Article

Stone Age Mnemonics

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Abstract: Ongoing hominin encephalization during the Middle Pleistocene supported the emergence of controlled vocalizations, meaningful mimetic progressions and exogrammatic skills. 'Exograms' are defined as memory traces stored outside the brain as consciously-sequenced information packages meant to stabilize and transmit adaptively-advantageous perceptions of reality. It is suggested that the abstract rock art of the period documents a culturally orchestrated mnemonic convergence and the application of emergent cognitive abilities at a collective level.

Keywords: *Homo erectus*; causality; collective memory; ritual; rock art

Introduction

Rock art research is an endeavor pursued by archaeologists and, indeed, most inquiries into the origin and significance of rock art are published in archaeological journals. Notches, engravings, geometrical patterns and figurative representations – engraved, or painted – are vestiges of the past and, as such, they are categorized as 'artifacts.' According to the Collins English Dictionary (2014), an *artifact* "is something made or given shape by humans, such as a tool or a work of art, especially an object of archaeological interest." Unfortunately, the 'simple-to-complex' understanding of technological development has left its imprint on rock art research. Most approaches to the development of hominin symbolling abilities adopt such a linear hierarchy according to which, abstract petroglyphs are classified as expressions of inferior cognitive faculties and iconographic illustrations as self-evident signs of higher cognition. For example, in the paleosemiotic interpretation pioneered by E.V. Culley (2016) notches, engravings and abstract geometrical patterns are labeled as *ancestral* and *emergent* symbolling abilities, while figurative paintings are categorized as *fully-mobilized* expressions of cognitive modernity. But, the *transition from abstract to iconic* cannot be dated, mostly because there are no clear-cut abstract or iconic 'periods.' The archaeological record documents both Lower and Middle Paleolithic examples of iconic understanding and Upper Paleolithic instances of abstract representation, which means that the relationship between the two is rather complementary than linear. For example, the 250 thousand years (ka) old naturally shaped scoria pebble from Berekhat Yam in Israel (Goren-Inbar 1986) or the 300 to 500 ka-old Tan-Tan proto-sculpture from southern Morocco (Bednarik 2013) point to the existence of such an iconic sense already during the Acheulian. By the same token, the anthropological literature mentions cultures that favor abstract patterns over naturalistic illustrations (Sreenathan et al. 2008) to such an extent that, until recently, it was firmly believed that they did not develop iconographic understanding – a presumption that has implicitly presented them as cognitively not yet 'modern.'

Cognitive archaeology adopts a multidisciplinary approach and, in addition to placing the artifact in an established chronological context – as orthodox archaeology does – it also addresses the mind behind the artifact. Malafouris (2013) goes a step further and, by abolishing the artificial separation between mind and artifact, he suggests that what is outside the head must not necessarily be outside the mind. He concludes (ibid.) that it is epistemological contingency, rather than metaphysical necessity, that makes us see in the *objects*, *marks* and *gestures* of human prehistory

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merely external products of the mind, rather than integral parts of it.

The Oxford Dictionary of English (2010) defines *mind* as "a set of cognitive faculties including consciousness, perception, thinking, judgement, language and memory… [it] holds the power of imagination, recognition, and appreciation, and is responsible for processing feelings and emotions, resulting in attitudes and actions."

In the case of works of art, the entanglement between mind and artifact is self-evident. But, tools and other objects of archaeological interest are no exceptions. For example, Acheulian tools are complex and appear to have required advanced planning to create (Wynn and Coolidge 2016). The stress on symmetry and, to an extent, on the esthetic properties displayed by Acheulian bifaces, together with their makers' ability to visualize the outcome of the labor invested implies the presence of basic transmission skills, beyond simple 'aping.' Indeed, it is believed that proto-linguistic abilities (Bickerton 2009, Benozzo and Otte 2017), controlled vocalizations meant to convey meaning (Morley 2003) and illustrative – rather than imitative – mimetic progressions (Donald 1991) were already in the cognitive 'toolkit' of *Homo erectus*, with whom the Acheulian is associated. In such a context, bifaces may also be perceived as 'cognitive tools,' or *mnemonic devices* – beholding a biface conditions the mind to the depiction of symmetry, temporal causality, and the recognition of such properties in objects/phenomena other than the specific tool. To stay with Malafouris (2013), the mind shapes the object, but the object also shapes the mind: our species-specific consciousness emerges at the interface between mind and artifact, very much like in the quantum-inspired 'orchestrated reduction' hypothesis proposed by Penrose and Hameroff (2011). Similarly, Coman et al. (2016) argue for a prehistoric 'mnemonic convergence,' which they understand as a cultural memory 'update' meant to boost the emergent properties of cognition at a collective level. These 'emergent properties of cognition' seem to have their common denominator in *memory* – for example, consciously controlled vocal or mimetic sequences are collectively-devised 'memory trace' configurations. 'Mnemonic convergence,' in such a case, would be the culturally-prescribed 'correct remembering' of a specific sequence. Abstract rock art is an integral part of such a cognitive landscape and, in this paper, I will focus on its role as a mnemonic device meant to facilitate collective memory recall.

Memory, Engrams and Exograms

Memory is of fundamental importance in the question of what makes us human, and how we managed to experience the world in a conscious format. Memory is not necessarily something of the past. *Mental time travel* (Suddendorf and Corballis 1997), for example, is the capacity to mentally reconstruct events from the past as well as to imagine possible scenarios in the future. At a more complex scale, *inductive reasoning* recalls the memory of specific observations and detects patterns and regularities upon which causally consistent hypotheses can be elaborated. Such mental constructs are heavily influenced by 'the predictable-world bias,' which revolves around the inclination to perceive order where it has not been proved to exist, either at all or at a particular level of abstraction (Holland et al. 1989).

The first manifestations of human-specific memory can be inferred by relying on archaeologically preserved traces. From the many complementary cultural techniques devised to enhance collective memory recall, only the graphic expression was preserved, as rock art. But, given the culturally biased perception of the concept 'art,' a less controversial term was proposed, namely: 'exograms' (Donald 1991, Bednarik 2014b). Exograms are concisely defined as 'memory traces' stored *outside the brain*. Thus, they are functionally related to 'engrams,' which are theorized (not necessarily following Semon, who coined the term in 1921) to be biophysically or biochemically combined memory traces stored *in the brain* – and other neural tissue – that become consolidated in response to external stimuli.

The consensus view in neuroscience (Schacter 2002) is that the sorts of memory involved in complex tasks are likely to be distributed among a variety of neural systems, yet certain types of knowledge may be processed and contained in specific regions of the brain. Such brain parts as the cerebellum, striatum, cerebral cortex, hippocampus, and amygdala are thought to play an important role in memory. For example, the hippocampus is believed to be involved in spatial and declarative learning, as well as consolidating short-term into long-term memory. Simplistically formulated, short-term memory units (i.e., 'memory traces') distributed in various cerebral areas become associated and consolidated in the hippocampus, where they become long-term (stabilized) *information packages* (i.e., 'engrams') that can be recalled either as an environmentally-determined reaction, or voluntarily, without environmental cueing.

The question is whether engrams become re-consolidated each time when specific external stimuli recur, or whether they exist as permanently consolidated information packages that can be retrieved in an unaltered form – voluntarily, or in response to such stimuli? I would suggest (following Thum et al. 2007, De Jaeger 2014, Gabora 2018) that they are perpetually re-constructed, with slight variations between successive consolidations. In this case, memory is not reliable, it plays tricks on us, and it is dependent on emotional states that are present at the time of reconstruction or on shifts in subjective values and attitudes that have developed during the time elapsed between the experience and its reconstruction.

Our sense organs register the physical settings of an experience. Specific images, sounds, tastes, textures and smells that were present at the time of the experience can trigger out its recall. The sensory input associated with the event is anchored in space and time and stored as a short-term causal A-B-C-D memory trace sequence in the hippocampus. In order to free up neural storage and processing space, loosely linked memory traces – 'tagged' with a spatial, temporal and emotional extension – are broken up and distributed among various cerebral regions. Upon voluntary or environmentally-dictated recall, re-consolidation may be corrupted by subjective axiological shifts that have developed during the time elapsed between storage and retrieval. Likewise, stresses present at the time of retrieval may also influence the outcome of the re-consolidation process. Thus, the sequence in which memory traces are ordered is highly probabilistic and it may assume various configurations (e.g. B-D-A-C) that are not necessarily consistent with each other over time. A long-term consolidation of an engram cannot occur as long as memory traces are in such a state of superposition (Gabora 2003) and as long as each retrieval results in slightly different and thus, unreliable configurations (Schacter 2002). The only way to add *durability* to specific configurations is by embedding them according to an *objective* causality.

Engrams belong to what is known as *subjective*, i.e., autobiographical memory. Engrams are not created to last, and their texture may vary from one re-consolidation to the next. Given the almost unlimited probabilities in the re-sequencing of memory traces stored in various parts of the brain, it is not surprising that biology and psychology – the disciplines that study autobiographical memory – have not succeeded capturing engrams in time and locating them in space. The only solution to add detectable durability to specific configurations that memory traces can assume is, as said above, adjusting them to an objective causality. Objectivity implies an *external* and agreed-upon *rule of sequencing* which would also render them *accessible* to other brains (*sensu* Block 1995). Such a 'rule' must be accessible itself – learned through copying, or by resorting to various cultural techniques. In other words, consciously-constructed information packages that follow a communally agreed-upon objective causality can be fixed and passed on, from one individual to the other and from one generation to the next. This is precisely the commonly-accepted definition of *collective memory*, which is adopted even by a popular online platform like Wikipedia.

Collective memory is already a cultural category and, therefore, culturally constructed, stabilized and transmitted information packages, unlike engrams, are stored externally, and they are devised to last. While subjective (individual) memory relies on short-lived engrams, objective (collective) memory can be passed on from one generation to the next with the help of *exograms*. Exograms can thus be described as memory traces stored outside the brain as consciously-sequenced information packages meant to stabilize causal calibrations of reality. They belong to the field of cultural and social sciences, with cognitive archaeology being the discipline dedicated to the study of their origin and meaning.

While engrams re-consolidate on spot, as short-lived subjective responses to environmental stimuli, exograms are *permanently consolidated information packages* that can be retrieved voluntarily, as *learned responses* to cultural signals. Moreover, the culturally agreed-upon (objective) causality of exogrammatic representation leaves its imprint on the probable outcome of individual memory recall and thus, an apparent synchronicity between the two becomes the hallmark of cultural evolution.

Material and Non-Material Mnemonic Techniques

Memory and *knowledge* are intimately interwoven categories. Externally stored memory traces are information units that can be combined through associations determined by 'exogrammatic rules' which, in their turn, follow a communally agreed-upon causality. Exograms are the final product of such a cognitive process. Causally-sequenced and stored knowledge can be transmitted from one mind to the other. However, exogrammatic representation is not restricted to graphic abstractions. Memory traces are not strictly visual but, like those used in the consolidation of engrams, they are provided by all the senses. Graphically-externalized memory traces serve only as indexical references to those who are in the possession of *exogrammatic skills* and are thus able to re-iterate and express a causal sequence meant to explain the essence of a specific natural – or other – phenomenon. The *re-iteration*, that is, the conscious causal sequencing of memory traces relies just as much on vocalizations and mimetics (*sensu* Bickerton 2009, Donald 1991). Moreover, exogrammatic skills must also be learned – although the ability for the external storage of information is a biological development, the transmission of exogrammatic *meaning* becomes culturally-conditioned.

Cultural manifestations in which graphic, lexical, rhythmic/musical abilities are applied simultaneously as means of transmission are known in anthropology as 'ritual.' Ritual is characterized by its rigid and conservative nature, which is important for a high-fidelity transmission of knowledge and, implicitly, for reducing the risk of loss, which is inevitable when transmission relies on mere copying. By the same token, *repetitiveness* is instrumental in the embedding of the specific causal order upon which ritual is constructed. Therefore, the first instances of 'fixing' such a causality in stone or wood – instead of simply 'illustrating' it in sand – should coincide with the emergence of hominin ritual behavior. The systematic use (which is not necessarily the origin) of the cognitive abilities that are the prerequisites of ritual behavior – external storage of information (Bednarik 2014b), proto-language (Bickerton 2009), mimetic skills (Donald 1991), rhythmic and proto-musical abilities (ibid., Morley 2003) – can be confidently traced back to archaic hominins, at approximately 300 thousand years (ka) ago. At 300 ka, Middle Paleolithic (Middle Stone Age) 'Mode 3' industries dominated the cultural landscape, world-wide (Bednarik 2013). Unfortunately, the stories, songs and dances of our Mode 3 past are long-forgotten, and the paleoanthropologist must reconstruct a rich cognitive landscape by relying on a limited number of surviving scratches incised in durable material.

Australian Aboriginal cultures have never abandoned Mode 3 industries. Therefore, turning to them to understand the origins and meaning of exogrammatic storage is highly rewarding. Likewise, with ritual taking such a central place in Aboriginal life, we may gain useful insights into its role in cultural transmission. Like *Homo erectus* before them, the ancestors of the Australians were explorers *par excellence* – that is, they had ventured to new shores, to environments that were utterly different from those they were used and adapted to. Upon their arrival, the First Australians were equipped with all the cognitive abilities that paleoanthropologists define as 'modern.' Apparently, they made full use of these capacities: the land was 'named,' and a causal order that was communally-devised in their minds was projected on the physical environment. The cultural approach was followed by a cognitive and behavioral adaptation to their own construct of reality. The specific causality of Dreamtime stories was augmented with songs and dances and, most importantly, with portable 'rock art,' meant to 'fix in stone' the very causal order (blueprint) of Creation. *Tjuringas*, also known as 'material mnemonic devices,' are typical examples of external memory storage. They tell Dreamtime stories that can be easily 'read' by those initiated in exogrammatic skills. The 'readings' are accompanied by 'non-material mnemonic techniques,' i.e., music, dance and song. Every such communal recapitulation of the causal order upon which the environment was mentally constructed re-consolidates the prescribed sequencing of collective Dreamtime memory traces and transmits the information to those who participate in a *coroboree*, or – through meticulous initiation rites – to the next generation. Ritual rigidity and 'The Law' inhibit improvisation and the slightest 'innovation' in the sequencing of memory traces is punishable. Reality is kept 'alive' thanks to ritual behavior – that is, ritual reconstructs and re-consolidates the specific sequencing that makes Reality and the information it pertains accessible to those whose minds are tuned to the same causal 'wavelength.'

Environmental changes that took place after the first 'calibration' of Reality – from meteorite impacts to desertification and rise in sea level – became added to the initial stories and accommodated to their specific causality as 'geomythical sequels' (Hamacher and Norris 2014). Thus, the body of information that had to be transmitted increased additively (not to be confused with 'cumulatively') and, in order to pass on such a vast amount of knowledge, ritual behavior became the central component of Australian culture, unlike in other parts of the world, where cumulative (not 'additive') technological innovation became the cultural preference adopted to address environmental instability (Steiner 2016). From such a perspective, the retention of Mode 3 industries – with every single tool and technique also embedded in ritual – is rather an index of spiritual sophistication than of technological backwardness.

In such a context, Cameron's (2015) question whether Australian 'rock art' should be perceived as 'art or knowledge,' becomes pertinent. Moreover, with the starting point of this discussion being abstract (Mode 3) Lower and Middle Paleolithic material – and non-material – mnemonic techniques and, with the emphasis on ritual transmission, the Australian example might prove instrumental in understanding the role played by exograms in cultural contexts that can be reconstructed only by relying on archaeologically-preserved transmission techniques, namely: rock 'art.'

Contextual Focus

The perception of the immediate environment – as provided by our senses – together with memory traces that may be associated with such a phenomenal 'knowledge,' become accessible to other minds only when they are systematically organized, according to communally-devised rules for a causal sequencing. Einstein's (1954: 12) definition of science, as an "attempt to make the chaotic diversity of our sense-experience correspond to a logically uniform [unified] system of thought" describes precisely the mechanism by which *phenomenal information* becomes converted to *accessible knowledge*. Exograms play a major role in this process and, therefore, the first instances of exogrammatic representation must be correlated with the emergence of 'scientific thought.'

Liane Gabora's (2003: 434) 'contextual focus hypothesis,' namely, "the [mental] capacity to shift between associative – conducive to forging new and random concept combinations – and analytic thought, which is conducive to manifesting them in an ordered, reciprocally understandable fashion" formulates in a succinct manner such a cognitive process. According to Gabora, at the *divergent* end of the continuum there is a defocused, intuitive and associative mode that finds remote or subtle connections between 'concepts' that are correlated but not necessarily causally related. At the other – *convergent* – end of the operational range of the contextual focus is a rule-based, analytic mode of thought that analyzes relationships of cause and effect. Insights and new ideas germinate in a defocused state in which one is receptive to the possible relevance of many dimensions of a situation. They are refined in a focused state, in which irrelevant dimensions are filtered out and only the relevant ones are condensed.

In the case of the human brain, the indiscriminate associative combination of concepts may lead to a combinatorial explosion of possibilities; in other words, to a state of *undecided superposition*. Such a complex state is difficult to maintain and a potential downfall of processing in an associative mode may occur. When – in the divergent mental state – concepts appear in the context of each other, their meanings change in ways that are non-compositional, i.e., they behave in ways that violate the rules of classical logic (Gabora and Kitto 2013). Despite its potential impact, this challenge is not as insurmountable as it might at first seem, as there is one mathematical formalism which was invented precisely to describe such contextuality: quantum theory (ibid.).

Substituting Gabora's 'concepts' with 'memory traces,' I would suggest that their rule-based causal associations can be depicted in the abstract motifs of early rock art, which illustrate a *collapsed* state of superposed memory traces. External memory storage (*sensu* Donald 1991) becomes the *technique* that overcomes the risk of a potential downfall of processing which would be the inevitable outcome of trying to compute the ever-increasing amount of memory traces that were stored in the neural recesses of our big-brained ancestors. Exogrammatic rules lead to a reliable and adaptively-advantageous *stabilization* of the indiscriminate associative possibilities in the combination of memory traces and convert them to causal and, therefore, *reciprocally-understandable* information packages.

Miyagawa et al. (2018: 1) hypothesize a similar cognitive process according to which, "symbolic thinking led to a fundamentally different way to compute data, one that extracts only the essence required for abstract representation instead of computing the entire set of incoming raw information." Such a 'collapsed state' is maintained with the help of ritual behavior, which lends to a causal calibration of reality the durability that is necessary for its perception, representation and transmission.

The Art and Science of Tracking

Without knowing it, Louis Liebenberg (2013a, 2013b) supplied an impressive amount of empirical evidence that strengthens and illustrates Gabora's (2003) contextual focus hypothesis. Liebenberg suggests that there is a link between the development of the 'science of tracking' and the origin of cognitive modernity. He differentiates between two 'scientific' types of tracking: (a) *systematic tracking* is restricted to a step-by-step following of signs, which can be complemented with (b) *speculative tracking* which, in its turn, relies on the meticulous gathering and combination of information from signs, until it provides a causally-correct indication of what the animal was doing and where it was going. Speculative tracking involves the creation of a working hypothesis based on a causal association of memory traces related to animal behavior, topography and other tangential phenomena. The emphasis is primarily on identifying, *mentally-sequencing* and *verbally-debating* empirical evidence in the form of tracks and other signs. In other words, with a knowledge of animal behavior in mind, trackers 'zoom-in' to look for signs where they expect to find them. They can decide to follow them systematically, or to interpret the signs, *simulate* a causally-correct mental model and let the hypothesis guide them to the animal. The ability to *predict* – relying on inductive reasoning – animal behavior based on minimal indexical referencing is achieved in a convergent (analytical) mental state. Conversely, and complementing 'scientific tracking,' following the identification of signs, the hunters do not waste time to follow them one-by-one, or to debate their meaning at length. They process the minimal information in a divergent (associative) mental state, in which causal order is not necessarily observed and they proceed with running the prey down, based on their 'intuition.' During the run, they maintain such a defocused mental state and enter a trance-like condition in which they become the chased animal and assume its behavior. For example, in the last episode of David Attenborough's BBC documentary *The Life of Mammals* (2002) such a 'persistence hunt' is followed. At its beginning, the hunters focus on finding tracks and signs necessary for a causal prediction of the prey's movement. During the run, and likely because of the physical strain involved, the hunters become defocused and fall into a trance-like state in which they access the mind of their quarry and intuitively follow the route taken by the fleeing animal. This is not a sign of paranormal abilities achieved in an altered state of consciousness, but the result of the simultaneous, non-analytical processing of memory traces related to animal behavior, which enables the hunter to 'become' the animal – that is, assume its feelings, instincts and behavior.

Liebenberg uses interchangeably the terms 'science' and 'art' of tracking. This is not incidental: systematic, i.e., convergent tracking may be designated as a scientific endeavour, while tracking in a trance-like – that is, in a divergent – mental state is what Liebenberg calls 'creative science.' The specific causal outcome ('collapse') of a defocused memory trace combination achieved in a trance-like condition during the hunt can become part of a reciprocally-understandable *repertoire* which, in its turn, can be stored externally ('stabilized') and *transmitted* as 'knowledge.' The experience of the trance is recalled in the ritual dance that recapitulates the hunt and the insights acquired in a divergent mental state are shared with the community. The mimetic re-iteration may be accompanied by graphic illustration (not necessarily painted on rock) which, in this case, could be a figurative depiction of the hunt, or of a therianthrope.

The First Artist/Scientist

This takes us back to the question whether exograms are 'art,' or 'knowledge?' Are *abstract engravings* on stone/wooden *tjuringas*, or *figurative illustrations* of hunted animals and therianthropes witnesses to convergent and, respectively, divergent mental processes? Does abstract rock art *sketch* causal constructs of reality and do figurative art-like productions *illustrate* subjective phenomenal experiences? Meanwhile, let us suffice with the observation that both exogrammatic modalities are meant to transmit/share knowledge acquired in antithetical mental states. The ability for both abstract and figurative representation must have evolved in parallel with the capacity to shift the contextual focus between associative and analytical perceptions of reality and with the emergence of the practice to alternate between systematic and trance tracking.

However, the preference for abstract or figurative exogrammatic representation depends on the importance of the specific type of knowledge that must be transmitted: a conscious formatting of reality became a necessity when, due to increased neural capacity, an indiscriminate associative combination of memory traces could have easily resulted in a combinatorial explosion of possibilities which, in its turn, could have had maladaptive consequences. With which human ancestor did the neural storage capacity become large and complex enough to accommodate an amount of memory traces that could have resulted in a breakdown of associative processing? Answering this question will implicitly determine the date when convergent thought and an analytical/causal perception of reality became the most important cognitive signature of our ancestors.

I have tentatively compared the functionality of Australian material mnemonic techniques to that of archaeologically-preserved Mode 3 rock engravings. My comparison was justified by the similarity between the motifs depicted and the technological setting within which they were conceived and produced. I have theorized that the ancestors of Australian Aborigines, very much like *Homo erectus* before them, had ventured to new environments at a developmental stage when all the cognitive abilities that paleoanthropologists define as 'modern' were in place. I argue that biological fitness acquired through cognitive flexibility enabled *Homo erectus* to venture out of Africa and granted their survival and success in novel environments. Very much like the First Australians, they have presumably 'created' causally-ordered mental landscapes to which they became adapted and in which they thrived.

According to Liebenberg, the ability to shift between the mental states that are employed in persistence hunt can be attributed to *Homo erectus*. Indeed, the paleoanthropological record seems to support Liebenberg's suggestion (Carrier 1984, McCall 2014).

Following Donald (1991), let us consider his suggestion according to which, with the enlarged cranial capacity of *Homo erectus*, the human mind became radically different from its ancestral, pre-human condition. This change was characterized by a shift from an *episodic* to a *mimetic* mode of cognitive functioning, made possible by the onset of the capacity for voluntary retrieval and fluid sequencing of stored memories, independent of environmental cues. If not environmental, then the cues would be, arguably, *cultural*. Therefore, memory storage techniques should also be cultural, i.e., *external and reciprocally-understandable*. Cultural transmission with *H. erectus* must have been beyond simple copying, which would already imply complex and lengthy vocalizations in a culturally agreed-upon order.

Ian Morley, in his seminal thesis on the archaeology of music (2003), concludes that by approximately 600,000 years ago, with *Homo erectus*, the vocal and neurological apparatus for voluntary control over the structure and complexity of vocal utterances was already fully-developed. This enabled *extended* and *planned sequences* of such utterances. Morley attributes a communicative dimension to consciously-controlled pitch, contour and intensity. As control increased, the length and complexity of sequences would also increase. Subsequently, ''the order in which the expressive vocalizations occurred could assume meaning'' (ibid.: 196). Here, Morley describes a typical convergent cognitive process and, because his focus is on music – which we immediately identify as an 'artistic' expression – the thin red line that separates art and knowledge becomes blurred.

To sum up, the *origin* of the cognitive abilities which are the prerequisites of ritual behavior – external storage of information (Bednarik 2014b), proto-language (Bickerton 2009), mimetic skills (Donald 1991), rhythmic and proto-musical abilities (ibid., Morley 2003) – can be confidently traced back to *Homo erectus*.

From Random Use to Systematic Application

Based on isolated finds, like grooves incised on a bovid bone from the Bulgarian Kozarnika Cave (the age of which was estimated by Bednarik [2014a] to be >1 million years old), I would suggest that the antiquity of ritual behavior may be pushed back in time to an even earlier age. Let us not forget that the Kozarnika bone is likely only the graphic aspect of a behavior that, as seen above, cannot be separated from its vocal, rhythmic and mimetic extensions. Spirals, parallel lines or zig-zags traced on materials other than rock would have not survived the test of time, due to taphonomic processes. Isolated finds may however hint to behaviors that were practiced in contexts in which stone, bone or wood became the preferred material used for exogrammatic representation. For example, although the ability to draw has a documented 73 ka antiquity (Henshilwood et al. 2018), the persistence of engraving techniques at the same location (Blombos Cave), 3 millennia later (d'Errico et al. 2001), points to the intention to stabilize in time and secure the meaning behind the abstract hashtags depicted in both the perishable drawing and the incisions in durable bone and ocher. I would theorize that the practice – and the causal understanding of reality that lies behind it – did not appear suddenly, but it gained in importance and assumed increased meaning at around 300 ka ago, which would also explain the number of finds dated to that period. This might also point to the possibility that it was approximately at this time when the first individual cognitive trials of a causal understanding of reality through inductive reasoning became a well-established collective and trans-generational cultural practice.

Donald (1991) identifies three uniquely human systems of memory representation, namely: (i) *mimetic* (starting with *H. erectus*, at c. 1.5 million years ago); (ii) *lexical* (archaic *H. sapiens*, 300,000 years ago) and (iii) *external* (attributed exclusively to 'anatomically modern' humans, at 40,000 years ago). Contrary to the three-tiered model, I would suggest that the cognitive abilities listed above have developed in synchronicity, as complementary parts of a complex ritual behavior. Therefore, a single transition is more likely than three hierarchically-distributed cognitive punctuations. Especially so, because the cognitive expressions of the first and second stages – as theorized by Donald – already include the mental abilities attributed to the third stage. Mimetic, lexical *and* graphic external memory representations are not only complementary to each other but, because they are the products of the same cognitive process, they do not make any sense when ordered hierarchically.

In conclusion, symbolling abilities seem to have been present in a latent/emergent form already with *Homo erectus*. However, the faculty – or its random use – does not imply its immediate and wide-scale application. The well-documented systematic application of these ancestral abilities – the entire set of which I have labeled 'ritual behavior' – may be attributed to archaic *Homo sapiens* who, presumably, were also in the possession of latent iconographic abilities that would become fully-mobilized only when acquiring meaning and importance in a strictly cultural environment (for a discussion, see Steiner 2017).

Species-Specific Consciousness

So far, I have repeatedly referred to a 'consciously-sequenced' perception of reality. I have also floated the idea that Lower and Middle Paleolithic abstract representations should be perceived as the tangible signs of an emergent species-specific consciousness. At this point, I must address the elusive concept of 'consciousness.' Given the various perceptions and explanations – which range from the spiritual to the neuropsychological and quantum-mechanical – there is no clear-cut consensus definition of consciousness. From the perspective of what was said up to this point, the best fitting approach would be that offered by Ned Block (1995). Block differentiates between *phenomenal* (P-) and *access* (A-) types of conscious perception: 1) *P-consciousness* is raw experience of movement, colors, forms, sounds, sensations, emotions and feelings, with our bodies and responses at the center (This is, practically, Einstein's ''chaotic diversity of our sense organs,'' as described in a previous section. It can also be likened to Gabora's divergent, unfocused mental state, the phenomenal awareness of superposed and non-compositionally related memory traces.) and 2) *A-consciousness*, which is information stored in our minds and made accessible for verbal report, reasoning, and the control of behavior (Einstein's ''logically unified system of thought'' and Gabora's convergent mental state – in which loosely related memory traces assume a ''causally-ordered and reciprocally understandable form'' – would be the best parallels.). I argue that the ability to shift between Block's P- and A- aspects of consciousness and between the divergent and convergent ends of the operational range of Gabora's contextual focus are closely related and contemporaneous cognitive aptitudes.

The abstract rock art corpus that has survived from the very period when such abilities emerged are the material remains of a cultural behavior that must have included additional, non-material cognitive mechanisms of *converting individual phenomenal perception to collectively accessible knowledge.* As Block stresses, A-consciousness implies *verbal report* (i.e., [proto-]linguistic skills), *reasoning* (that is, a causal interpretation and perception of not necessarily causally-ordered information and the ability to predict in the future, based on analytically-devised rules) and *controlled behavior* (which is determined by and adapted to the causally-ordered construct of an already predominantly cultural environment).

A Cultural Exaptation?

Francesco d'Errico and colleagues approximate a comparable cognitive transition in a recent (2017) paper suggestively titled *From Number Sense to Number Symbols*. In the article, they suggest that a 44 ka-old incised baboon fibula from Border Cave (South

Africa) and a similarly notched 72 ka-old hyena femur from Les Pradelles Cave (France) may be interpreted as 'exosomatic devices' meant to store numerical information. Judging by the dates of the artifacts and by similar finds in other parts of the world, the authors conclude that such exosomatic devices were in use with archaic humans during the African Middle Stone Age and the European Middle Paleolithic. They interpret the cognitive background of these devices as 'cultural exaptations' which, simplistically formulated, means the application of a biologically-developed cognitive potential in a cultural environment, where the biological ability – or pre-adaptation, as the term 'exaptation' was previously known – becomes adaptively useful and thus, perpetuated in a novel form.

However, the ages of these artifacts are much later than those attributed to the already mentioned and similarly notched/engraved finds from Kozarnika, Wonderwerk or Bilzingsleben and dated by Bednarik (2014a) to > 1 my, 300 ka and > 325 ka. Apparently, we can identify two distinct periods in which abstract notches and engravings had special meaning and importance: (i) the exogrammatic representations of archaic hominins from the first period (up to c. 300 ka) may be perceived as the indices of an emergent consciousness and ritual behavior, while (ii) notches and engravings dated to c. 70 ka and continuing well into the Upper Paleolithic may, indeed, be perceived as expressions of cultural exaptations rooted in earlier, but only randomly applied symbolling abilities.

Language and Time

The subtitle of Derek Bickerton's (2009) book *Adam's Tongue – How Man Made Language and How Language Made Man* – is just as suggestive as that of the abovementioned paper. Block's A-consciousness implies *verbal report* and reasoning. While musical and mimetic abilities would have had a role in the reiteration and trained perception of causally-sequenced constructs of reality, the descriptive character of language would have been instrumental in the consolidation and transmission of such a conceptually-constructed cultural environment. Not incidentally, Bickerton stresses on the close relationship between niche construction and the development of language. Very suggestively, the 'how man made language' part of the subtitle refers to the process of constructing the cultural niche, while the 'how language made man' is a fitting description of how man adapted to his/her own cultural construct.

Language and time are closely related categories. Bernie Taylor (2017) offers an excellent model for the origin of our linear perception of cyclical time. Without being aware of it, his approach is complementary to Bickerton's proposal regarding the origins of language. Taylor introduces the concept of 'biological time,' that is, the meticulous observation of animal behavior, the specifics of which – calving, rutting, mating, gestation periods – are correlated with seasons, floods, lunar phases and other repetitive natural phenomena. Lunations become thus indexical references for, say, the availability of food resources. Animal behavior may vary from season to season and tracking the animal may ask for different strategies during different lunar phases. Similarly, the meat of certain animals may be rich in fat and nutritious, depending on the heliacal or nocturnal rising/setting of specific constellations, with the hunt being planned accordingly. Observing and *remembering* biological time results in an impressive amount of knowledge the transmission of which, according to Taylor, relies not only on language, but is complemented by rock art. For example, the famous stag from the Axial Gallery of Lacaux was painted above a row of abstract dots and a rectangle. The latter, in Taylor's interpretation, points to a specific time of the year when the stag's antlers are at their fully developed stage and, therefore, the animal possesses the maximum amount of 'potency' during its biological time (see Lewis-Williams 1988, Steiner 2017 regarding the importance of 'tapping' power-animal potency). Of special interest here is that, although the Axial Gallery was painted during the Upper Paleolithic, the iconic depiction of the stag is accompanied by abstract representations. Therefore, the functionality of the latter cannot be directly related to the conversion of phenomenal perception to accessible knowledge but rather interpreted as a subsequent phase of cultural adaptation to an already established construct of reality, an adaptation of subsistence, social and ritual activities to the biological time of the stag depicted in this specific mural. Therefore, Taylor's 'biological time' may just as well be called *cultural time*.

According to Eliade (1957), the full acceptance of cultural time is one of the reasons for modern man's anxieties. Man's desire to escape the causal confines of his own construct of reality – modelled on language and cemented with time – can already be depicted in the 'creative explosion' of the Upper Paleolithic when, as a consequence of tens of millennia of cultural conditioning, the ability to shift the contextual focus to its associative end (*sensu* Gabora 2003) became severely eroded and restricted to children and, eventually, to 'ritual specialists' (for a discussion see Bednarik 2007, Snow 2013, Steiner 2016).

From Biological Cognition to Cultural Behavior

In the sections above, I have followed the simultaneous emergence of consciousness and the first instances of exogrammatic expression by drawing parallels between Ned Block's theory and cognitive phenomena that seem to support the view that the abstract patterns of Lower and Middle Paleolithic rock art reflect our ancestors' preoccupation with adapting reality to a culturally-devised conscious format. One of the main points in the argument was Gabora's *contextual focus hypothesis*, which was expanded by Gabora and Kitto (2013) in order to accommodate a quantum approach to consciousness. When – in the associative mental state – memory traces appear in the context of each other, their meanings change in non-compositional ways that violate the rules of classical logic. Gabora and Kitto adopt the classical Copenhagen interpretation according to which, *conscious observation results in quantum state reduction*. That is, memory traces in an undecided state of superposition become manifested in an ordered and reciprocally-understandable format, according to a communally-devised 'causal stencil.' The quantum collapse is the result of convergent thought that extracts only the essence required for abstract representation instead of processing the entire set of memory traces that are open to infinite associative possibilities in a defocused mental state. The *causal stencil* is a cultural product which, as I argue, is the general motif of the oldest abstract representations.

Contrary to the popular Copenhagen tradition, Penrose and Hameroff (2011) argue that quantum state reduction is not the result of conscious observation but, quite the opposite, *consciousness is the result of quantum state reduction*. In other words, a specific outcome of the combinatorial probabilities of superposed memory traces occurs in synchronicity with – and as a function of – an objective quantum state reduction (OR).

I am inclined toward the classical model, because of its compatibility with my understanding of the role played by the oldest (> 300 ka) abstract representations, as detailed in the previous sections. However, the Penrose-Hameroff hypothesis may explain the cognitive background of abstract notches and engravings that I have tentatively ascribed to a later (< 70 ka – 12 ka) period that precedes and then overlaps with the Upper Paleolithic iconic explosion. I would therefore suggest that the objective causal order to which our conscious perception of reality adjusts itself – like in the Penrose-Hameroff model – is the very construct of reality devised by our Lower/Middle Paleolithic ancestors and stabilized during tens of millennia of ritual behavior. While their abstract notches and geometrical patterns reflect a conscious modelling and calibration of reality, abstract representations from the second period may be explained as indices of the conscious conditioning of our behavior, as an adaptation and adjustment to an already externalized – and therefore objective – cultural construct of reality. *Art-as-we-know-it* would emerge as a next step, as a technique (*sensu* Ellul 1964) devised to buffer between biologically-developed cognition and culturally-acquired behavior.

Symbol, *number*, *language*, *time* and *art*, according to anarcho-primitivist philosopher John Zerzan (1999), are the very cultural constructs that alienate the 'noble savage' from his natural environment and which restrict the full realization of his biological potentials. However, Zerzan's *reification*, i.e., the tendency to take the conceptual as the perceived and to treat concepts as tangible realities, is a cognitive exaptation of both 'savage' and 'civilized.' The only difference between the two is in how their commonly-shared cognitive aptitudes were applied and how the inherent risks of cultural evolution were managed (cf. Steiner, 2017).

Conclusions

Steady cranial growth during the Lower and Middle Paleolithic (L/MP) led, starting with *Homo erectus*, to a surge in neural storage capacity and thus, to the necessity to process ever-increasing amounts of information. The transition was also characterized by the onset of the ability to shift between associative – conducive to forging memory trace combinations that are contextually, but not necessarily causally related – and a rule-based, analytic mode of thought, conducive to manifesting them in an ordered, reciprocally-understandable fashion that analyzes relationships of cause and effect. The indiscriminate associative combination of memory traces stored in the neural recesses of our big-brained ancestors could have easily resulted in a state of undecided superposition. Such a complex state would have been difficult to maintain and a potential downfall of processing in an associative mode became an imminent risk – when memory traces appear in the context of each other, their meanings change in ways that are non-compositional, i.e., they defy the rules of classical logic. External memory storage became the technique meant to overcome the risk of such a potential downfall. It was suggested that the abstract motifs of early rock art would represent a 'collapsed' – and hence, transmittable – state of superposed memory traces. Exogrammatic rules allow for a specific – and adaptively-advantageous – stabilization of the infinite combinatorial possibilities of memory traces and convert them to communally-accessible information packages. The mimetic, rhythmic, lexical and graphic representation techniques of consciously-sequenced memory traces have developed in synchronicity, as the complementary parts of a complex ritual behavior employed in the already cultural transmission of externally-stored 'objective' knowledge.

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