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EXOGRAMS

Robert G. Bednarik

Abstract. Palaeoart constitutes the entire surviving corpus of exograms available from the distant hominin past, providing a principal resource for accessing cognitive dimensions of early humans. The potential of exogrammatic review has remained largely unexplored so far in palaeoart research. The reasons for this are explored, and the role of exograms in the development of semiotic capacities and mental constructs is examined. It is shown that, among the classes of evidence available to reason about the cognitive evolution of hominins, exograms, although truncated taphonomically, are the most comprehensive and dependable source of information. However, it also emerges that this record needs to be considered in scientific rather than simplistic humanistic terms. Its potential in exploring neuroscientific aspects of hominin evolution is investigated.

Introduction

The arguably most conspicuous aspect of Pleistocene archaeology is that it has rarely addressed the most important question in the discipline: what is it that caused the development of hominins to change from an evolutionary (dysteleological) process to a teleological one? It is generally agreed that this process began as an evolutionary progression, determined essentially by Darwinian natural selection. It should be also obvious that it ended as the precise opposite: a teleological, clearly not evolutionary process. Archaeologists define the incommensurability of their discipline and the sciences by speaking of 'cultural evolution'. Archaeological progressivism, based as it is on a Eurocentric reality construct, implicitly views development as teleological, towards 'more developed' forms. Regarding evolution as having an ultimate purpose, the creation of a superior species, is an ideologically inspired falsity, and the concept of 'cultural evolution' is somewhat of an oxymoron: cultural development is not evolutionary, cannot be evolutionary. One might say that the development and transmission of culture is by memes rather than genes, and the process of development is reversible. Thus the change from a dysteleological to a teleological development is the key element in understanding the human condition (Bednarik 2011a), and yet it has rarely been examined in this light — although various causes have been suggested for human evolution, such as 'art' (Dutton 2009), cooking (Wrangham 2009; Wrangham and Carmody 2010), sexual selection (Miller 2000) and technology (Taylor 2010). How and when human self-selection and human culture changed the process to a teleological one is crucial to understanding recent hominin history.

The specific purpose of this paper is to investigate phenomena that are widely considered as representing 'prehistoric art'. Here, archaeology has often regarded palaeoart forms as decorative, as art. The very concept of 'art', poorly definable by science, derives from Western thought and appears to have limited or no meaning if applied to traditional cultures. What is definable by science is ritual and the role exograms play and probably played for many millennia as part of assorted human rituals. In modern traditional societies ritual is usually accompanied by the production of works viewed as artistic. Ritual can include nonreproducible exograms such as mimicking of various animals long before they were drawn in tangible exograms. Therefore regarding palaeoart as art is an application of an etic and ethnocentric idea to products of societies about whose emic parameters nothing is known in most cases ('emic' refers to knowledge and interpretation within a culture, 'etic' refers to interpretation by another culture). These products are capable of defining cultures, but have not been used to define early, particularly Pleistocene, cultures. The taxonomy of cultures applied by Pleistocene archaeology is based essentially on tool types, which is why the discipline has fundamentally failed in defining emic cultures. Invented or etic stone artefact types, which probably lack emic legitimacy, and their combinations within assemblages are usually regarded as diagnostic in identifying cultures. Obviously tools do not define cultures, and in creating the Pleistocene cultural taxonomy, cultural indicators provided by palaeoart have been consistently eschewed in favour of imagined properties based on technological indices. Moreover, archaeology then created corresponding fictitious ethnic identities that almost certainly never existed as collectively identifiable political, tribal, linguistic, ethnic or genetic entities. But what should be of even greater concern than these unwarranted recursive applications is that because of this lithocentric stance the role of exograms in human history has so far been ignored. Here, a scientific approach will be attempted instead, leading to the replacement of the 'art concept' by a less subjective construct such as the term exograms.

The nature of exograms

Exograms are externalised memory traces, a *gram* being something drawn or written. The word derives from the concept of the engram, first proposed by Semon (1904, 1921: 24). An engram is a hypothesised memory trace, a persistent protoplasmic alteration of neural tissue thought to occur upon stimulation of the brain, and accounting for memory in animal brains. It was thought that external sensory stimuli resulted in discrete biophysical or biochemical changes in neural tissue. Lashley (1923a, 1923b, 1924, 1930, 1932, 1935, 1943, 1950) spent several decades trying to locate engrams in rat brains, succeeding only in demonstrating that there is no single biological locus of memory, but rather many. Penfield (1952, 1954) and others reported being able to reactivate memory traces by stimulating the temporal lobes, but the reported episodes of recall occurred in less than 5% of patients and could not be replicated by later neurosurgeons (e.g. Jensen 2005). Subsequent work by others, such as Thompson's (1967, 1986, 1990; Thompson et al. 1976; Steinmetz et al. 1987, 1991, 1992; Christian and Thompson 2005), confirmed the finding that the phenomena accounting for memory are widely distributed throughout the cerebral cortex.

Because of Wilder Penfield's classic works the concept of the engram has spawned the idea of storage of memory traces external to the brain, at least in humans, first proposed by Gregory (1970: 148). The notion of such a 'surrogate cortex' was then developed by Goody (1977) and Carruthers (1990, 1998), but its essence had been understood significantly earlier, by Plato. The effect of external storage, just like the storage of computer memory in an external drive, can potentially increase available memory volume indefinitely, relieving the primary device of its restraints. Plato (in *Phaedrus*, 274e–275a) noted that the use of writing fosters forgetfulness, because people were 'calling things to remembrance no longer from within themselves but from external marks'. Human culture as it developed over millions of years would have been unthinkable without such external memory traces; today it is largely based on them.

This raises the question of exograms in the advance of human culture, the topic of this paper. The first proposal that the author is familiar with, identifying phenomena as engram-like, externalised, 'permanent' forms to which the human intellect of the creator as well as conspecifics could refer, is in Bednarik (1987). We sought to explain very early rock art as externalisations of cognitive reference frames expressed in sensuously perceptible materials (1987: 223), as projections of neural structures (1987: 226) and as sensuously perceptible projections of neural systems (1987: 225). Most relevantly, this paper argued for a significant communication potential of such engram-like phenomena, because other hominins would have possessed 'resonating' cerebral systems capable of response. Our subsequent assessments (Bednarik 1990, 1992a) of the cognitive development of hominins derived from these insights. Donald's (1991: 308–333; 2001: 305–315) coining of the neologism 'exogram' to define the concept was a welcome development, even if he was apparently unaware of the author's and Semon's earlier work.

In order to clarify the status of the concept of exograms it is essential to review Donald's views on them. His three stages of cultural evolution (cf. Fairservice 1975) are not supported by the relevant archaeological evidence and have been subjected to the following criticisms. His belief that 'Neanderthals underwent a drastic, rapid extinction' has rightly been defined as 'unsupported assertion based on a kind of current "folk-wisdom" that has to be relegated to the realm of pop-science', 'comparable to phrenology' (Brace 1993); this 'extinction' is debatable if for no other reason than the presence of Neanderthal genes in modern non-Africans (Green et al. 2006). Donald's contention that the introduction of language would speed up the rate of cognitive evolution is analogous to claiming that the rate of mutation determines the rate of genetic evolution (Cynx and Clark 1993), and his ideas of language origins had been refuted before he presented them (Falk 1975, 1987; Arensburg et al. 1989, 1990; Bickerton 1990). They are absurdities today (Krause et al. 2007; cf. Enard et al. 2002; Zhang et al. 2002; Sanjuan et al. 2006; Falk 2009; Bickerton 2010). Other critiques include his 'cavalier misuse of information available from anatomy, anthropology, and archaeology' (Brace 1993, cf. 1996, 1999); his inadequate presentation of the relevant neurology and his neglect of cognitive ethology (Cynx and Clark 1993). In response to Donald's (1991) pronouncement that 'unlike the constantly-moving contents of biological working memory, the products of thinking, when reformatted exogrammatically, could be frozen in time, held up to scrutiny at some future date, altered and re-entered into storage', Adams and Aizawa (2001: 58) state that 'there can be no cognitive science of transcorporeal processes' (cf. Rupert 2004; Malafouris 2004; Aizawa and Adams 2005; Block 2005; Prinz 2006; Adams and Aizawa 2008). Adams and Aizawa define cognition by non-derived, intrinsic or original content; and by cognitive processes of a special kind, the mechanisms by which organisms remember, perceive, attend and learn. However, of the three 'theories of content' they cite (Dretske 1981; Fodor 1990; Cummins 1996), explaining how original content arises naturally, none is universally accepted

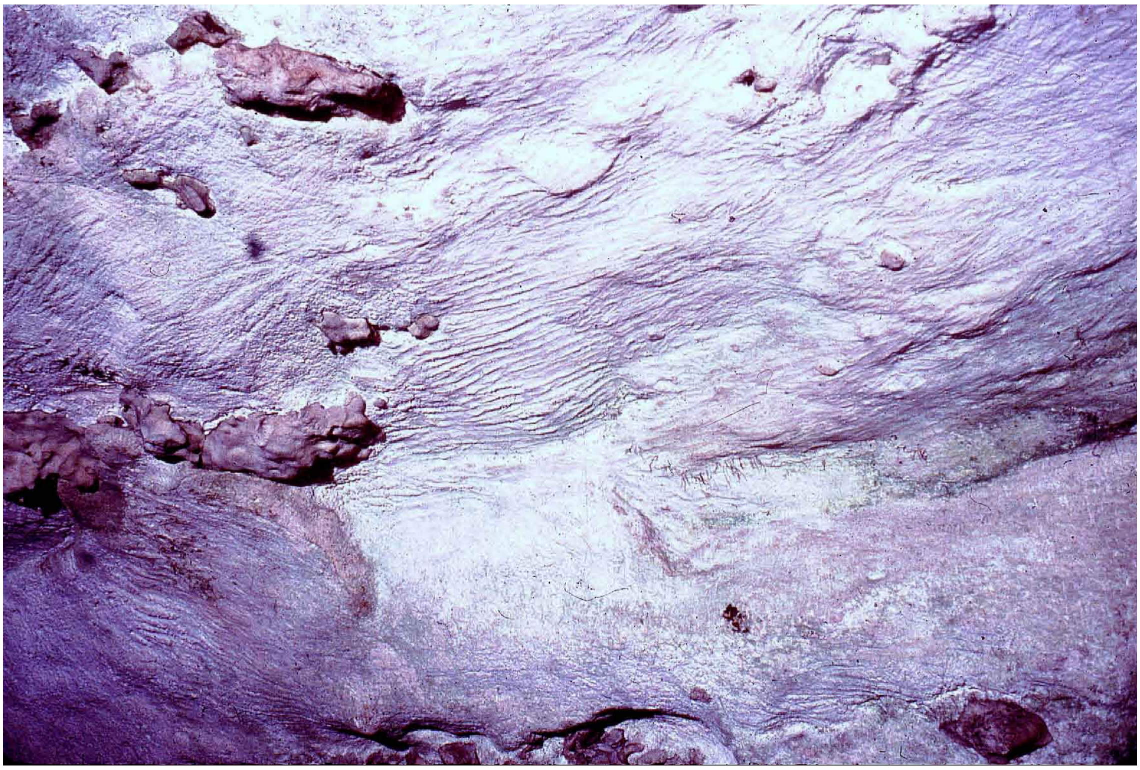

Figure 1. *Finger flutings in Prung-kart Cave, South Australia, with chert nodules embedded in the ceiling.*

today. A generally acknowledged theory of cognition, or of which tasks are cognitive, remains elusive (Menary 2007: 15), although an increasing number of neuroscientific studies are devoted to the subject.

The principal flaws of Donald's reasoning are his reliance on the now discredited replacement ('African Eve') hypothesis (cf. Bednarik 2008a, 2011a) and his lack of familiarity with the archaeological information on presumed early 'symbolling abilities' (e.g. Bednarik 1992b). His obliviousness of pre-Upper Palaeolithic exograms renders his chronology of the introduction of exograms and how it affected the cultural development of hominins flawed. After all, the most instructive form of evidence for this process, crucial in understanding the origins of human modernity (Bednarik 2011b, 2011c, 2013b), are the finds from the earliest periods, whose antiquity exceeds the advent of the 'Upper Palaeolithic' by up to more than twenty times. Also, neuroscience and the aetiology of hominin behaviour (Bednarik 2012) need to be central to any comprehensive consideration of the introduction and roles of exograms.

Whereas engrams, as imagined, would be impermanent, of constrained format, fixed physical medium, limited capacity and size, and not easily refinable, exograms exceed their potential in most respects. Exograms are, as Donald noted, semi-permanent, unconstrained and reformatable, can be of any medium, have virtually unlimited capacity and size, and can be subjected to unlimited iterative refinement. In appreciating their roles in hominin evolution it may be useful to begin with our observations (Bednarik 1987) that even the most basic anthropogenic rock markings carry numerous inherent messages, for both the maker and any conspecific. If the latter happens to be equipped with the same 'cortical software' (i.e. cultural understandings) as the maker, those messages would be far more comprehensive than for other humans, but even for culturally unconnected individuals, such markings convey meanings. We initially focused on finger flutings, among the simplest form of rock art and made by drawing several fingers of a hand across a cave wall covered by a speleothem deposit called moonmilk (reprecipitated calcium carbonate occurring as a white, very soft surface layer; Bednarik 1999a). Such markings can be preserved for tens of millennia in caves, especially when the moonmilk becomes desiccated and stabilised, so they may remain available for scrutiny and reinterpretation (Fig. 1).

Observer-relative narratives

Donald's neglect of pre-Upper Palaeolithic exograms is widely shared by Pleistocene archaeologists, which renders it essential to dispel certain misconceptions before it becomes realistically feasible to consider the subject usefully. The lithocentric cultural and ethnic models of the Pleistocene are made up of 'observer-relative, institutional facts' (Searle 1995), in the complete absence of emic information. Based on invented or etic stone artefact types and their relative combinations within assemblages that are regarded as diagnostic in identifying cultures (see Thompson 2012), these models eschew authentic cultural indicators such as palaeoart. Since palaeoart consists of exograms, the roles of exograms in human history have also been ignored, despite isolated endeavours to correct this (e.g. Bourrillon et al. 2012). Another impediment is the inadequate consideration of taphonomic effects in the interpretation of such remains, whose quantitative and qualitative properties have been severely distorted (Solomon 1990; Bednarik 1994). The incommensurability between archaeological and scientific narratives is not only evident in their different concepts of evolution, but also in various other aspects, such as the definition of 'sample'. Excavation can only yield non-random samples, because the remains secured from it cannot be expected to be representative of anything other than themselves; their composition is merely accidental, and there is not much control over the historical sequence of key discoveries in the discipline. In science, a random sample needs to be representative for the entity it exemplifies (Kuhn 1962), and there needs to be design in the succession of research (i.e. a universal theory). Similar considerations apply to other terminology archaeology has introduced from the sciences and misused (Bednarik 2013a), accounting for some of the incommensurabilities between the two.

A recently dominant belief of Pleistocene archaeology, now well past its zenith, correlated the advents of the 'modern mind', the Upper Palaeolithic and what are defined as 'modern humans', placing them in Europe at 30 ka (30 000 years) to 40 ka ago (e.g. Cann et al. 1987; Stringer and Andrews 1988; Davidson and Noble 1989). Although it did not consider the question of exograms, it is clear that this former dogma would regard their introduction as also coinciding with these factors, and as indicative of 'modern behaviour'. Not only is there no credible empirical support for these developments co-occurring, each of them has been misunderstood:

(1) Empirically, there is no such thing as a mind; it has no mass, composition, substance or definable location; hence there is no modern mind. This is a traditional shorthand generic term for mental processes occurring in the human brain, but the concept of 'modernity of mind' is fraught with various difficulties (Bednarik 2012, 2013b; Helvenston 2013). Not only have humans never been modern (Latour 1993), some authors refer to human modernity as a set of variables one can reasonably expect to find a million years ago, even earlier (Bednarik 2011b, 2011c), while others favour a much more narrow definition (e.g. Humphrey 1998). In reality the human 'mind' has changed significantly even in recent millennia (Maguire et al. 2000; Draganski et al. 2004; Smail 2007; Helvenston 2013). Most certainly the brains of final Pleistocene people were very different from those of literate contemporary Westerners, and the 'mind' only reached 'modernity' in recent centuries.

(2) People of Palaeolithic, Mesolithic, Neolithic, Chalcolithic, Bronze Age and Iron Age technologies coexist today with a nuclear age in countries such as India. Are the Jarawas, who use stone tools and iron nails from shipwrecks (Bednarik and Sreenathan 2012) of the Stone or Iron Age? These simplistic definitions do not apply in most parts of the world and are anachronistic. More relevantly, there is no clear separation of the Middle and Upper Palaeolithic tool kits in Europe; the transition is marked by many intermediate features and took tens of thousands of years (Camps and Chauhan 2009). Most importantly, the gradually developing skills in Eurasia were not introduced from Africa, but in most cases arose in situ (Bednarik 2008a).

(3) The dogma that 'anatomically modern humans' (AMHs) evolved in isolation in sub-Saharan Africa has its source in an academic hoax (Terberger and Street 2003; Schulz 2004; Bednarik 2008a) that became a viral meme in the late 1980s. This model postulates that these Africans were a new species, unable to viably breed with other hominins, whom they then replaced (exterminated) worldwide. According to this gospel, Eve's veritable progeny introduced rock art, mobiliary art, language, proper culture, various advanced technologies, interment, seafaring, clothing, cordage, shelter structures, body adornments, music and, apparently, genocide. All of these attributions are falsities, the innovations implied occurred much earlier and in most cases during the Lower Palaeolithic. The complete lack of empirical support, be it genetic, palaeoanthropological or archaeological has not prevented this myth from dominating archaeological thought for a few decades. (For a cogent criticism of the term AMH see Tobias 1995.)

From a bioscientific perspective, the most prominent somatic developments in human evolution are the relentless Pliocene/Pleistocene encephalisation and its sudden reversal towards the end of the Pleistocene. The phenomenal increase in cranial volume (de Miguel and Henneberg 2001), almost unparalleled on this planet (the horse is an exception), imposed a massive evolutionary burden on hominins, in obstetric demands (O'Connell et al. 1999), reproductive fitness (Joffe 1997) and social and economic cost (Bednarik 2011a). Its toleration is justified by the significant advantages of the larger brain, particularly in cognitive and intellectual returns. This sounds eminently reasonable, because there is universal agreement that the demands made on the human brain increased correspondingly. But if this is so, why did the enlargement of the brain suddenly become reversed during the final Pleistocene, as brain size plummeted at a rate 37 times (!) greater than that of previous encephalisation (Henneberg 1988, 1990, 2004: Fig. 1; Henneberg and Steyn 1993)? If there has been no reduction in intellectual or cognitive competence corresponding to the shrinking human brain, why should one assume that these properties were underwritten by the previous enlargement? Both palaeoanthropology and archaeology have ignored this glaringly obvious issue, as well as other crucial questions. For instance, why has natural selection allowed the establishment of thousands of deleterious alleles in the recent evolution of humans? The pinnacle of archaeology's teleological evolution, the 'anatomically modern human', is susceptible to thousands of disadvantageous genetic conditions their predecessors were free of (Rubinsztein et al. 1994; Walker and Cork 1999; Enard et al. 2001; Olson and Varki 2003; Marvanová et al. 3003; Bednarik 2008a, 2008b, 2011a, 2012; Sherwood et al. 2011; Bednarik and Helvenston 2012).

An example of false beliefs in Pleistocene archaeology is the notion that the perceived modern human 'mind' is shared by all AMHs, for the past 30 or 40 ka in Europe. It seems almost impossible to displace this fantasy, and yet it is obvious from neuroscience that the brains of literate individuals differ greatly from non-literate. The notion that extant humans share the 'mind' of 'Aurignacian' people is based primarily on the perceived modernity of 'Upper Palaeolithic' palaeoart, conflating modernity of anatomy, behaviour, 'mind' and 'artistic appreciation' (Helvenston 2013). The absence of evidence that this Aurignacian 'art' is the work of AMHs and the availability of many indicators that it is attributable to mostly juvenile Neanderthaloids (Bednarik 2007) provide a significant impediment to this African Eve-based hypothesis. All cultural activity modifies the chemistry and structure of the brain through affecting the flow of neurotransmitters and hormones (Smail 2007) and the quantity of grey matter (Maguire et al. 2000; Draganski et al. 2004; Malafouris 2008; Bednarik 2012; Bednarik and Helvenston 2012). For instance the general introduction of writing in recent centuries has dramatically changed the brain of adult humans. Although they start out as infants with brains similar to non-literate peoples, these brains are gradually reorganised as demanded by the thinking implicit in literacy, which is quite different from the thought patterns found in oral societies (Helvenston 2013). The use of all symbol systems (be they computer languages, conventions for diagrams, styles of painting) influence perception and thought (Goodman 1978). Or, in other words, the use and proliferation of exograms that defines the human ascent must have profoundly altered the hominin brain.

Beads for the natives

Some of the points made above are well illustrated by beads, because these are among the most instructive exograms of the distant human past (Bednarik 1997a, 1997b, 2001, 2005, 2008c). Besides being a form of exogram capable of communicating vast amounts of information (about the wearer or the maker, group affiliation, status and so forth), beads are expressions of self-awareness. While such properties as theory of mind (ToM), consciousness and self-awareness (De Veer and Van Den Bos 1999; Gallup 1970, 1998; Gallup et al. 2002; Heyes 1998; Keenan et al. 2003; Mitchell 1993, 1997, 2002) have been demonstrated in many species, including the extant primates (for reviews see Bednarik 2008a, 2011a, 2011b, 2013b), they are typically more developed in hominins. In a child it is at the age of about 40 months that the ToM surpasses that of the extant great apes, and homology would suggest that australopithecines probably had considerably more developed cognitive faculties at their disposal than chimpanzees or bonobos. Body adornment is an obvious consequence of self-awareness and in incipient form may be present in some chimpanzees (McGrew and Marchant 1998; McGrew 2004; Nishida et al. 2009). Therefore from a biological perspective, and ignoring archaeological doctrine, it might be expected that the earliest physical evidence of body decoration should be of the late Pliocene. This reasonable scientific expectation contrasts with the earliest hard evidence of beads and pendants, dating from the Acheulian and other Lower Palaeolithic traditions, essentially of the Middle Pleistocene (Bednarik 2005). The discrepancy can readily be accounted for by taphonomic logic (Bednarik 1994): the probability of such evidence surviving to the present, and being found and identified correctly, is practically zero. Beads are stringently selected against by taphonomy, which is emphasised by the fact that most of the earliest reported specimens are of highly deterioration-resistant materials (silica minerals). This very probably accounts for the evident discrepancy between bioscientific anticipation and empirical evidence. Yet Pleistocene archaeology endeavours to reject all exograms preceding what it calls the AMHs. In doing so it effectively states *that the massive and evolutionarily expensive increase in cranial volume had little practical influence on cognitive competence*.

While it is possible to deny the intentionality or communicative potential of other exograms such as simple engravings on bone, ivory and stone (see below) to preserve the replacement model of recent human evolution, one would expect the secure identification of beads and pendants to be largely uncontroversial. Small objects, drilled through with stone tools, could be either beads or pendants; or they could be small utilitarian objects such as buckles or quangings (pulling handles used in sealing) which the Inuit use (Boas 1888: Figs 15, 17, 121d; Nelson 1899: Pl. 17; Kroeber 1900: Fig. 8). Such utilitarian objects are generally of distinctive shape, use-wear and material; they need to be very robust. Small objects that were drilled through either in the centre or close to one end (e.g. teeth perforated near the root); that are too small or too fragile to be utilitarian objects; and that lack the typical wear patterns of such articles can safely be assumed to be beads or pendants (Bednarik 1997a). An example of such complete lack of ambiguity are the disc beads made from ostrich eggshell. These are extremely common in the ethnography of southern African people (Woodhouse 1997), and in the archaeological record they are found from there to China and Siberia (Wendt 1974; Mason 1988; Kumar et al. 1988; Bednarik and You 1991; Bednarik 1993a; Woodhouse 1997; Morris 2000; Grün and Beaumont 2001). Of significantly greater antiquity are the over

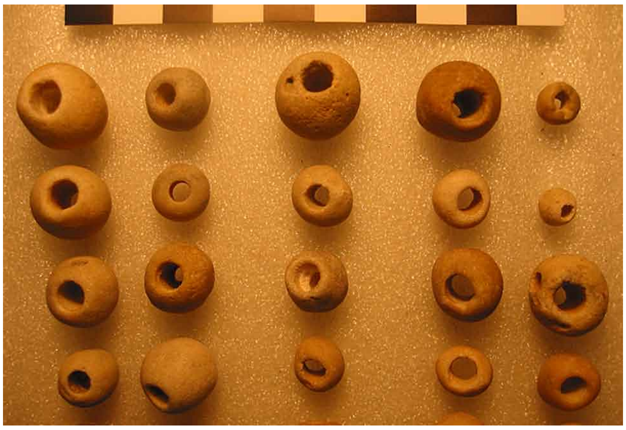

Figure 2. *Some of the hundreds of stone beads from the French and English Acheulian; scale in cm.*

forty similar ostrich eggshell beads from El Greifa site E, in Wadi el Adjal, Libya (Bednarik 1997a). They come from a substantial sequence of Acheulian occupation deposits representing many millennia of continuous occupation of a littoral site on the shore of the huge Fezzan Lake of the Pleistocene (Ziegert 2007). However, the Libyan beads, about 200 ka old, may well be exceeded in age by many other finds, such as the pendants from the Repolusthöhle, in the Austrian Alps (Mottl 1951; Bednarik 1992b), or the several hundred centrally perforated fossils from Acheulian deposits in France and England (Bednarik 2005). First reported by Boucher de Perthes (1846), Rigollot (1854), Prestwich (1859: 52), Wyatt (1862) and Smith (1894), they remained widely ignored for the entire 20th century and were correctly identified as *Porosphaera globularis* only recently (Fig. 2), and their extensive modification and use wear as beads were only then recognised (Bednarik 2005). The worn crinoid fossils from a site in Israel are another example of Acheulian beads (Goren-Inbar et al. 1991).

All these numerous beads managed to survive for hundreds of millennia, and their use demonstrates self-awareness and the existence and communication of complex symbolic meanings, without which beads cannot possibly exist. Whatever their practical purpose may have been (decorative, communicative, emblematic, economic, protective, commemorative, ideological etc.), their function was always symbolic. Contrary to Malafouris (2008), who sees 'the self as emerging through the ornament', self-awareness, including autonoetic awareness, must precede bead use, because without self-awareness (and several other, precursory conditions) beads lack any justification for existence. Hominins did not first make beads and then think of a way to render such entirely abstract and non-utilitarian artefacts relevant. The example Malafouris cites, the forty-one late Middle Stone Age shells from Blombos Cave in South Africa, are certainly not the 'landmark' in cognitive evolution he sees in them. Not only are they preceded by numerous earlier beads and pendants several times as old, body self-awareness (as distinctive from 'mind self-awareness'; pers.comm. Robert A. Dielenberg) can safely be assumed to predate them in the primate ancestry by dozens of millions of years. The view that the first appearance of 'the human ability to be reflectively conscious of one's own perspective on the world' must be deducible from archaeological finds is itself anthropocentric, considering the incidence of ToM and self-awareness among non-human animals (Gallup 1970; Call and Tomasello 1998; Gallese and Goldman 1998; McGrew and Marchant 1998; McGrew 2004; Iacoboni et al. 2005; Sommerville and Decety 2006; Keysers and Gazzola 2007; Nishida et al. 2009; Bednarik 2011a).

Beads are exograms conveying complex meanings, and they imply other faculties still. For instance beads and pendants involve the use of cordage, which in turn almost demands the facility of knotting — both of which are also essential in the construction of seagoing rafts (Bednarik 1997c, 1999b, 2003b). And as replicative archaeology has shown, the making of beads, especially from ostrich eggshell, involves some rather complex technological steps (Bednarik 1997a). But beads were certainly not the first exograms used by hominins (see below).

Therefore body-adorning practices should realistically be expected to have existed at least throughout the Pleistocene, but most of them would have involved materials that had no prospects of surviving for any length of time. For instance haematite, which may have been used in body adornment, has been utilised by hominins for at least one million years (Beaumont and Bednarik 2013). The observation that, with the exception of the El Greifa ostrich eggshell specimens, all other Acheulian beads found are of silicified stone objects speaks for itself: only the most deterioration-resistant could have survived, and most of those that may have endured have probably not been recovered so far.

Taphonomy and complex systems theory

Of the several issues challenging archaeological constructs that are based on the assumption of representativeness of data, some are so obviously pertinent that they need not be considered in any detail. For instance obtainability of true random samples is self-evidently always elusive. However, two specific aspects will be considered here to show that valid interpretations of the complexity of pre-Historic societies cannot be simplistically deduced from the archaeological record.

The first, taphonomic distortion is of universal significance, but its effectiveness increases linearly as a function of age (Bednarik 1994: Fig. 2). The entire archaeological evidence base is meaningless without subjecting it to taphonomic logic, which views it as the surviving remnant of a cumulative population of manifestations that have been subjected to continuous degradation selecting in favour of properties facilitating longevity. The surviving and humanly detectable traces of a phenomenon of the past can define that phenomenon only to the extent that adequate recourse to taphonomic logic has been made (Bednarik 1990–91). It applies to any phenomenon or event of the past, be it astronomical, sedimentary, geological, palaeontological, palynological or archaeological. This form of logic is quantifiable (at least as integral functions; see Bednarik 1994: 73) and is not a hypothesis presented for testing, but a theorem facilitating the assessment of past conditions that cannot be observed directly.

Its profound effects on the ability to interpret what is regarded as archaeological evidence remain inadequately understood. Valid archaeological interpretation is only possible by identifying those quantitative and qualitative variables that are attributable to taphonomy. Most phenomenon categories of the human past have taphonomic lag times exceeding 99% of the duration of the actual category's existence. This applies, inter alia, to exograms, which can occur in many forms (phenomenon categories). The earliest examples on record are almost exclusively of some of the most deterioration-resistant materials; taphonomic logic prescribes that the most probable explanation for this pattern is that they are neither the oldest exograms made, nor the only ones made at the time in question.

In practical terms taphonomic logic demands that the earliest archaeological finds of any phenomenon category, if they occur in very small numbers but are of a type that would have been extremely numerous due to their nature (such as beads, which can only assume meanings if they are used in large numbers), are almost certainly from the category's taphonomic lag time. Older use of the phenomenon is certain to have occurred, and there is a high probability that great numbers of specimens made of less enduring materials also existed, but had no prospects of surviving for the enormous time span involved. Therefore the most consequential misuse of archaeological reasoning occurs when these rare glimpses of key finds are explained away as flukes, as 'running ahead of time' (Vishnyatski 1999). Not only does this deprive the discipline of its potentially most important evidence, it is also illogical: why would a few individuals produce artefacts that can have no other purpose but to express symbolic properties, such as beads, if none of their contemporaries even comprehend their meanings? This is an absurd proposition, as is clear from the consideration of what exograms are and how they are effective.

Another logical constraint demanding that the human ascent to cognitive modernity must have been gradual and much slower than orthodox archaeology considers is provided by complex systems theory (Andersson 2011). The cultural systems emerging for the entire duration of human evolution are obviously complex systems. If the belief of Pleistocene archaeology, that technology was constrained by cognition, were true, any early appearance of sophistication would indeed be impossible, except by a 'running ahead of time'. However, the progressivist teleological concept of a relentless ascent from lowly simians to the crown of evolution defies scientific ideas of how complex systems operate. Development is not necessarily a continuous upward process; there is no ultimate goal, and numerous examples of cultural and technological 'devolution' or regress are available. For instance after the Tasmanian Aborigines were separated from the Australian mainland tribes by the island's sundering towards the end of the Pleistocene, their cultural and technological abilities declined (Jones 1977, 1978). The volume of information that can be stably maintained over time is limited by the propensity for introducing error in generational information transmission (Andersson 2011), as in the relationship between the length of genetic sequences and the rate of error in RNA replication (Eigen and Schuster 1977). When the mutation rate increases beyond a crucial point, the system of short-term memory carriers can no longer maintain a long-term memory. But locally narrow specialisations, such as in maritime technology (Bednarik 1997c, 1999b, 2003b), or technological forays during a small number of generations that failed to persist in the long run, may have had limited prospects of being retained over time. Technological conservatism was adaptive for hominins, complex systems science predicts, and there are again examples demonstrating this. For instance, if bow and arrows are superior to spears, why did the Aborigines at Torres Strait, who saw the Papuans use this technology, not adopt it? Most importantly, intelligence was driven primarily by social factors, not by technology, which was not limited by some cognitive potential maximum sophistication. Cognitive evolution cannot be driven by selection for its technological effects, because cognitive capabilities must precede any technological expressions they might reasonably lead to (Alvard 2003). Andersson (2011) predicts that hominins must generally have been smarter than their technological traces (which archaeology in any case misinterprets all too often) might lead us to believe. As he points out, this is the case today with modern humans, and it applies equally to other extant primates.

Therefore lowest common denominator technology, the kind archaeology might be able to recover, is no measure of cognitive potential, or even of potential technological sophistication. This was precisely the reason for establishing the First Mariners Project (Bednarik 2003b), because the only form of technology that might illustrate maximal technological competence is that on which the most perilous projects are based (e.g. seafaring). In considering the long-term transmission and maintenance of innovations and innovative practices, Pleistocene archaeology has not applied any of the understanding of complex systems theory, and so it continues to deliver tainted explanations.

For instance of concern in the present context are the reactions of the replacement advocates to the Acheulian beads (d'Errico and Villa 1997; Rigaud 2006–07; Rigaud et al. 2009). They claim that the perfectly perforated wolf's tooth from Repolusthöhle must be the result of animal chewing, but omit to clarify why similarly perforated teeth of the Upper Palaeolithic were not caused by this. They also choose to ignore the specimen's extensive wear from the suspending string. Such different ways of considering finds on the basis of their age are routinely applied to early evidence that contradicts the replacement hypothesis ('African Eve'). For instance any tubular bone fragment with regularly spaced, circular holes from an Upper Palaeolithic deposit is inevitably presented as a flute, but when a similar object is recovered from a Mousterian layer (Turk et al. 1995), it is explained away as the result of carnivore chewing (d'Errico et al. 1998). Yet this specimen has a two and a half octave compass that extends to over three octaves by over-blowing (Turk and Dimkaroski 2011), and its holes are carefully shaped, showing none of the signs of animal gnawing (compression and opposing indentations).

Preserving the dogma that 'Neanderthals' were too primitive to use flutes is becoming progressively more incongruous. If these Robusts created the early cave art of Chauvet Cave (Bednarik 2007; Sadier et al. 2012) and rock art in Zarzamora Cave and El Castillo (Spain), or used the feathers of raptors (Morin and Laroulandie 2012), presumably for decoration (i.e. as exograms), they were significantly more sophisticated than most archaeologists allow them to be. Similarly, such finds as beads of the Acheulian are not unexpected; they need to be anticipated from hominins that should be assumed to have possessed a level of self-awareness and mental competence similar to that of a 10-year-old present-day human (Bednarik 2012). Beads are technologically far simpler artefacts than sea-going watercraft, without which the Pleistocene pelagic colonisation of at least twenty islands and one continent would have been impossible (Bednarik 2003b), which in some cases (Wallacea, Sardinia) extends one million years into the past. Yet the fossil sponge beads found at many Acheulian occupation sites, it has been claimed, are not modified and the signs of wear may be natural (Rigaud 2006–2007). However, demonstrating the anthropic nature of these assemblages of fossil casts does not even rely on these aspects; it is demonstrated by their composition: all such beads are of spherical shape, are of a specific size range, and bear central tunnels that are open on both ends. Only about one quarter of a natural sample of the *Porosphaera globularis* casts is of close to spherical shape; only 14% of them feature the natural tunnels; and less than 10% fall between 10 mm and 18 mm diameter, the size range of most of the beads. Therefore less than 0.3% of a random sample would be of the shape and size range of the collections of beads from Acheulian sites, and also have some degree of tunnelling (Bednarik 2005). However, not a single natural specimen would have a tunnel with two openings (unless very extensively weathered or damaged by chance), as all of the beads obviously do. Therefore the occurrence of whole collections of these beads with Acheulian tools cannot be explained by any natural process, even before the unmistakable human modifications are considered. What the African Eve proponents evidently fail to consider is that their tunnels are the result of a predator-avoidance strategy by the sipunculan worm *Trypanites weisei* Mägdefrau 1932 or a similar species. That means that, although they may come close to breaking through at the fossil's other side, they never actually do (Neumann et al. 2008). Creating a second tunnel entrance would defeat the worms' protection strategy, hence there are no undamaged natural specimens with two openings of the tunnel. Therefore the modifications observed on these hundreds of collected fossils are not even needed to invoke anthropic agency. By focusing their attention on attempting to refute the modification and wear traces, the replacement advocates have only demonstrated that they did not appreciate the biological data and instead attempted a redundant falsification.

This example illustrates the accommodative pattern of reasoning by 'African Eve' (discontinuity or replacement) adherents: rather than exploring what happened in the human past, they first strive to uphold the dogma and then retreat from that position as reluctantly as possible (as seen in Rigaud et al. 2009; cf. Rigaud 2006–2007). This pattern is also apparent in numerous other cases, for example when it was attempted to refute the notational nature of some Pleistocene artefacts (d'Errico 1989), only to then accept it (d'Errico and Cacho 1994); or the rejection without examining them and later acceptance of anthropogenic modifications of the Berekhat Ram pebble (d'Errico and Nowell 2000). In the latter case the authors admitted that the object had been modified extensively, but emphasised that 'it may not be possible to identify what, if anything, the object may depict and we are certainly not arguing that it is necessarily a figurine' (op. cit.: 163). This begs the question: what would the deliberate grooving of an object to accentuate its appearance as a female torso signify? This is particularly pertinent when the similarly extensive grooving on the Tan-Tan proto-figurine is considered (Bednarik 2003c). To assert that the hominins concerned modified stones naturally resembling a human figure to emphasise the pareidolic effect *without actually being aware of it* shows to what lengths the 'African Eve' believers are prepared to go to defend their beliefs.

Early exograms and realities

Taphonomy (which determines the selective survival of material evidence, and thus the qualitative and quantitative composition of all samples in archaeology) has seen to it that most exograms could have never survived from the Pleistocene, and most of those that could endure would probably not be recognisable as having functioned as exograms. Nevertheless, there are several classes of such materials that can, under fortunate circumstances, remain not only recoverable, but also identifiable as exograms. Such examples from the Middle Pleistocene have been classified into beads and pendants, petroglyphs, portable engravings and notches, proto-sculptures, pigments and other manuports (Bednarik 1992b, 2003a; Beaumont and Bednarik 2013). They are universally rejected by all 'African Eve' believers as being in any way meaningful products of human activity. The earliest published examples are briefly listed here.

Beads and pendants. These have been reported from French and English Acheulian occupation deposits since the mid-19th century (Boucher de Perthes 1846; Rigollot 1854; Prestwich 1859; Wyatt 1862; Smith 1894; Bednarik 2005). Lower Palaeolithic pendants were also reported from the Repolust Cave in Styria, Austria (Mottl 1951), followed by the Acheulian beads from Gesher Benot Ya'aqov, Israel (Goren-Inbar et al. 1991), and the ostrich eggshell beads from El Greifa site E, Libya (Bednarik 1997a; Ziegert 2007).

Proto-sculptures. Besides the Berekhat Ram specimen from Israel mentioned above (Goren-Inbar 1986), there is only one more Lower Palaeolithic example, the find from Tan-Tan, southern Morocco (Bednarik 2003c).

Engravings and notches. The series of portable engraved objects from Bilzingsleben, Germany (Mania and Mania 1988), includes examples on bone, ivory and stone. More recent engraved or notched objects also attributed to the Lower Palaeolithic or transitional period come from Sainte Anne I, France (Raynal and Séguy 1986), Whylen, Germany (Moog 1939), Xinglongdong Cave, China (Gao et al. 2004), and Wonderwork Cave, South Africa (Beaumont and Bednarik 2013). An apparently engraved bone fragment from Kozarnika Cave, Bulgaria, dated to 1.1 to 1.4 million years ago, still remains to be authenticated.

Petroglyphs. The Lower Palaeolithic occupation deposits of Auditorium and Daraki-Chattan Caves, both in India, yielded petroglyphs predating the Acheulian, comprising cupules and linear grooves (Bednarik 1993b; Bednarik et al. 2005). Cupules at Sai Island, Sudan, are about 200 ka old (Van Peer et al. 2003), and those of Nchwaneng and Pothole Hoek in South Africa might be of the Fauresmith tradition (Beaumont and Bednarik 2013). East London, also in South Africa, yielded a lattice pattern thought to be in the order of 400 ka old (Laidler 1933, 1934).

Pigments. Extensive evidence of pigment use begins at least 1.1 million years ago in southern Africa, e.g. at Wonderwork Cave (Beaumont 2004a, 2011; Chazan et al. 2008; Beaumont and Bednarik 2013) and Kathu Pan 1 in South Africa (Beaumont 2004b; Beaumont and Bednarik 2013), and Kabwe in Zambia (McBrearty and Brooks 2000; Beaumont and Bednarik 2013). In Europe and India, pigment use has also been demonstrated from many Acheulian deposits (Bednarik 1992b, 2003a).

Manuports. The earliest known example of a manuport, which include unusually coloured or shaped stones transported by hominins, is the red jaspilite cobble deposited 2.5 to 3 million years ago in Makapansgat Limeworks Cave, South Africa (Dart 1974; Bednarik 1998, 1999c). More recent specimens have been reported from all three Old World continents (Bednarik 2003a), including quartz crystals and fossil casts.

From the subsequent Middle Palaeolithic (and Middle Stone Age in sub-Saharan Africa) the incidence of palaeoart finds increases significantly, to thousands of specimens known from that period. For the purpose of determining the advent of the use of exograms, the earliest examples are of particular importance, even if they appear to be extremely isolated. The oldest such find is the Makapansgat cobble, which has been carried a great distance to the dolomite cave and was very probably collected due to pareidolic detection of its suggestive features of a head and face. Although it is unknown whether it is to be attributed to australopithecines, which left numerous fossils in the cave, or to a very early human species (Bednarik 1998), its mere presence in the site presupposes apperceptive capability in the hominins concerned. Such a process of understanding which observed visual qualities of an object are related to past experience and implies that an otherwise unrelated referrer has been linked to a referent. This may appear to be a relatively simple connection to make, but it is beyond the cognitive ability of most species. Symbolling proficiency underlies exogram generation, investing entities with meaning. But what may seem obvious to a 'modern human' is no more so than the way the brain forms a conscious construct of reality. There is no viable universal theory of how the neuronal mechanisms and systems of the brain create reality from the sensory input of the phenomenal world. Whereas the rest of the animal kingdom merely responds to sensory stimuli, extant humans assess them 'consciously' and assemble them to create constructs of reality. How they do this remains profoundly unknown, and yet it defines them.

An object becomes meaningful when it is invested with a content that enables it to stand for something else. More complex is the relationship when this meaning is *recognised as being intended* by the author of the manifestation (say, a surface marking made by a conspecific):

> We know that somehow hominids discovered that they all lived in a common world. This would have been impossible but for two conditions: in the physical world, processes spread out from centres [e.g. reflected light experienced as colour] and retain certain characters, enabling different individuals to perceive the same object; and somehow humans managed to communicate their awareness of this to each other … when humans externalised certain patterns (beginning perhaps with parallel lines), it may have enabled a beholding individual to recognise them as existing within his own neural system … It seems plausible to see the emerging human consciousness, and appreciation of the human condition, as the result of a rather successful attempt to define the nature of the cosmos with the aid of a common frame of reference.

> Its form did not even need to be communicated, it had long been present in the brain (Bednarik 1984: 29).

The phenomenon we referred to is the earliest kind of palaeoart markings, in both rock art and portable 'art'. We see these as externalisations of properties of the visual system that, once rendered visible, would resonate in the neural system of a beholding conspecific (the interpretant). As Barrett (2013) contends, in semiotics we need to fundamentally distinguish between the representant (the thing being represented), the representation (the thing doing the representing) and the interpretant (the agent acknowledging or recognising the representation as standing for the representant). This form of communication made the autopoiesis that underlies all human constructs of reality feasible. When the response of one individual to a material quality was recognised empathetically by another, as for instance the response to the soft white moonmilk by marking it with finger flutings, the patterning resonated in the interpretant's neural system. 'Thus would the self have become objectified in the enactments of the other' (Barrett 2013: 11).

The idea is not new: Descartes already recognised the possession of the awareness of the self, and of the self's place in the world. Constructivism, however, holds the view that the only reality humans can know is that which is represented by human thought (Bednarik 1985, 1990). Thus the key question is how the brain recalls and interprets cognitive data or experiences and represents those interpretations externally, and this remains unresolved. As Maturana states, 'the content of cognition is cognition itself' (Maturana and Varela 1980: xviii): everything said is said by an observer. His and Varela's theory of autopoiesis imply that '[w]hen we refer to our interactions with a concrete autopoietic system … we project this system on the space of our manipulations and make a description of this projection' (Maturana and Varela 1980: 89). '[A]utopoietic mechanisms operating as self-generating feedback systems … cannot be separated from those who manipulate and use them' (McGann 1991: 15). Human cognition is a particularly complex autopoietic system, i.e. a system that possesses sufficient processes within it to maintain the whole. It yields precisely what Plotkin (2002) describes as an imagined world made real. 'Provided that the internally consistent logical framework is not challenged by it, there is no reason to assume that an entirely false, cultural cosmology or epistemological model could not be formed and maintained indefinitely by an intelligent species' (Bednarik 1990: 2). Most importantly, the evolution of human sensory facilities and intellect can be assumed to have only equipped us with adequate faculties to make them useful; there is no evolutionary benefit in the ability of defining the reality of the cosmos correctly (Bednarik 1984).

Why the nature and origin of human constructs of reality are so hard to define resembles the impossibility of finding a self-consistent set of axioms for deducing all of mathematics, which Kurt Gödel has shown to be impossible due to the self-referential nature of mathematical statements (Hofstadter 2007). Ultimately consciousness is self-referential awareness, the self's sense of its own existence, and this is why its aetiology remains unsolved. Nevertheless, the issue *can* be resolved by involving the role of exograms (Bednarik 1987). The sustained use of every reference system, be it writing, diagrams, imagery, language, numbers, computer language or whatever, changes the structure, chemistry and operation of the human brain, as noted above. No such system, however, could be assumed to be as effective and all-pervasive in effecting such changes as the continuous use of externalised memory traces. Without it the human brain as it exists today would be rather like an unconnected computer terminal, rendering the individual's ability of relating to what is experienced as the 'real world' severely impaired. Numerous neuropathological conditions illustrate such a state.

In the late part of the Pleistocene, competence in employing and exploiting exograms became the primary selecting factor in maximising cognitive fitness, gradually replacing traditional, 'natural' selection criteria. Obviously this process is by its very nature autocatalytic, and its effects can be observed throughout present-day societies, being evident virtually everywhere. *Exograms generate not only frames of reference, they also create self-referential realities*. The mechanism of establishing these remains unknown, but it probably resembles the much better understood system of body awareness, or of how the individual makes a judgment about a conspecific's body movements (Bednarik 2012). The former is established in the right hemisphere's superior parietal lobule (Bednarik 2013b: 27); the latter has been suggested to be obtained by running a virtual reality simulation of the corresponding movements in one's own brain (Ramachandran 2009). Mirror neurons (Stern 1985; Di Pellegrino et al. 1992; Rizzolatti et al. 1996; Bråten 2004, 2007; Ramachandran 2009; Bednarik 2012, 2013b) are probably involved in this process, as deduced from certain neuropathologies (Bednarik 2011b). Therefore the most likely explanation of how human constructs of reality are established is that the brain creates a virtual reality-like model of the external world, quite probably in the parietal lobe, in much the same way as the mental image of the body is formed (Bednarik 2012). In this, the exograms are indispensable, forming the strongest link between brain activity and the external world. This is the mechanism by which humans experience 'reality' 'consciously', and it is also the neural basis of what is termed 'volition'. This human ability of deriving abstract goals from the prefrontal cortex is unique in the animal world, but it would have been rendered possible by the described system.

Discussion

The rise of cultural behaviour and the growing comprehension of cause and effect, which ultimately led to the establishment of science, are attributable to the described developments, and these can be tentatively placed in the Early Pleistocene. Mainstream Pleistocene archaeology has not recognised the consistent and skilled use of exograms throughout the Middle Pleistocene, and very probably extending into the Lower Pleistocene. The relevance of that discipline to the subject matter needs to be seen in that light. ToM, self-awareness, consciousness, technology and culture were all available to non-human species, although they were not developed to the integrated system of the self-reflective human brain that observes itself, generating volitional decisions through excitatory/inhibitory neural functions. Homology would imply a state of self-awareness in *Homo erectus* resembling that of a present human of about 8–12 years of age (Bednarik 2012), which coincides with that species' ability of maritime colonisation (Bednarik 1999b, 2003b). The faculty of established verbal communication, or speech, can therefore safely be attributed to that species, which orthodox Pleistocene archaeology has been denying vehemently. Language, obviously, is one system of exograms that leaves no archaeological traces, but seafaring expeditions of the kind undertaken in the Mediterranean and Wallacean waters during the Early and Middle Pleistocene are not possible without the use of reflective language.

Archaeology tends to view exograms as symbols, yet various forms of them are clearly not symbolic (involving referent and referrer). Symbols are widely shared with conspecifics, generally via culture, whereas there is a distinctive separation of personal exograms (not shared with conspecifics) and shared exograms (culturally determined). The language boards and other communication devices primatologists use in communicating with apes help define the difference between symbol and exogram: they are not native or naturalised systems of external storage, and they could not be created by apes. Exograms, by contrast, do not necessarily have referents, but express abstract concepts. For instance palaeoart, such as rock art, is certainly comprised of exograms, but there is no more justification for defining it as symbolic as there is for consigning it to 'art'.

Ultimately it is the consistent and skilled use of exograms that most separates humans from other animals and that serves as the clearest indicator of essentially modern behaviour (Bednarik 2011a, 2011b, 2012, 2013b). If Pleistocene archaeology ignores the early presence of exograms in the archaeological record, or is preoccupied with explaining it away, it fails completely in its professed task, the clarification of hominin history. These phenomena need to be studied by the relevant sciences (neurosciences and cognitive sciences) rather than be subjected to humanistic word games (Bednarik 2011d). This requires the formulation of empirically based and testable propositions about the neural processes involved in the establishment, application and transmission of exograms within societies. There exist no precedents for such work, but the sciences are certainly better equipped to deal with these subjects than any of the humanities. Exograms are too important to be left to the attention of archaeology: not only are those that survived the only physical evidence available of the cognitive, cultural and intellectual evolution of humans; they probably saved humanity from abject decline towards the final Pleistocene. That period is marked by the sudden and so far unexplained cessation of several million years of continuous encephalisation, when the cranial volume of humans abruptly began to plummet (Henneberg 1988, 1990, 2004; Bednarik 2011a, 2012). Over the course of a few tens of millennia the human brain shrank at a rate 37 times greater than that of the previous rate of encephalisation, an atrophy that has not been explained, or even considered in any consequential fashion (but see Bednarik in press). Caused in all probability by the incidental self-domestication of humans, as were numerous other sudden changes in the recent evolutionary trajectory of the species, this took place during a period when it is assumed that the demands made on the human brain escalated significantly. How was this development possible?

The logical answer is that many of the brain's functions, in particular most of its memory, became increasingly encoded in externally stored memory traces. The human brain became the central processing unit of a vast system of memory, externalised in numerous forms and media. The ensuing exponential increase in the complexity of human culture became possible by the burgeoning reliance of the brain on exograms — even as brain volume declined precipitously.

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Robert G. Bednarik
P.O. Box 216
Caulfield South, VIC 3162
Australia
auraweb@hotmail.com

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