of woodprints as well as the prehistoric rock art scenes of winter from Northern Russia; they both transported the viewer to the cool air of winter. We additionally used the colour blue due to its association with cold, in contrast to warmer red or yellow colours.

The creation of this installation brought together distinctive artistic traditions, visual clues related to our knowledge about the world we access as a part of the neurophysiological capacity of seeing, and the neurophysiological knowledge of our response to visual stimuli. Based on the number of conversations and requests for the image we have received it seems to have been successful.

Rock art

The rock art composition used in our installation reveals how the prehistoric artists used another neurophysiological capacity to see; that of haptic experience. Here, we can see how other neurophysiological capacities such as the sense of touch assist image recognition and comprehension. It allows us to use clues other than visual when we are trying to understand the world around us, by accessing the knowledge that goes beyond the visual recognition based on accessing long-term memory (James et al. 2002; Masson et al. 2016; Ratey 2002). This involves early sensory areas (V1 for visual input and S1 for haptic input), as well as higher-level areas, and has been recently summarized particularly well in the work of Masson et al. (2016, 3411): 'In addition, visual and haptic perceptual spaces are represented well in ventrolateral occipito-temporal cortex (LOC), suggesting this area as a candidate for a multisensory convergence area, or even a supramodal shape representation. Moreover, we were able to demonstrate that prior visual experience activates early visual cortex during haptic processing even in the absence of visual input'. It is of particular relevance here when we consider the use of rock surface morphology in visually communicating the hunt as a part of the experiential art (Janik, Roughley, and Szczęsna 2007, 2009, 2018, 2020).

By moving a hand over a rock surface while following marks pecked into the rock we feel through touch the way one who has had experience in and the memory of skiing in a particular landscape conveys it visually. By reconstructing the rock surface morphology it is possible to see the way the skiing technique we today classify as the Nordic style, walking up and sliding down the slope, with the help of pushing with the use of ski poles to gain velocity (Figure 7).

To anyone who is a skier, as almost everyone who lives in the boreal zone is, the area on which the rock art is located can be physically related to the carvings as he/she have relived their experience by looking and touching the rock surface, as in the context of other activity; 'PET scans show that when a subject, seated in a room, imagines they are at the front door and starts to walk either to the left or the right, activation begins in the visual association cortex, the parietal cortex, and the prefrontal cortex – all higher cognitive processing centres of the brain' (Ratey 2002, 107). The implicit addition of the haptic aspects of the carvings by prehistoric artists drew on a further element of the brain's capacity to enhance the experience of seeing.

It is remarkable to see and experience how the neurophysiological capacity to see and touch have been deployed here, as well as how the process of constructing images on the background surface affects the way we receive the image. Visual 'silence' and 'noise' are very important when one considers the artist's intentionality about what he/she decided to show the viewer. The composition with the hunt is vast and measures c. 2,6 m in length and c. 2,9 m in width, hence it is impossible to see completely in one glance. To focus the gaze of the viewer, therefore, the artist decided not to distract us with visual noise; only 10% of the light loaded with visual information enters our eyes, so if we reduce the noise, the less information we provide the clearer the image will be. If we visualize a wall with many pictures hanging on it versus the same wall with one lone picture, our visual comprehension of what we see with the latter is much quicker. This technique has been used as successfully in cave art as open-air rock art; in this case the visual storytelling implies the significance of the hunting scene by letting it be as a separate *visually non 'cluttered' image* (Janik, Roughley, and Szczęsna 2007; Janik 2009, 2020). We see here how the cultural need to focus on this particular visual narrative is helped by the neurophysiological capacity to see and touch that

Figure 7. Winter hunting scene, Zalavruga, White Sea, Russia (~4600 years old).

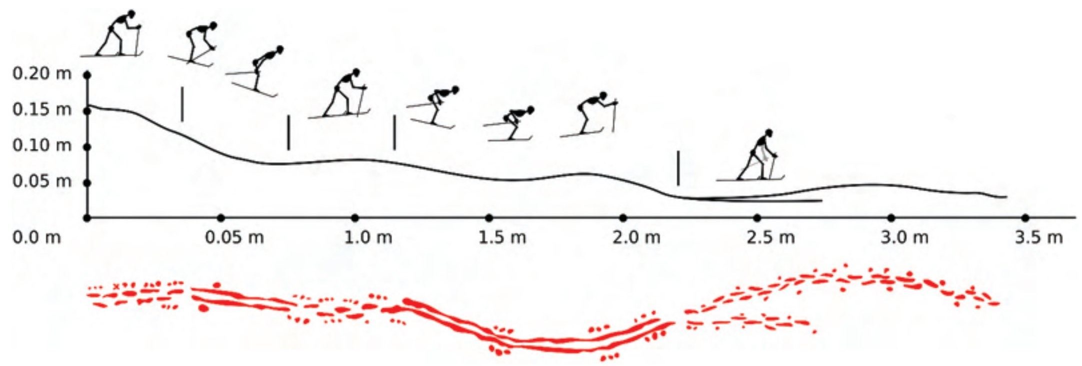

Figure 8. Morphology of the rock surface and the Nordic skiing technique.

was employed by prehistoric artists (Figures 7 and 8). *Visual and touch clues are therefore both used in story-telling*. What is conveys depends on our cultural traditions and perspectives that are part of long term memory, part of the cultural set of categorizing the world around us.

The meaning of the hunt will further depend on our cultural preferences. The hunt can be interpreted as part of constellations of Ursa Major and Ursa Minor creation myth inspired by the mythology of Northern Peoples, wherein elks are pursued and hunted. We have to remember that such myths play an active role in the construction of the imagery, and that conversely the imagery can influence the myths themselves since they were created thousands of years before we find them first recorded in ethnographic or historical record.

Visual story-telling as part of cultural, social or spiritual life places a particular requirement on the artist to deliver the *visual clues as elements of indexing a story as a part of the visual narrative*, e.g. as images are painted or drawn on cave walls and are pecked into rock surfaces. In making sculpture a number of neurophysiological capacities have been utilized by past and contemporary artists, and of these, the most visually arresting are human figurines lacking detailed faces.

Sculpture

The importance of cultural preference not only in interpretation but also in exercising choices in the suppression of neurophysiological capacities, is perhaps best illustrated by the 'Venus figurines' of Mid Upper Palaeolithic age (Janik 2012, 2013, 2014). One distinct characteristic of these is the lack of a face. The figurines are distributed from France, Italy, Germany and the Czech Republic to the Russian Plain, dating from ~30,000 to ~15,000 years ago (Figure 9).

The face is probably the most important part of our bodies in non-verbal communication. We can instantaneously recognize some else and can convey our feelings to them, for example, by smiling (Ekman and Friesen 1978; Ekman 1993). It is understood that by altering our facial muscles we can accomplish different expressions/non-verbal messages communicated to the viewer, (Kitada et al. 2013). We can also read lips in order to understand what someone is saying without listening to them. This is not learned; we are born with the capacity for facial recognition: 'The core of the human neural system for face perception consists of three bilateral regions in occipito-temporal visual extrastriate cortex. Those regions are in the inferior occipital gyri, the lateral fusiform gyrus, and the superior temporal sulcus. These regions are presumed to perform the visual analysis of faces and appear to participate differently in different types of face perception.. . .

Figure 9. Female self-portraiture, Kostenki 1, complex 2.

For example, lip-reading elicits activity in regions that are associated with auditory processing of speech sounds. Similarly, the perception of facial expression elicits activity in limbic regions that are associated with processing emotion' (Haxby, Hoffman, and Gobbini 2000, 223). We can also estimate the age of the person we are looking at, or their sex. The research dates to the experiments carried by Guillaume-Benjamin-Amand Duchenne de Boulogne published in 1862, *The Mechanism of Human Facial Expression*, where he distinguished over 60 discrete emotions expressed by the human face, while Charles Darwin in *The Expression of the Emotions in Man and Animals* published in 1872 argued for the existence of only four universal emotions expressed by the human face, that can be described using contemporary language as six emotions: anger, disgust, fear, happiness, sadness and surprise. In the 20th century the most influential research was by Paul Ekman (Ekman 1993; Ekman and Friesen 1978). Subsequent advances in brain research allowed the pinpointing of particular parts of the brain related to specific emotional expressions of the face (e.g. Calder et al. 1996, 2000; Calder, Lawrence, and Young 2001; Ratey 2002), distinguishing two additional facial expressions related to the emotional state of the person. Haptic experience plays an important role in facial recognition; neurophysiological capacities of seeing are not enhanced as in the case of rock art. Instead, here, touch is used to recognize in the process of seeing. As suggested by Kitada et al. (2013) the visually impaired who cannot see are able to recognize faces via haptic-based knowledge. Seeing or touch however, were not used in prehistory to communicate via the images of faces. Our *neurophysiological capacities were suppressed/* not used where the creation of human figurines is concerned.

The answer to this observation might lie in the figurines themselves, since they have been seen to be made as a form of self-portraiture, as inferred from the projection of the body (McDermott 1996; McDermott and Johnson 2013) communication with others was not sought (Janik 2012, 2013, 2014, 2020). These figurines were coloured in red (Figure 9) or black, or a combination of both, enhancing the alertness of the seeing brain. I suggest that this way of seeing was linked to the Palaeolithic visual vocabulary that indexed particular relationships centring on the sites. Thus we have multi-dimensional interpretations, since the relationships are based on shared materials used in their creation such as mammoth tusk or local stone marls. The expression of the relationships is based both on the process of fragmentation (Chapman 2000) and the lack of it. The body of figurines made out of mammoth tusk are not broken, while figurines made out of marl are. It is very rare to find unbroken figurines, such as the example from Kostenki 1, complex 2 (Figure 9). However, mammoth, from whom the tusk material derived but'whose depictions were produced solely from marl are never fragmented, while all other creatures (e.g. human females, lions, bears or birds) – also made of marl, are. Fragments of their bodies were taken from the sites as a part of network relationships that were built via shared material culture. From the perspective of the neurophysiological capacities of seeing, what is most interesting, however, is that the only figurines left behind at settlements were heads of animals with their faces, while all parts of female bodies are present, including heads without faces. The lack of facial features seems to have been a cultural preference with high importance, *negating the visual clues of non-verbal communication either in recognizing the women or their emotional state*, suggesting that communicating such was in this case not of importance.

We can see in the context of Mid Upper Palaeolithic 'Venus' figurines that cultural preferences were used to 'reverse' the neurophysiological capacities of seeing. This was implicit, of course, since none of the artists knew about the areas of the brain linked to facial recognition. They appear, however, to have held strong bias against showing the face. In this way, the figurines played an active part in story-telling where individual identity was not shared with other members of the community.

Summary

Advances in brain research, modes of archaeological data interpretation and archaeological willingness to engage with the disciplines outside of traditional ways understanding past societies such as ethnography and anthropology gives us unique opportunities to unlock the past.

Cave and rock art, and figurines are the 'witnesses' as to how past and contemporary viewers have been 'manipulated' by prehistoric and contemporary imagery. Artists, through the ages, while being unaware of the neurophysiological capacities of seeing, used them with great success to non-verbally communicate their stories.

By implicitly exploring the neurophysiological capacities of seeing, prehistoric artists used colour both to alert the viewer to see and possibly to provide a strong stimulus into the subject and the meaning of the image. Story-telling was enhanced by the use of light as an element that prioritized the illuminated parts of walls, giving both visual focus and perception of movement for nonverbal and verbal communication. Haptic experience was also used in creating visual illusion of movement and landscape as part of experiential art, where the memory of movement triggered activity in particular areas of the brain in creating and seeing representations. A further interesting aspect of prehistoric art is the culturally-based denial of exercising our neurophysiological capacity of seeing, but also the culturally-based denial of exercising them, as in the lack of use of blue in dark caves or the depicting of facies in otherwise realistic sculptures.

This paper has scoped out some of the ways in which archaeologists can usefully engage with neurophysiology to better understanding the archaeology of seeing.

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