

Re-Thinking Early Prehistoric Art as a Cognitive Technology: Neuroscientific, Anthropological, and Techno-Functional Perspectives

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Introduction

There have been numerous scholarly approaches among archaeologists, anthropologists, and art historians to prehistoric or the so-called “primitive” art¹ of traditional societies. The basis of my project at the Italian Academy is to combine different approaches in order to better understand interconnected aspects of production, perception, and use of artworks in diverse prehistoric contexts. Early art² is often understood as a unique window into prehistoric minds and their cognitive, creative, and aesthetic properties, and diverse sets of interpretations have been devised over the years. These have included early suggestions about sympathetic magic, later functional explanations in which depictions represent external information storage, explorations into the links between art and shamanic visions and practice, or more recent studies regarding the ontological basis of schemes of everyday practice that become reified through visual media.

The proposed project is set to develop an integrated and cross-disciplinary approach to re-evaluate cognitive aspects of early art in a comparative perspective, and builds on the work of several previous studies with diverse theoretical and methodological backgrounds, which I will first review.

State-of-the-Art

In recent archaeological scholarship, two general kinds of interpretation have attempted to understand early prehistoric art. The first type of interpretation can be called functionalist, which tends to emphasize the ecological and cultural context of image-making (e.g., Mithen 1991; Shipman 2010). For instance, Palaeolithic cave paintings and *art mobilier* depict a wide range of Pleistocene animal species, which inhabited the same ecological space as human groups. Such approaches focus on functional aspects of the origin of image-making, such as exchange of information about resources, and group alliances. Various critiques of functionalist interpretations have already been raised as overly simplistic or at the very least one-sided (e.g., Dowson 1998).

¹ Here one remains perplexed whether to put the quotation marks not only on the adjective “primitive” but also on the noun “art,” as it remains a deeply inadequate label to describe figurative or geometric depictions in traditional cultures. Alfred Gell (1996) compared artworks to traps or snares, seeing both traps and artworks as objects with “complex intentionalities.” And, yet, despite this labor of language, one can hardly come up with a better, more adequate label to name such objects and depictions. In the following text, my preference will be to refer to specific objects as “artworks” rather than “art.”

² The expression “early art” is intentionally left chronologically broadly defined in this text as I am not restricting the scope of this comparative exercise to a particular prehistoric period.

Interpretations of the second type focus on the idea of shamanism, and proponents of these theories suggest that early examples of artistic expression should be understood by envisioning a shamanistic³ context for their making. The explanation is based on a psycho-cognitive argument that assumes the universality of visions seen in altered states of consciousness (e.g., when experiencing hallucinations induced by psychostimulants) as “hard-wired” in the neurological functioning of modern human brain. Subsequently, images perceived during such states became rendered in art. This computer analogy builds on the idea that neural structures of the brain as “hard-wired” are determined by hominin evolution while the “software” of an individual brain, shaped by individual experience, is of lesser importance (Helvenston and Hodgson 2010: 83). David Lewis-Williams is the main propagator of the inextricable link between shamanic or shamanistic practices and altered states of consciousness and images and symbols depicted in the art of hunter-gatherer societies (e.g., Clottes and Lewis-Williams 1998; Lewis-Williams 2002). He extended this argument to a range of early agriculturalist groups (Lewis-Williams 2004; Lewis-Williams and Pearce 2005). In a shamanic system the world is seen as a tiered cosmos where shamans are exceptional individuals who possess the power to travel and communicate between different levels. Shamans are believed to use special powers to transcend these different levels by performing “such tasks as healing, divination, control of animals, control of weather and extracorporeal travel” (Lewis-Williams 2004: 30). Lewis-Williams connects a shamanistic organization of the cosmos to the neuropsychological properties of the human mind, emphasizing “wired” experiences in altered states of consciousness that “include sensations of passing through a vortex or tunnel and flight” (Lewis-Williams 2004: 30). Visual hallucinations perceived in altered states of consciousness are induced by sensory deprivation or sensual stimulations, including psychotropic substances. Such symbolic and magical resources can then be socially appropriated and manipulated. In rock art, very often were depicted particular animals and hybrid beings with mixed attributes of animal and human bodies, so-called therianthrope images. These are understood as spirit animals, i.e. spiritual counterparts of wild animals who may act as powerful spirit guides and helpers for humans. Lewis-Williams suggested that the depictions of spirit-animals on cave walls (either painted or created by utilizing natural protrusions of rock or natural staining on cave walls), released the beings from the underworld that they inhabited. Cave walls acted as a “living membrane” between this world and the nether world, akin to the way sculpted materials were created whereby “the carver of the image merely released what was already inside the material” (Lewis-Williams 2002: 199–200; cf. Ingold 2000: 126). Similarly, at the Early Neolithic site of Çatalhöyük in Turkey houses, often decorated by

³ Note that some authors insist on the differentiation between the use of adjectives “shamanic” and “shamanistic,” arguing that rather than using these terms interchangeably, it would be more appropriate to use “shamanistic” when referring to a more general set of ritual practices that recognize the importance of special individuals, such as healers and similar, whereas “shamanic” should be reserved for a more restrictive number of instances where shamanism as a social institution is undoubtedly established (e.g., Taçon 2010: 78). Yet, the complexity of ethnographic examples worldwide suggest that this delineation is probably overly pedantic.

figurative and geometric wall paintings, may have served as constructions of a tiered cosmos, where “each replastering and repainting may have been a new celebration and enactment of the emergence of spirit-animals and “goddesses”” (Lewis-Williams 2004). All prehistoric art can then be read as the reflection of various stages of hallucination. According to such a view, art showing simple geometric forms, known as entoptic images, depicts trance states which are experienced cross-culturally, as first argued by Reichel-Dolmatoff (1978) based on a study of the Tukano of Colombia.

Such all-encompassing shamanistic interpretations of art production in traditional societies have been criticized by Robert Layton (2000), who argues that this type of synthetic model, which compiles diverse aspects of shamanistic practices from around the world, limits the richness and variability suggested by both ethnographic and archaeological evidence. This is not to deny that in the South African context, which is the starting point of Lewis-Williams’ analysis, shamanism and rock-art are indeed closely linked. However, rather than seeing artistic production as an inevitable part of shamanism in small-scale societies worldwide, Layton uses ethnographic evidence to argue for a more diverse spectrum of expressions in the context of traditional societies, whether these be secular, mythical, or shamanic (cf. Sauvet et al. 2009).

Another study into the animist and totemist contexts of art-making by the anthropologist Tim Ingold (2000) has criticized the tendency to see imagery in traditional societies as representationalist, and suggests that they are instead meant to open up the superficial world of appearances by penetrating “beneath the surface of things so as to reach deeper levels of knowledge and understanding” (Ingold 2000: 130). The act of depicting, either by painting, carving or sculpting into diverse materials, is understood as an act of releasing another world.

David Freedberg’s (1989) seminal book *The Power of Images* addressed wider issues such as the reception of images, aiming to develop a history and theory of response and psychological perception of art regardless of particular historical and regional contexts. This approach influenced and inspired more recent cognitive neuroscience research on art (e.g., Hodgson and Watson 2015; Huang 2009; Freedberg and Gallese 2007; Massaro et al. 2012; Solso 2000), to which I will return later. Freedberg’s approach was further discussed and explored by the anthropologist Alfred Gell in his influential book *Art and Agency* (Gell 1998: 97, 150, 153), which took an explicitly anthropological approach to art in general and the question of idolatry in particular using semiotic and agency-centered theories and focusing on relational properties of objects of art. Since the publication of Gell’s volume in 1998, what has been discussed endlessly among anthropologists and archaeologists is the question about the attribution of agency to works of art in particular and material culture in general. Many authors criticized Gell for attributing to works of art only the so-called secondary agency via a mediating human subject, stating that this approach is reductively anthropocentric (e.g., Henare et al. 2007). This critique became especially loud in more recent anthropological discussions on symmetrical

approaches that aim at displacing the centrality of anthropomorphic subject, or in anthropologies beyond humans.

Over the past ten years or so, the anthropological literature has increasingly been preoccupied with what is more recently referred to as the “Ontological Turn.” It refers to approaches that suggest moving beyond a single and dominant ontological plane of being and understanding and opening up to the alterity of non-modern ways of conceptualizing the world. Here is not the place to dwell into the details and diversity of existing theoretical takes on the question of ontology in anthropology and archaeology. I will instead focus on one particular approach that has made an explicit link between the proposed ontological regimes and modes of depiction, which I find particularly thought-provoking and heuristically useful when discussing early art.

Descola’s Taxonomy of Worldings and their Depictions

Most recently, the anthropologist Philippe Descola integrated visual art into his anthropological approach of ordering schemes of practice in different social and cultural contexts using a four-fold taxonomy of ontologies (Descola 2013a). This approach is of key importance in my dealings with prehistoric art and I will here spend a little bit more time trying to explain the main tenets of Descola’s approach as well as some criticism and reformulations it has received over the past couple of years.

Descola’s attempt to link different ontological schemes of practice and visual expression resulted in an exhibition held in Musée du quai Branly in Paris in 2010 accompanied by a monograph entitled *La Fabrique des Images* (Descola 2010), where the four different ontological regimes—totemism, animism,⁴ analogism, and naturalism—were recognized in distinct modes of depiction characteristic of each. Descola (2013a) suggests that schemes of practice in different socio-cultural contexts determine different relations between humans and non-humans along the axes of **physicality** (the body) and **interiority** (the mind), and can form sets of relationships different from those that structure the dominant western ontology. Such different combinations affect the way art and images are produced in each context depending on different ways of seeing, understanding, and being in the world, or what he also refers to as “worldings.” Ontology here means something different than a world-view or culture (Descola 2014). Descola suggests four combinations based on different links along the physicality and interiority axes:

(1) **Totemism** sees the continuity between humans and non-humans both in terms of their bodies and souls and is primarily found among Australian Aborigines. In the totemic world, animals and humans share the same ancestral land. All living beings descend from the era of the “Dreaming,” when the ancestral figures

⁴ In Descola’s scheme, the terms which come from older ethnographies, such as animism (since Tylor 1859[1871] often referred to as a tendency to attribute a spirit to an inanimate object or “other-than-human persons,” Hallowell 1975; cf. Bird-David 1999; Guthrie 1993) and totemism (ways of classifying social entities *sensu* Lévi-Strauss 1963), are appropriated with very particular sets of definitions.

shaped the features of the land, impressing it through their movements and in this way shaping it. The relationship that all living beings have with the land can be described as *essential*—that is, these beings are *consubstantial* (of the same essence). When it comes to depicting animals and humans in Aboriginal Australia, one can often find images of kangaroos, some with the use of the so-called “X-ray” style of painting, which shows the internal layout of organs and lines along which the body parts are partitioned during butchering. The very body of the depicted kangaroo can be seen as the ancestral, immobile landscape in its totality;

(2) **Animism** sees humans and non-humans as having the same “culture,” which is the underlying humanity rather than animality, while their differences stem from their respective bodies, which determine different perspectives different beings have. Animism as an ontological scheme of practice is characteristic of many traditional societies around the world, perhaps best documented among Amerindian groups of circumpolar North as well as those found in lowlands of South America, the latter representing the rich ethnographic basis of Descola’s own fieldwork. In this type of ontological regime, a vital force exists in human exchange with the animal world. Here, hunting can enable the flow of vital force between human and non-human beings. In this type of ontological universe, there is a limited pool of souls and predatory modes of relations between different human and non-human *collectives* (*sensu* Latour). According to Descola, a subspecies of animism is **perspectivism**, identified among Amazonian groups by the Brazilian anthropologist Eduardo Viveiros de Castro (2004). It refers to the idea of having different perspectives on the question of one’s humanity. The perspectival difference is grounded in the body. Needless to say, Viveiros de Castro (2009) finds Descola’s taxonomic ordering reductive and argues that perspectivism evades taxonomic classifications and is an indigenous philosophy, a “cannibal metaphysics,” or a “bomb” to our naturalist mode of thinking rather than a subspecies of a neatly ordered taxonomy of ontologies (cf., Latour 2009). In an animic universe, modes of depictions narrate of the transformation between different classes of beings and can encompass metamorphosed or even hybrid forms, such as therianthrope images. Often hunting scenes can be depicted that are everything but routine exchanges between different classes of beings that inhabit different planes of existence due to different bodies they occupy. An exchange of perspectives for a human hunter can be deadly when encountering a powerful spirit animal. Here the importance of ritual practitioners, or shamans, can be paramount in negotiating these different perspectives and they are the only beings who can cross from one to another without getting lost. Masks that are found in the rich cultural tradition of the groups inhabiting North West Pacific Coast are another example of the type of artworks characteristic of this ontology that rather than covering up open up the actual being lurking beneath the surface of the body form. The activity of carving is seen as linked to the process of releasing a being as the shape and the properties of the carved material determine the final shape of an object (Ingold 2000);

(3) **Analogism** is equated with the schemes of practice where exists the discontinuity between humans and non-humans on both physicality and interiority axes. It is linked to more complex social formations with elements of social hierarchy in a multiplicity of different forms of relations found among the empires of the Ancient World. In this ontological universe, depictions of anthropomorphic images of humans as well as natural phenomena represent emanations of cosmocratic deities or manifestations of the divine (cf., Sahlins 2014). Here, the world is seen as populated by singularities that need constant interpretation. The intention then is to represent links between singularities of the world with the emphasis on the fragmentation of the interiority while everything is relationally linked to everything else – a depiction of a fractal figure and recreation of a microcosm in its totality. In the analogical type of depiction, the ambition is also to create a correspondence between humans and their sentiments, on the one hand, and the universe, on the other, by depicting natural phenomena, such as a mountain or a body of water; and,

(4) **Naturalism**, defines the modern, scientific Western/European ontology that sees continuity between humans and non-humans along the physicality axis, assuming the same biological basis of life, while discontinuity is postulated along the interiority axis in the assumption that what differentiates humans from other non-humans is the fact that the former have culture. In Descola's view, naturalism as the dominant ontology developed from the start of the 17th century and was linked to the scientific revolution in Europe. He recognizes the artistic start of this mode of depiction among the Flemish painters of the 15th century. The emphasis is being placed on a human individuality being represented in paintings with faithful resemblances, as well as the imitation of nature, which is relegated to a separate domain and becomes a backdrop to human action. Depictions of landscapes, still life, and monofocal perspective are emblematic of this ontology.

Ingold (2016) criticizes Descola for being a classic French naturalist in the tradition of Cuvier and Durkheim by assembling a dead museum of artefacts from traditional cultures that lost all their vitality by being entrapped within the proposed grid. He also accuses Descola of a synchronistic snapshot approach to ontologies rather than the dynamic one that would engage with ontogenetic process of becoming. Ingold further questions the universality of the divide between the mind/interiority and body/physicality axes that is the starting point of Descola's whole edifice. On the other hand, Sahlins (2014), more positively and constructively, suggests that what binds animism, totemism, and analogism is an inherent **anthropomorphism**, which is also only seemingly absent in the naturalist ontology. While Sahlins is convinced of the empirical reality of these different schemes of practice he remains skeptical of their neat delineations into different ontologies as proposed by Descola.

All these more or less justifiable objections and reformulations aside, Descola's project described here and anthropological/ethnographic perspective could potentially offer much to a student of early art. For once, there is a possibility to examine archaeological examples of artworks with an explicit grid in mind, even if it

must remain heuristic and flexible, while accepting that ontological schemes of practice and modes of relations are finite rather than open to an infinite number of combinations. This possibility not only recharges lateral comparisons triggered by Descola, but importantly enables a diachronic comparative perspective, which my own project addresses. Potentially, it provides grounds for a new type of ethnoarchaeological research too. In order to move things forward, two particular research questions are singled out:

- (1) If deemed useful in distinguishing different forms of “worlding,” viewing, understanding, and depicting worlds based on the proposed schemes of practice, can prehistoric examples of art-making world-wide help us in refining and perhaps modifying Descola’s ontological regimes as linked to modes of depiction?; and,
- (2) How can one most usefully integrate various aspects related to technological studies of artworks and their contextual details with Descola’s ontological schemes of practice by distinguishing the dependence of different modes of depiction in relation to sensual and motor experiences of technical gestures and neurophysiological universals linked to perception and cognition?

In relation to the second question, importantly, Descola highlights the schematization of practical action, which in order to be effective often remains under the radar of conscious understanding, and can directly be linked to ingrained techno-functional gestures used in the production and use of art. He emphasizes the importance of analyzing schemes of technical gestures (Descola 2013b). Such schemes can effectively be linked to the production of art-works and their uses as governed by neurobiological mechanisms of perception. This perspective has the potential to link cognitive neuroscience and anthropological approaches to art, and techno-functional issues that are at the core of how archaeologists and art historians study pieces of “art,” for example through technological analysis of carving, residue analysis investigating the use of pigments, and functional analysis looking into the handling and manipulation of objects and the emergence of non-verbal messages (Lemmonier 2012).

Before I turn to the review of neuroscientific approaches in the study of art as well as techno-functional methodologies for high-resolution recording and analyses of artworks, and their potential in the examination of the chosen case studies from Italian prehistory, I will briefly review two previously published examples of the study of early art in which I employed elements of the described anthropological approaches. Both examples relate to chronological contexts of last foragers partly affected by changes leading to the adoption of agricultural lifeways.

Examples of Prehistoric Forager Art and Modes of Depiction in the Eastern Mediterranean

Göbekli Tepe, Turkey

The first example refers to the site of Göbekli Tepe (Borić 2013 and references therein), which became known for its astonishing examples of a variety of carvings on T-shaped stelae. Some of these were 7 m tall with their

stylized anthropomorphic shapes and were found within circular stone enclosures. The site is dated to the mid-10th millennium BC, which marks the beginning of the Pre-Pottery Neolithic (PPN) period across the Levant and it continued to be used throughout the PPNA and PPNB periods. It is situated on a large limestone ridge some 800 m asl in the vicinity of the present-day city of Şanlıurfa in Turkey, not far from the Syrian border. Many of these pillars are decorated with zoomorphic images, and to these animal depictions we can add the existence of a large number of limestone sculptures. Wolves, boars, dogs, aurochs, goitered gazelles, wild Asiatic ass, lions/leopards, hyenas, snakes, scorpions, and several species of birds, including vulture, are all portrayed. The fact that many of the images depicted at Göbekli Tepe can be seen as having a narrative structure—even in the absence of hunting activities, the lack of an “X-ray” style, and a sense of movement associated with the portrayal of animal forms—could perhaps be considered important clues about the animic,⁵ rather than totemic, logic behind the depictions. What is particularly striking with the depictions at Göbekli Tepe is that a number of animal species (lion, wild boar, fox, leopard, hyena) are shown with dangerous bared teeth. That the main intention of depicting these animals in such a way was to underline strong, dangerous spirits lurking beneath the skin of the depicted animals is further strengthened by the display of enlarged canines and erect penises, as well as likely attack postures with raised heads and front legs in relation to the main body axis of a quadruped. Indeed, in certain instances where foxes are shown, we could even speculate that the raised posture of the body, as if the animal is standing on two legs, can possibly be connected with an attempt to mimic a human stance. Especially bared teeth in the depiction of these animals are reminiscent of examples of Inuit ethnographic depictions previously discussed by Ingold (2000), where in a scene depicting a caribou and a hunter, the caribou is depicted with bared teeth as if a dangerous spirit animal lurks beneath the animal skin.⁶ These two convergent examples of iconographic depictions seem to relate to a similar underlying ontological grounding of schemes of practice, which can be referred to as animism (*sensu* Descola). I have suggested that the pervasive mode of relations at Göbekli Tepe is that of predation.

Lepenski Vir, Serbia

The second example relates to the artistic tradition of sandstone boulder found at the site of Lepenski Vir in the area of the Danube Gorges of the Central Balkans (Borić 2005; 2007; 2016 and references therein). The site is situated on the right bank of the Danube River, which is here the border between Romania and Serbia.

⁵ For the preference in using the term “animic” over “animist,” see Descola 1992: 125, n. 5.

⁶ This showing of the animal’s real face, that is, its inner being is explained in the following passage that refers to ethnographic observations among “perspectivist” Amerindians of Amazonia: “... the possibility of metamorphosis expresses the [...] fear of no longer being able to differentiate between the human and the animal, and, in particular, the fear of seeing the human who lurks within the body of the animal one eats ...” (Viveiros de Castro 1998: 481).

It was occupied from the beginning of the Holocene, i.e. from around the mid 10th millennium BC probably as a good place for fishing due to its proximity to a whirlpool that facilitated easier catch of large fish such as catfish as well as different species of sturgeon that were every year swimming up the Danube from the Black Sea to spawn. During the Early Holocene along the Danube in this region, complex, probably sedentary, Mesolithic hunter-fisher-gatherer communities were established with substantial settlements and a specific cultural tradition along with their focus on intense utilizing of the River Danube for subsistence. Most of the sites also contained concentrations of human burials, which were often placed according to a particular mortuary norm: as extended supine inhumations with their heads pointing in the downstream direction. At the end of this period, at the time when these communities came into contact with the earliest agriculturalists, moving into Europe from Anatolia around 6200 cal BC, it seems that the site of Lepenski Vir became a central place of these indigenous forager communities possibly due to its location in front of a large trapezoidal mountain that was located across the Danube, and which might have served as an important landmark. What is more, the built environment of Lepenski Vir at this time became elaborated with the construction of trapezoidally shaped bases of dwelling features paved with reddish limestone that also had central rectangular stone-lined hearths in their centers. This phase of occupation at the site features over 100 carved/sculpted sandstone boulders associated with trapezoidal building structures. Some of these artworks were dressed only with geometric motifs over their spherical surfaces while other specimens were carved into figurative depictions of hybrid human/fish beings often depicted with down-curved mouths, frontal human faces, and fish bodies save for one particular example where atrophic arms and possibly a vulva were also shown. These boulder artworks were found predominantly around central hearths and might have represented important heirlooms of each individual building. Geometric motifs found on other boulders show complex patterns of wavy lines, some of which could be interpreted as depicting either intestines of a fish or fish bones and other patterns that can be associated with the interior of fish bodies. These depictions can fall in the genre of “X-ray” images of human or animal bodies found as a specific mode of depiction among some ethnographic examples, such as Australian Aborigines. Several of these boulders also commemorated burials placed inside these trapezoidal building spaces, frequently in connection to their heads. The connection between the carved boulders and the dead, who were placed parallel with the river, could perhaps be extended to the annual cycle of sturgeon migration and it is likely that complex beliefs existed about the interdependence between fish and humans. One could speculate that such beliefs might have been present throughout the preceding Mesolithic period but for the first time became reified in non-perishable artworks produced at Lepenski Vir. When deciding what ontological scheme of practice can be attributed to this particular culture tradition, many elements point to a totemic system (“X-ray” images and possible continuities between humans and fish and humans and the landscape along both the physicality and

interiority axes) but other elements may suggest an animic ontology in which vital exchanges between humans and animals might have equally been important.

Both of these examples show a potential of involved anthropological analysis and many elements have been illuminated by moving away from the immediate archaeological context of the discussed artworks, and by looking at more universal features of their production, iconography, and use. Yet, neither of the two examples have so far been analyzed from explicitly neuroscientific or technological perspectives, which could potentially yield new relevant layers of information about the nature of these types of depictions and various more universal aspects pertinent to their execution, meanings, and use. In the following, I outline some aspects of these two additional sets of approaches that my project incorporates in the study of early art.

Neuroscientific Approaches in the Study of Art

Neuroscientific approaches to art focus attention to the fundamentals of visual perception and are directly linked to emotional and cognitive properties of the visual brain and its subsequent materializations through depictions. Visual-perceptual abilities are linked to the process of how the human brain responds to visual information—the perception/response system. A specific stimulus–response (SR) event as a memory trace becomes stored in specific neural micro circuits (Martin 2007).

Linked to the question of visual perception, Guthrie (1993) suggested that anthropomorphism and animism are an evolutionary disposition or an adaptive trait for detecting animate beings, be they animals or humans, predators or prey. According to this view, due to their vulnerability in the course of evolutionary history, primates, and in particular humans, who also must have undergone distinctive neurophysiological changes in the course of their evolution compared to other primates, relied on the “better safe than sorry” principle, which often allowed a quick response in all cases of ambiguous visual cues of animate beings in an environment, leading often to perceptual misidentification of inanimate natural features for animate predators or prey: there exists a fast-track, preconscious pathway for processing visual information which can be associated with the posterior temporal lobes (Caramazza and Shelton 1998; Caramazza and Mahon 2003; Mahon and Caramazza 2009; Martin 2007). This resulted in constant scanning of the environment in a subconscious way for the presence of living things, i.e. the detection of camouflaged animals. Further, it has been determined that human amygdala responds more to stimuli to do with animals than objects, such as tools (New et al. 2007; Young et al. 2005). Moreover, visual systems of both humans and monkeys under reduced visibility rely on coarse visual information, such as shape, i.e. outline of an animal, or salient features, i.e. visual cues for detecting an animal in a natural surrounding (Macé et al. 2010; Elder and Velisavljević 2009). The unique human ability to anthropomorphize (Heberlein and Adolphs 2004) can directly be linked to

the foregoing anthropological discussion on the inherent anthropomorphism of different ontological regimes in traditional societies.

Neuroscientific research has determined the importance of the connection between color and motion, with the importance of movement in visual perception, associations, and response. Eye movement patterns are affected by cognitive tasks, and behavioral eye-tracking studies have been used to study content-related top-down as well as visually-driven bottom-up processes in art perception (Massaro et al. 2012).

It has also been stressed that human inherent plasticity means that the brain undergoes ongoing neurogenesis and that individual human experience can modify brain structures (Erickson et al. 1998) with the importance given to the connection between embodied or grounded cognition that argues that the mind is rooted in the material world. Perception is thus “*shaped and determined by the motor possibilities of the perceiving brain/body, i.e. the response systems*” (Helvenston and Hodgson 2010: 68; cf. Noe 2004). This gave rise to the embodied theory of perception and multimodal notion of vision: “Our visual perception of objects in the real world implies a lot more than the mere activation of our visual brain. Vision is always a multimodal enterprise, encompassing the activation of sensory-motor, visceromotor, and affect-related brain circuits” (Massaro et al. 2012: 2). In this context, among those who study early art it has also been suggested that due to different environmental and other constraints that separate the experience of prehistoric and modern humans, there must be significant differences in the organization of some of the mental faculties (Helvenston and Bahn 2004).

One of the important neuroscientific discoveries relates to mirror neurons and a variety of mirroring mechanisms in the brain linked to the phenomenon of imitation (Rizzolatti and Sinigaglia 2006). The neural structures that are activated when the subject performs a certain action or experiences a particular sensation become also activated in the subject who only observes those who perform an activity or experience a sensation first-hand. Here the key role of empathy is stressed in relation to the experience of works of art (Freedberg and Gallese 2007). The development of mirror neurons in certain primates could perhaps also be linked to complex social interactions that are part of the so-called Social Brain Hypothesis (SBH) proposed by Dunbar (1998) and further elaborated more recently (Dunbar et al. 2010). According to SBH, development of novel biological and cultural mechanisms were evolutionary responses to the need of organizing social networks as the consequence of increasing group size and ensuing social complexity.

There is also the phenomenon of similarities and convergences in the iconography of depictions between different and often very remote examples of early art, such as, for instance, those found in Europe and, more recently, in Southeast Asia where there cannot be any common origins or diffusion of styles and modes of depictions that would account for observed similarities. It has been suggested that these “similarities derive from the way the visual brain processes visual information” (Hodgson and Watson 2015:

784). Several pervasive graphic features have been found in different examples of prehistoric artworks around the world: (1) predominance of sideways profile views and outlines, i.e. occluding contours; (2) emphasis on spinal contour; (3) salient features of the body shown (e.g., horns, antlers, head); (4) exaggeration of certain salient features of the corporeal form.

Similarities also exist in the importance and modes of depicting motion, which has previously been stressed as visually salient feature of the dynamic qualities of an image (cf., Arnheim 1992; Freedberg and Gallese 2007). Cross-culturally, similar sets of graphic devices were used in palaeoart to depict motion: multiple images placed in sequence, as at Göbekli Tepe; repetition of particular body parts; superimposition of multiple depictions of animals as in the Palaeolithic art of Chauvet Cave; or, motion-like depictions of limbs (Apéllaniz 2006; Azéma 2005; 2007).

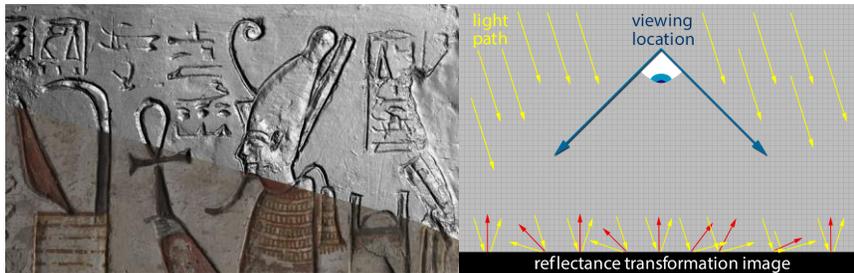
Having reviewed, arguably selectively, certain aspects of neuroscientific research that can productively be linked to the study of early art, I turn to some of the more recently developed digital recording techniques that can help in the study of art from a technological perspective. These approaches are connected to a well-established analytical framework developed by the French archaeologists André Leroi-Gourhan (1964) when studying the complete *chaîne opératoire* (operational sequence) that involves different steps from the selection of raw material for manufacturing, the process of manufacturing, use and sometimes re-manufacturing and re-use, and eventual discard of artefacts, including objects defined as art.

Techno-Functional Approaches in the Study of Prehistoric Art

More recently, two particular digital recording techniques came into prominence that allow rendering of high-resolution imagery that can then be used in the study of objects of art without the necessity of using high-cost 3D scanning facilities. These are 3D modeling using close-range photogrammetry and Reflectance Transformation Imaging (RTI). Apart from advantages regarding the costs of recording, these techniques are highly portable and also allow one to produce 3D libraries of studied artworks and thus contribute to their preservation/conservation and eventual presentation as tangible cultural heritage.

RTI is a computation photography technique that captures the surface shape and color of the artifact with good results achieved on different types of surfaces and enables interactive re-lighting of the subject from any light direction (e.g., Díaz-Guardamino et al. 2015; Jones et al. 2015; Porter et al. 2015). Starting from a set of photographs (around 60-70 images) acquired with a fixed camera under varying lighting conditions, RTI encodes the acquired data in a compact way, using view-dependent per-pixel reflectance functions, allowing the generation of new images using any light direction in the hemisphere around the camera place. The software used is *RTIBuilder* (open source) and the rendering of the image is exported with the *RTIViewer*.

It allows the researcher to enhance perception and interpretation of the object's surface through interactive rendering of the surface with dynamic re-lightening. RTI is particularly helpful in the study of engravings.



(A) An example of RTI representation showing color information (bottom portion) and “specular enhancement” mode showing surface shape and enhanced reflectance (top portion); (B) reflection information captured in the RTI.

The photogrammetry represents a complimentary method and is normally used as a preliminary recording step, not only to produce a library of studied art objects in 3D (which can be used for dissemination purposes on the web), but also to obtain a preliminary medium-resolution rendering of the surface of each art object as high resolution of each accomplished by the application of RTI would be too time- and data/space-consuming. This further allows one to survey and select certain areas of interest to record those by means of RTI afterwards.

With both of these techniques, the intention is to examine traces that reveal manufacturing as well as use histories/biographies of studied objects.

Early Prehistoric Art in Italy: Case Studies

The comparative scope of my project encompasses examples from Palaeolithic hunter-gatherer rock art as well as *art mobilier* to the artistic expression of the first farming communities in Europe and the eastern Mediterranean, with a particular focus on Italian examples of prehistoric artworks. After southwest France, Cantabrian Spain, and southern Germany, some of the most interesting examples of early prehistoric art have been discovered in Italy. However, rather than parietal paintings and engravings that dominate the archaeological record of caves in southwestern France and Cantabrian Spain, at Italian Palaeolithic sites more frequently encountered are examples of painted or engraved portable objects of art with only several painted or engraved Palaeolithic cave/rockshelter sites. The question regarding what is the cause of such a differential/unbalanced distribution of Palaeolithic art across Europe will be developed in the course of the project but cannot be discussed in much detail in this short paper. Yet, the predominance of portable engraved objects in early Italian prehistory makes the use of the suggested imaging techniques more feasible. In this final section, I will provide some details about the context and range of prehistoric artworks in Italy with particular emphasis on those sites that were selected for first-hand studies by employing photogrammetric and RTI recording techniques.

One of the earliest examples of art in Italy comes from Grotta Fumane and can be dated to ca. 40,000 cal BP. Here pieces of cave wall contained a red ochre painting of an animal figure (perhaps a weasel) and an anthropomorphic figure with a likely depiction of horns—perhaps a therianthrope image (Broglio et al. 2009). In Grotta Romanelli in Apulia, a series of carved figures possibly depicting bovids were found as well as geometric motifs and a vulva (Martini 2016; Mussi 2002). Grotta Paglicci in the Gargano Peninsula is known after a parietal painting of a horse and handprints dated to the Gravettian period, ca. 25,000 cal BP (Martini 2016; Palma di Cesnola 1987). At the rockshelter of Riparo Romito in Calabria that contains Epigravettian layers dated to ca. 15,000 to 13,000 cal BP, engraved outlines of bovids in sideways profile views were found. Engraved outlines of bovids were also found at Grotta del Caviglione in Balzi Rossi in Liguria, at Cala dei Genovesi in the Levanzo Island, at Addaura and Niscemi Caves at Monte Pellegrino in Sicily and the Caves of Za Minica, Puntali, Racchio, and Isolidda in the Palermo and Trapani areas (Martini 2016; Mussi 2002).

Regarding *art mobilier*, at the site of Riparo Dalmeri, associated with the Epigravettian layers dated to around 13,000 cal BP, a large number of red ochre painted limestones were found across the site surface with both figurative (animal and human) and geometric motif depictions all intentionally placed within the occupation area with the ornamented side facing down (Dalmeri et al. 2011). Portable art engravings were found in Grotta Polesini in Lazio (Venditti et al. 2016), Riparo Tagliente in Veneto, Fucino caves in Abruzzo, Grotta Paglicci in Apulia (Arrighi et al. 2008; 2012), Riparo del Romito in Calabria (Graziosi 1973; Grifoni Cremonesi 1998), Riparo di Vado all'Arancio (Minellono 1972), Grotta delle Settecannelle in Lazio (see below). At these sites, both “naturalistic” incised animal depictions and geometric motifs on portable objects are found. The materials used included river pebbles, limestone slabs, animal scapulae, and flint flakes.

Settecannelle

One of the sites from which material has been made available for this project is Grotta delle Settecannelle (e.g., Ucelli Gnesutta and Cristiani 2002; cf. Borić and Cristiani 2016 and references therein). Examples of portable art at this site come from two final Epigravettian levels: Layer 10, dated to the period between ca. 15,650 and 13,490 cal BP, and Layer 8 dated to ca. 13,030 to 11,760 cal BP. Stone pebbles were in a number of instances incised with “naturalistic” depictions of aurochs. These layers also yielded incised bones with a geometric style of depiction and artifacts with repetitive incisions. One black-burnt bone object bore parallel rectilinear incisions in combination with a zig-zag motif. The decoration extends on the whole surface leaving free only the central part. In this zone, a microscopic examination revealed that a grid of straight lines was traced at first in order to follow a preconceived decorative pattern for the rectilinear motif. Three abstract motives are represented on the bone: a meander, an angular band, and a broken line.

This example hints at the possibility afforded by the reconstruction of technical gestures in the execution of works of art that could further be linked to neuroscientific and wider anthropological issues.

Riparo Gaban

As a comparandum to previously reviewed examples of Last Ice Age forager art, I chose to look at a chronologically later example of artistic production found at the site of Riparo Gaban in the Adige Valley in Trentino. Here, in collaboration with colleagues from the Soprintendenza Archeologica del Trentino, University of Trento, and Museo Tridentino di Scienze Naturali, a radiocarbon AMS-dating project was run to determine with more precision the date of the Mesolithic-Neolithic transition at this site and region and the date for the appearance of artworks that were found both in the latest Mesolithic (Castelnovian) layers dated to the late 6th millennium BC as well as in the earliest Neolithic layers dated to the late 5th millennium BC (see Pedrotti 2009). The site is well known as it yielded the richest repertoire of portable art produced in the Alpine region. The specimens include bones and pebbles incised with both figurative and geometric motifs. For instance, the so-called “Venus of Gaban” is an anthropomorphic figurine carved on a blank extracted from a red deer metapodial bone and colored with ochre. Another anthropomorphic figurine was carved on a pig molar. There was also an elongated pebble decorated with anthropomorphic features, and due to certain iconographic similarities it was compared to figurative examples of artworks from Lepenski Vir (Bagolini and Biagi 1985).

The reconstruction of technical gestures in this example of prehistoric art and its broader contextualization and comparison with examples of portable art from earlier prehistoric periods will further broaden the comparative scope of the project.

In the foregoing background discussion only preliminary sketches of the ongoing project are provided, arguably with many aspects needing further analyses, along with a more comprehensive integration of neuroscientific, anthropological, and techno-functional approaches. By examining the cognitive and socio-cultural aspects involved in manufacture, use, and destruction, or discard of artworks in the archaeological case studies under examination a more grounded reconstruction can be made of the past perceptual backgrounds, modes of seeing and relating in the world as well as cognitive efficacy of early artworks.

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