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On the scientific study of palaeoart

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Introduction

In the title of a scientific paper one must invariably compromise between the need to adequately define the paper's subject, and the need to formulate the shortest possible, intelligible abstraction of that subject. The above title is no exception, and even its terminology needs to be qualified. 'Palaeoart' is a term defining all those early, 'prehistoric' arts for which ethnological access to meaning, purpose, or cultural significance is lacking. The term 'prehistoric' refers generally to an ethnocentric whim dividing human history by the advent of writing. This division is offensive to the peoples being studied by prehistorians; it is based on the application of an alien cultural concept to their cultures and denotes the ethnocentricity of that approach. It involves an implicit but unsupportable assumption that oral transmission of traditional knowledge is less reliable than its written transmission and its interpretation by 'specialists'. Not only is this a non-refutable proposition, but there are valid arguments in favor of the opposite view, and indigenous peoples throughout the world are entitled to disagree with Eurocentric models in 'science'. The Aboriginal people of Australia, for instance, vigorously oppose the ideology implicit in the term 'prehistoric'. It is used here merely to refer to the subjective study of early cultures by members of an alien society who are engaged in creating that society's constructs about early cultures.

Similarly, the word 'scientific' is intended to express contradistinction to 'scientistic' rather than relate to materialism or some other philosophy sometimes identified with science. Science can only exist if it remains uncontaminated by a belief in its own objectivity, which is perhaps a rare state in institutionalized 'science'. I have also used the word 'art' in my title, which is impossible to define empirically or scientistically, probably because it defines itself by denoting anthropocentric reality. The apparent paradox in this title (how can a scientifically undefinable entity be studied scientifically?) can easily be resolved, however: first, science itself exists

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within an anthropocentric and thus subjective frame of reference. It does not explore reality; usually it augments and reinforces anthropocentricity. Second, I shall posit below that art itself is the only humanly accessible phenomenon in the real world that humans can study scientifically. I define art as a medium or vehicle externalizing concepts of reality conveying awareness of perceived reality to the sensory perception of the beholder (Bednarik 1991a). Art, therefore, creates and maintains the common reality of humans.

In this paper I shall examine some aspects of the decline of certain modes of archaeology; the relationships between their methods and models and those of 'prehistoric' art studies; and the question of how recent developments might affect 'cognitive archaeology'. I will argue that the latter can survive the epistemological crisis in archaeology: while scientific interpretation of archaeological 'data' may often not be feasible, certain hypotheses about 'prehistoric' arts may be susceptible to refutation. Several areas could be considered here, but I shall limit myself to five: approaches via semiotic studies, some of the material analyses of rock art recently developed, current dating technology, internal analysis, and the approach via cognitive universals in human perception.

Archaeology and palaeoart studies

Many archaeologists believe either that studies of early art are of no relevance to 'proper archaeological practice', or that they can only be of very limited use in archaeological interpretation. I concur wholeheartedly. Recently it has transpired that 'speculation and the subjective are part of the "scientific" process' in archaeology (Hodder 1984: 28), its nonscientific nature has been revealed 'by a scientific style of discourse' (Hodder 1990: 51), and its role as a sociopolitical tool for the creation of idiosyncratic archaeologies has been recognized (Hodder 1986: 161; see also, for example, Shanks and Tilley 1987; Tangri 1989; Fletcher 1991). In all disciplines, the acceptance of hypotheses is more often based on the biases of scholars than on actual objective merits (Feyerabend 1975; Kuhn 1970; Thomas 1982; Bednarik 1985, 1990a). But while in the 'hard sciences' hypotheses tend to find themselves subjected to rigorous testing sooner or later, falsification of archaeological interpretations is frequently not possible. In all disciplines, the popularity of a hypothesis may be governed by political factors (power brokering, nepotism, intrigue), but in archaeology it is not necessarily possible to displace unsound models, because falsifiability remains so often elusive.

Archaeology acquires its 'accepted fiction' (Bahn 1990: 75) with (a) a frequently untestable methodology; (b) a store of accumulated knowledge of which much is probably invalid; (c) vast quantities of ethnocentrically selected materialist 'data'; and (d) methods of induction which would not be credible even if the data were valid (for comprehensive recent discussion of the archaeological use of ethnographic induction, see Huchet 1992). Not only is it 'quite impossible to infer the substance of a complex archaeological phenomenon from its surviving "observable phenomena" alone' (Bednarik 1985), but the naive logic archaeologists sometimes apply (Bednarik 1989a) results in misinterpretations. To quantify data, subjective taxonomies are imposed on the finds, and the classes so derived are then examined by similarly questionable criteria. 'Crucial' indices are perceived, and changes in them are interpreted as indicating some demographic, cultural, or ecological changes. For instance, a marked increase in stone tool sizes over time could attract any number of adaptationist, diffusionist, postmodernist, behaviorist, post-processualist, feminist, deconstructionist, and Marxist interpretations, yet it may be the result of a rise in sea level (Bednarik 1989a). Or a quite different example: there are pronounced sedimentary, and various other, biases in the preservation of archaeological material, which are likely to be reflected in perceived distributional, and other (e.g., statistical), patterns. These biases are rarely accounted for in the interpretation of data, or in translating the empirical evidence into archaeological interpretation. For instance, the distribution of the Upper Palaeolithic female figurines found in Eurasia is often described as reflecting the distribution of the hypothetical tradition that produced them (Bednarik 1990b). This is most probably a fallacy, because it would be an incredible coincidence if the distribution of the tradition coincided with the distribution of sediments suitable for the preservation of these artefacts. Most of them consist of calcium carbonate (dentine or limestone), and all were found in loesses or limestone caves — i.e., in calcite or dolomite-rich, high-pH soils (Bednarik 1992a). Similarly, the distribution of the Upper Palaeolithic 'cave art' of Europe (99 percent of which occurs in caves) indicates not that it was a cave art, but in fact that it was not a cave art (Bednarik 1986a: 41). Archaeological misinterpretations, then, are attributable to erroneous determination of the common denominator of phenomenon categories (see below). For instance, a geomorphological common denominator is interpreted as an archaeological one.

The *ultimate* purpose of 'prehistoric' art studies is to explore the processes that have in some way contributed to the formation of human concepts, and if we were to find means of illuminating the origins of anthropocentricity (the interpretation of reality in terms of the material stimuli experienced by humans) we would be likely also to acquire a new understanding of the limitations it imposes on the human intellect. Such insights may free that intellect from the restrictions imposed by its epistemological limits, in the distant future. The deficiencies of a conceptual model of reality cannot be perceived from within such a model, by uncritical recourse to the biological intelligence that is its own product (Bednarik 1990b). In an anthropocentric system of reality, ideas or mental constructs must adhere to the system's inherent order not only to be acceptable, but even to be able to be conceived. An analogue is provided by my present paper, which will have to be rejected by those whose thinking is dominated by epistemological models that grant the human intellect access to objectivity.

The processes that led to human models of reality are attributable to the frames of reference created by the early cognitive evolution of hominids (Bednarik 1990c). The earliest cosmologies that are accessible to us are those externalized in the oldest known markings that suggest the existence of human consciousness. We may still lack viable methods of dealing systematically with this tenuous link with the origins of our anthropocentricity, but to disparage 'prehistoric' art studies by relegating them to a subsidiary role in a nonscientific discipline betrays a grave misapprehension about the purpose of the scientific endeavor.

The ideas some archaeologists have about the purposes of 'prehistoric' art studies seem even more absurd when one considers the sort of models they have in mind. These include the iconographic identification (i.e., using one's own cortical processes of matching neural patterns of objects with visual input) of objects supposedly depicted in the arts (such as tools, weapons, animal species, their tracks, etc.), which is scientifically untenable (Clegg 1983; Tangri 1989); or the determination of 'stylistic' and other distribution patterns which are seen as encoding various types of demographic, emblematic, and cultural information: for instance, tribal boundaries, cultural diffusion, even population densities! Many archaeologists have adopted a distinctly ahistorical approach to rock art; they regard the assemblage of a site as belonging to a single tradition unless otherwise demonstrated (Bednarik 1988a). The culturally crucial function of rock art (by far the most common form of palaeoart), that of a cultural determinant (Bednarik 1991b), remains ignored, as does its study as a record of cultural dynamics. Statistical approaches are favored, but they provide a false sense of security, producing unreliable results of generally limited relevance (see below). Thus archaeologists have not only failed to appreciate the true scientific potential of rock arts; they have usurped them for comparatively trivial purposes and utilized them in schemes for which they are poorly suited.

To begin with, distribution and changes in rock art 'styles' over time are not necessarily functions of economic, environmental, cultural, social, or even religious factors (Tangri 1989). Neither is apparent stylistic continuity proof for cultural (or any other) continuity (Bednarik 1988b). Even if it were it would be of no help, in view of archaeologists' ambivalence as to where style resides (Conkey and Hastorf 1990). Thus direct correlation between 'quantifiable' archaeological 'data' and rock art poses serious problems, and the lack of reliable dating for nearly all rock art in the world (Bednarik 1992b) only aggravates these. To make matters worse, the principal tool in the archaeological analysis of rock art (i.e., statistics) is scientifically invalid when applied to quantitative rock art data, because on close examination all premises it is based on can be seen to be unsound.

For instance, generally speaking only a remnant sample of the art can have survived at any rock art site. We cannot know which quantifiable characteristics of the surviving sample are culturally determined, and which are determined by other factors, such as location, type of rock support, or other environment-related circumstances. To illustrate this point one could imagine a cultural convention restricting all motifs of one type to granite surfaces, those of a second type to limestone: after a few thousand years, none of the motifs of the second type may have survived, because exposed limestone surfaces are dissolved by weathering. The statistical characteristics of the surviving sample would be so much influenced by geomorphological selection processes that it would be futile to speculate about their archaeological significance.

The vastly differing longevities of pigment types, or the changes of color many pigments experience over time (e.g., all iron oxides and hydroxides used in rock painting pigments are metastable — Bednarik 1979, 1987a, 1992c; Cook et al. 1989; I have also described white pigments that become completely black), lead to similar conclusions, as do the effects of petroglyph depth on repatination processes (Bednarik 1979) or on petroglyph longevity, and a variety of similar aspects. It is no coincidence that the oldest rock arts outside of caves regularly consist of red pigment (ochres age towards the haematite phase, which is also the most stable iron pigment, and the one best suited for interstitial retention in sandstones — Bednarik 1992c) or of deeply carved line motifs. For example, most Australian petroglyphs are not engravings, but sgraffiti, in which natural cutaneous rock laminae of differing colors were utilized for contrast, not groove relief. Much of this art cannot be expected to survive for longer than total repatination takes, and what have been seen as 'chronological' trends in rock art may simply be attributable to selective survival. The extent of archaeology's deficiencies can be fathomed by considering that such perceived trends are often presented as evolutionary, chronological (by circular argument), or empiricist evidence. In addition to geomorphological bias, many other factors can also greatly distort the statistical characteristics of rock art. Among them are location, recorder's bias, historical responses to alien iconographies, or indeed any process that contributes to the degradation of the art.

The perceived 'sudden' appearance of iconic art in Europe with Aurignacoid cultures (rather than Aurignacian — Bednarik 1989b) may well be another example. The division between the Middle and the Upper Palaeolithic is largely the result of archaeological taxonomizing processes, and may have little real validity in physical or cultural evolution (Lindly and Clark 1990). The sudden appearance of highly sophisticated art on the archaeological record can be most convincingly explained as the result of a shift in technology, from perishable materials to nonperishable. Not only is this more logical (nearly all art produced by any extant culture is in perishable form, and it is obvious that the beginning of the Upper Palaeolithic is marked by a distinct increase in the use of such materials as bone and ivory), but the evidence of preceding art traditions in several continents is considerably more extensive than suggested by superficial or biased treatment of the subject (e.g., Chase and Dibble 1987; Davidson and Noble 1989; for a critical review see Bednarik 1992d).

The statistical analysis of palaeoart

The most serious limitation of statistical analyses in rock art research is that posed by the inherent subjectivity of the data. Irrespective of the actual method used, statistics that address the content of rock arts always involve a taxonomy of motif elements, because the grouping of motifs perceived to be similar is a prerequisite for such treatment. Yet any such taxonomizing process is entirely based on the iconographic perceptions or graphic and depictive conventions defining the researcher's own system of reality, and does not reflect the artists' graphic cognition.

Empiricists seem to realize part of this problem, but their belief in their own objectivity still allows them to perceive meaningfulness in the arbitrary selection of criteria to create taxonomies. They believe that they can detect and recognize the visual clues contained in an alien art without recourse to the cognitive or epistemological framework of the culture concerned; that they can perceive 'meaning' and identify objects reliably (Bednarik 1990b). It has been demonstrated that the reliable identification of the iconic content of an art is restricted to participants of the culture in question (e.g., Macintosh 1977), yet the most common preoccupation of students of rock art is to muse about the nature of the objects depicted in the art, and to base chronologies and interpretations of meaning on their notions. Not only are animal species confidently identified, but many other aspects of the pictures are interpreted in a seemingly ethnocentric fashion. For instance, motifs of the Franco-Cantabrian 'cave art' are often interpreted as pregnant, falling, dead or dying, and so forth, just as depictions in other arts are prone to be pronounced as dancing, praying, adoring, flying, worshipping, etc. In general, these interpretations are based on the assumption that depictive conventions in the art of 'prehistoric' or ethnographic peoples are identical to those determining the enculturated perceptions, cognitive abilities and limitations of the contemporary observer. It may well be true that the modern beholder can in certain cases correctly interpret iconographic aspects of prehistoric art, but this is not the issue. It would need to be demonstrated that the cortically established patterns of detecting iconicity are identical in the mute artist and the contemporary observer — i.e., that the past and present strategies for detecting and interpreting visual clues in a marking are similar. (Iconicity refers here to the visual quality of a motif which conveys to most contemporary observers, especially Westerners, that a specific object is depicted.) Otherwise such interpretations would be no more susceptible to falsification than other archaeological interpretations.

It would initially appear that non-figurative art, consisting of 'geometric' arrangements, is more accessible to statistical analysis than figurative art. In fact the opposite is true, because while there is some merit in assuming that the observer shares iconic perceptions of the artist, that cannot be verified in non-iconic art. No two rock art motifs are identical in every respect; yet in order to prepare a site's assemblage for statistical treatment, apparently similar motifs must be grouped and considered together. Without this process no statistical treatment of any corpus of rock art is possible. Each and every motif possesses thousands of characteristics, and the analyst must decide which of them are to be considered. Otherwise there will inevitably be as many motif types as there are motifs at any one site. Among the characteristics available for selection are metrical indices, qualitative or formal aspects, aspects of the motif's relationship to the site, to other motifs at the site, to the motifs at other sites, to the topography of the site, to petrological or past vegetational or hydrographic aspects of the site or of the surrounding landscape, spatial or syntactic context, the identity or status of the artist (is a circle engraved by a man the same motif type as one engraved by a woman?). Not only can single elements have wide ranges of 'meaning', definable only in terms of 'prehistoric' context (consider Munn 1973); the number of characteristics of each motif is practically unlimited. Many of those characteristics that defy archaeological definition may be crucial in identifying motif types (e.g., the sex of the artist). Thus the parameters the analyst chooses will inevitably reflect her/his personal, cultural, historical, ethnocentric, and cognitive bias. Consequently, the information so derived is useful only in studying the analyst's own culture and cognition, and in studying the way in which s/he applies these in examining the surviving graphic traces of cognitive systems to which s/he has no cognitive access. However, that information is not scientifically relevant to the study of the 'prehistoric' culture concerned, except for purely descriptive purposes. It cannot be expected to provide valid data for statistical analysis of the palaeoart. The theoretical principle is depicted in Figure 1.

About science and epistemology

Everything said so far in this paper implies a rejection of interpretational approaches to palaeoart. One can selectively gather data about rock art

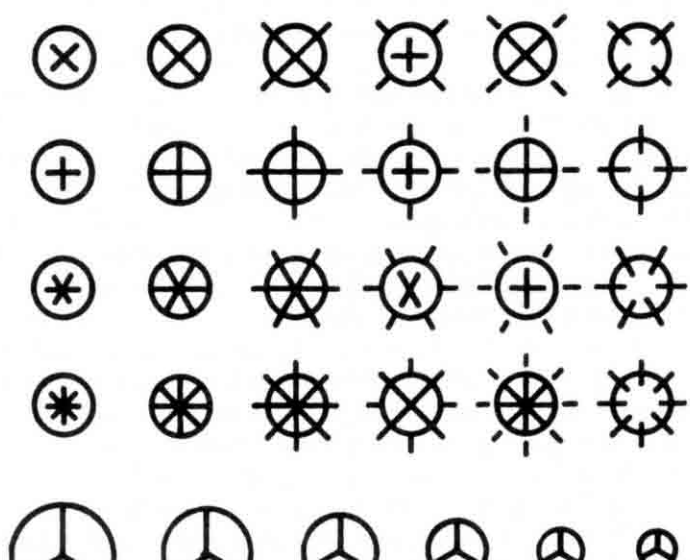

Figure 1. *Combinations of a circular and a radial motif often occur in rock art. Here are just a few of the many possible configurations. Consider that these motifs, together with hundreds of intermediate forms, occur in a rock art site: on what basis would an 'objective researcher' determine where in this continuum one motif type ends and another starts?*

and portable art, one can compare these, speculate about them, generate an endless variety of hypotheses from them (cf. Marshack 1989: 17), discuss the individual merits and probability ratings of these, but no amount of iconographic or statistical information provides falsifiable (Popper 1934) or refutable (Tangri 1989) interpretations.

It seems almost inevitable that palaeoart studies will share the fate of ecological or empiricist archaeology, but I will argue here that the opposite applies. Some archaeologists have traditionally treated early art in a condescending manner, because its cultural and idiosyncratic dimensions — i.e., its essentially human qualities — make it so difficult to extract what is considered to be 'valid archaeological information' from it. It is precisely these much derided human aspects that permit truly scientific access to early art.

Philosophically, this should have been self-evident. All phenomena of the physical world are made up of large numbers of variables, of which humans can only detect those their sensory faculties and intellect allow them to perceive (Bednarik 1984a: 29). From these they select what I call '*crucial common denominators of phenomenon categories*', which are the basis of cosmological taxonomies. Their selection is determined not by objective criteria in terms of how things really are in the world, but by the 'anthropocentrizing' dynamics of human reality-building processes: by how phenomena can be interpreted and integrated into a system of understanding based entirely on human faculties. Since the latter were derived from human evolution, which was never in terms of defining cosmic reality but in terms of survival value, they must be assumed to provide only a narrow spectrum of objective reality. Consequently, scientific constructs of reality cannot be expected to reflect real and objective reality. 'Indeed, if we were able to view "science" objectively we might discover that its main significance is what it can tell us about ourselves' (Bednarik 1985: 91).

There are, however, exceptions: a phenomenon that is created by humans specifically for the purpose of relating to a human sensory faculty can only consist of crucial variables determining its phenomenological externalizations which are accessible to human perception. Art is such a phenomenon; there can be no crucial common denominator for phenomenon categories in art that is entirely inaccessible to humans. Therefore, art is the only phenomenon in the real world that provides human access to its crucial variables. Indeed, one can invert this postulate by defining art as the collective phenomena in human experience about which we can argue objectively.

This truism explains in one stroke how humans attained their unique neural structures of relating to the world — i.e., their humanness —

through art. The introduction of phenomena consisting only of humanly perceptible variables (earliest mark production) would have prompted several developments: 'intentional' marks (consider rhythmic manipulation of tools) would have rendered perceived reality 'conceptually manageable' by providing complete rather than fragmentary sets of percepts, promoting visual and mental taxonomizing processes and the inclusion of the new neural structures in cybernetic feedback systems. 'Conscious experience', or rather, what we understand by it, became possible because the neural structures prompted by the early art production became available for the processing of stimuli of the non-artificial material world, in a taxonomizing format. This explains why the ultimate result, humanly perceived reality, is in the final analysis determined by art, and why it is at the same time valid and inadequate. As I have noted elsewhere (Bednarik 1990c), a false, cultural cosmology or epistemological model can be formed and maintained indefinitely by a biologically intelligent (Jerison 1973) species.

If the artificiality of art permits us an empirical access, at least theoretically, that is not available for natural phenomena, scientific access to palaeoarts may be similarly feasible. Assuming that the human faculties that are involved in present-day art production (especially the visual system) have remained physiologically similar during recent human evolution (Deregowski 1988), some heuristic access should be similarly possible to 'prehistoric' arts. Other physiological factors affecting art production would be the tactile ability of the fingers, the competence of performing the so-called precision grip, and that of precise and well-controlled arm movement. A precondition for producing art (other than finger marks) must have been to procure, hold, and direct marking instruments with confidence and precision, involving not only motor skills, but also the coordination of tool-mediated skills with the operation of the visual system (Marshack 1984). A proficiency in tool-making provided two prerequisites for art production: precision of vision-oriented motor skills, and the experience of observing the effects of altering crucial aspects of the perceptible environment through participation. These factors would have contributed to establishing neural structures that would prompt the behavioral patterns producing early art.

That the physical human characteristics involved in art production have remained comparatively unchanged is in part confirmed by the art itself — although this kind of speculation could well develop into a circular argument. The earliest known sculptures (Marshack 1985; Bednarik 1989b) and the later parietal art of western Europe both suggest that visual perception was essentially modern. Less can be said about early *sapiens*, but even though Neanderthals, for instance, had considerably wider fingers, they were capable of operating burins or engraving tools effectively, as was even the late *Homo erectus* of the Holstein interglacial of Germany (Mania and Mania 1988).

Accordingly, in any comparison of universals in art we will first need to establish whether the proposed common denominator can reasonably be assumed to have applied at the time the 'prehistoric' art in question appears to have been produced. Subject to this proviso, I propose that it should be possible to detect in archaic art universals that can be identified, studied, and quantified in contemporary art production (e.g., Arnheim 1964; Berger 1972; Getzels and Csikszentmihalyi 1976; Levy and Reid 1976). To be eligible for consideration, universals must be unrelated to such factors as cultural experience, cognitive systems, or individual preferences. Universals that may be susceptible to conscious variation, or that may themselves be the product of long-established traditions of art production (such as the canons of aesthetics), are of no value to us here. In the following section I shall describe a few types of such potential universals. No doubt they are not the only ones available to us; others will hopefully be described (for instance, G. Sauvet is trying to isolate universal concepts in form production that may be used to discriminate between pertinent and nonpertinent variants — personal communication) and prove to be more productive than those I offer for initial consideration. But I emphasize that, because of the special position of art in the human construct of reality, it is far more accessible to scientific examination than any other external stimulus in the human experience, and any universals in it are fundamentally more reliable than the known variables of any other external stimulus known to us: the phenomenon they define exists wholly in the realm of human experience, it has no dimension of reality other than the one we know as humans — at least in theory.

Some possible universals in 'prehistoric' art

This paper has been critical of most approaches to early arts, but as the Indian proverb says, 'It is better to light a candle than to curse the darkness'. I shall outline some possible solutions to the problems I have posed above.

Art production processes in contemporary art have been studied by many researchers and from many perspectives. For instance, studies of directional and perceptual preferences have shown certain patterns of preferences concerning starting point and direction of movement in drawing tasks. There are strong preferences in the way a simple motif is produced, which may be influenced by, say, the age and the handedness of a subject. Adult right-handed subjects have a strong preference for drawing a circle counter-clock wise, commencing at or near 12 o'clock, while left-handed subjects are ambivalent, preferring to commence clockwise circles at 10 o'clock, and counter-clockwise circles at 1 o'clock (van Sommers 1984). Several writers agree that right-handed children begin drawing circles clockwise, but progressively switch to counter-clockwise at a certain age (Thomassen and Teulings 1979; Haworth 1970; Ilg and Ames 1964). The work of Bender (1958) and Goodnow et al. (1973) suggests, however, that the adult circle production strategies are conditioned by training. Thomassen and Teulings found that the natural motor movements are to draw clockwise with the right hand, counter-clockwise with the left hand, as did Bender's alexic children.

This is just an example. The preferences in producing most of the other basic motifs occurring in very archaic arts have been similarly studied in contemporary subjects, but no one has ever compared the results of this research with production patterns in early arts. There are many known conventions in contemporary art production, such as anchoring, hierarchical organization, iconographic conventions and deliberate variations (e.g., combination of different graphic devices), line accuracy, the effects of geometric or spatial constraints (which I have observed even in Lower Palaeolithic engravings — Bednarik 1988c), the use of orthoscopic devices (in the sense of Bühler 1934), or of conventions combining iconic and non-iconic aspects. None of these and other methods of analyzing graphic production have been applied to palaeoarts in a consistent manner, yet it seems self-evident that some of these patterns are universal, and should thus be detectable in any graphic system. Such universals could be quite immune to cultural, stylistic, idiosyncratic or other variables; they might simply be related to the way humans perform certain tasks in accordance with the tactile, visual, motor, and cortical faculties at their disposal.

Until recently it has been difficult to effectively study art production strategies in 'prehistoric' arts because an appropriate methodology was lacking. Marshack tackled the technological analysis of early art forms on a major scale (e.g., Marshack 1972, 1975, 1985, 1992), claiming that he could establish internal sequences of engraved and painted marks, handedness of their authors, and a variety of other details pertaining to the production of the marks. He developed the technique of internal analysis, exploring various new methods, particularly microscopic examination of minute traces. A number of objections were subsequently raised by other researchers, prompting Marshack to stress the futility of 'technology-oriented research' (Marshack 1986: 68). His analytical methods were recently validated and refined by d'Errico (1988, 1989, 1991), who conducted replicative experiments and analyses of portable stone plaques in France. Similar work had been conducted on cave petroglyphs in Australia (Bednarik 1984b, 1986b, 1987/88, 1990d), including replicative studies. I was often able to determine which marks had been incised with the same tool, in which direction and in which sequence they had been incised, as well as other details (Figure 2).

These methods have been used by very few researchers so far, yet they provide an excellent promise of progress. Not only will they often reveal graphic production strategies in archaic art, but such information can then be directly compared with the results of studying production conventions in contemporary arts, and any universals could be identified from such comparative analyses.

This is not the only type of universal pattern in art. As I will show briefly, it is possible to identify several more. One which I have already discussed at length relates to the possible occurrence of visual archetypes in all arts, but particularly in those that are basically non-figurative. Years ago I noticed the perplexing similarity among the basic motif repertoires of all early non-iconic rock art traditions in the world, as well as their striking similarities with the motif types of certain subjective visual experiences called phosphenes (Bednarik 1984a and b, 1986a, 1987b). I speculated about a direct derivation of these repertoires from phosphene experiences, and a feedback system wherein any cosmological or metaphysical construct based on discernible motif types of such experiences would be validated indefinitely, due to the permanence of these immutable neural universals. This cogent theory has remained largely misunderstood, as shown for example by its recent misuse for an analogical interpretation attempt of Upper Palaeolithic art in western Europe (Lewis-Williams and Dowson 1988). I shall therefore briefly summarize the basic premises of the phosphene theory here.

Phosphenes are autogenous and involuntary phenomena of the mammalian visual system, whose form constants cannot be influenced by cultural conditioning and seem to be ontogenically stable. Since their forms are determined by physiological factors (electrobiology, neurophysiology etc., involving the retina, the *Fasciculus opticus*, and the visual center in the occipital cerebrum) such as, for example, the structure and electrophysiology of the retina and the effects of the blind spot where the optic nerve connects to it (cf. Meier-Koll's [1974] cybernetic model of phosphene stimulation), we can reasonably assume that phosphene form constants have considerable phylogenetic longevity (Bednarik 1984a). These forms would be variable only in accordance with structural or functional changes of those parts of the visual system that are involved in the generation of phosphenes. It does not seem likely that such changes

Figure 2. *Internal analysis of a small panel of tool markings on formerly soft wall deposit in Nung-kol Cave, South Australia. In this example, the art production sequence has been reconstructed. Where striation patterns are preserved, five apparently different tools have been identified, numbered 1–5. All marks were executed from top to bottom, with limestone clasts (the marks of a nearby panel were made with chert tools). The cross-sections of the tips (perpendicular to direction of movement) on two of the tools were determined, and are shown below (tool No. 1 and tool No. 2).*

occurred since the Middle Pleistocene, so we could tentatively credit the hominids or humans since then with phosphene types similar, if not identical, to ours. Phosphenes may be experienced by the human fetus (Anderson 1975), and they are believed to play an important role in the cognitive development of infants (Kellogg et al. 1965). The ability to scribble recognizable patterns does not exist in a child under the age of three, but then it develops so rapidly that the involvement of phosphenes in the activation of preformed neuron networks has been postulated. In most people, susceptibility to phosphenes declines sharply during childhood. They can be prompted by many influences (mechanical, optical, electrical, acoustic, magnetic, through deprivation, etc.), and the heavy emphasis of several writers on trance or narcotics-induced phosphene experiences (and the inexpedient connection with other entoptic phenomena, such as mescaline or LSD-caused hallucinations) has unfortunately detracted from the dialectic concerning the involvement and effects of phosphene experiences in early art production (Bednarik 1990e).

The most conspicuous aspect of all pre-iconic art is its astonishing global homogeneity (Bednarik 1988a, b, d, e). Its striking similarity to the art produced by children before they draw figuratively (i.e., before the age of four or so) cannot in my view be explained away as simple coincidence. What renders this evidence particularly compelling is that the phosphene types identified by Knoll and his co-workers in large, multi-racial samples have been independently confirmed by other researchers who were evidently unaware of Knoll's work. Van Sommers (1984) noted the consistent occurrence of motif constants in the drawings of young children which he called 'primitives'; they match Knoll and Kugler's (1959) phosphene types, yet he was not aware of the extensive work of Knoll and colleagues. Similar corroboration is provided by Fein (1976), who recorded the artistic development of one child in detail. DeBoer (1990), who studied ontogenic artistic development among the Shipibo-Conibo of Peru, observed that children's drawings before the age of five conform to the stage described by Kellogg and others, before a culture-specific style develops. Recently the prodigious phosphene motif production of an artist in India has been studied in considerable detail (Bednarik and Broota in prep.).

I have postulated that all pre-iconic art in the world reflects phosphene types (Bednarik 1986a, 1988d). Having studied firsthand the earliest arts of five continents, I have not so far encountered one single instance of refuting evidence, and I stress that this hypothesis is highly susceptible to refutation (Bednarik 1992d). It is therefore scientific, irrespective of what one might say of its validity.

If, as I have proposed, archaic art is related to phosphene experiences that have remained phylogenetically immutable since this art was produced, then phosphene types are clear and strong universals in palaeoart, and their 'validating effect' could have provided a powerful epistemological mechanism: the phosphene experiences of prehistoric people would have served to reinforce beliefs in the supernatural qualities of the already enculturated motifs, and would thus have validated the existing cosmology — whatever it was (just as the cosmology of contemporary society is constantly being validated and augmented by our apparent material and cultural achievements). It is therefore not surprising that an entirely phosphene-based art form survived almost unchanged for tens of millennia in Australia (Nobbs and Dorn 1988).

The attempt by Lewis-Williams and Dowson (1988; cf. Bednarik 1990e) to interpret Palaeolithic art, after reading about it in books, is based on numerous errors of fact. Not only did they wrongly assume that phosphene forms are a hallmark of shamanistic art and that they are common in Upper Palaeolithic art, but they also touched on another universal in art, again without realizing its potential. These writers believe that the neural effects of all drugs are 'broadly similar' (Lewis-Williams and Dowson 1988: 204), and that subjects experience non-figurative motifs which they elaborate into figurative ones at will, in accordance with their disposition. Two crucial errors characterize this view also. Firstly, the alkaloids or narcotics popularly known as drugs can be divided into several distinctive classes on the basis of their effects on the nervous system, and these differences are certainly far too significant for such generalizations. The 'psychedelic experiences' of the hallucinogens (Naranjo 1973), comprising lysergic acid diethylamide, mescaline, dimethyl tryptamine, psilocybin, psilocin, and various phenylisopropylamines, differ considerably from those of the 'feeling enhancers' (such as MDA, MMDA, TMD-2), cannabis, and particularly from harmaline and ibogane, of the 'oneirophrenic' (Turner 1964) plant extracts which have probably provided most of the alkaloids rock art students might be interested in. They are the active ingredients of such widely used potions as *yage* (Colombia) and *ayahuasca* (Peru), and may have been much used elsewhere in early periods. Indeed, the effects of harmaline are so distinctive that its use has on their basis been identified in the early Iran of Zoroaster (Flattery and Schwartz 1985). Briefly, the harmaline and ibogane-based narcotics produce an iconic imagery that is not conjured up at will, but is probably as 'hard-wired' as phosphenes. Controlled experiments with non-indigenes indicate the existence of neural structures in all humans, reacting to this alkaloid stimulation in established patterns. This is the precise opposite of Lewis-Williams and Dowson's postulates about drug-induced imageries, their second crucial error, and it raises the possibility that any art induced by specific alkaloids could be identified by its typical themes; it would be truly determined by universals.

The types of images dominating these drug-induced imageries are all too familiar from certain rock arts. Animal images clearly stand out, especially those of large felines, snakes, and birds of prey. Other typical visions are of death and of flying. Rock arts in which these themes are conspicuous occur in various parts of the world. Some major South American assemblages seem to consist largely of images of what look like spotted cats (jaguar), snakes, birds of prey, and dynamic humans with long lines emanating from their eyes and rising from their heads, surrounded by generous samples of geometric motifs of phosphene patterns. At Toro Muerto, Peru, many tens of thousands of petroglyphs (I regard this as the largest petroglyph site of the Americas) are dominated by these motifs, repeated over and over in huge numbers (Figure 3). I must emphasize, however, that I am not postulating that this art is necessarily narcotic induced; I am merely proposing that this possibility is worthy of consideration.

There are other points of interest. The dragon, that ubiquitous mythical beast found in so many parts of the world, is a synthesis of the three animal types dominating this drug imagery: a serpent's body with a lion's head and the wings and talons of an eagle. There are variations, some omitting the wings and feet, and on the west coast of Canada the feline head was replaced with that of a wolf. Surely this widespread mythical beast is more plausibly explained as the product of a common subconscious than as the result of cultural diffusion, or sheer coincidence! Ingestion of narcotics, intentional or unintentional (through grain molds such as ergot, for instance, widely ingested during the Middle Ages and accounting for so much imagery), was widespread in many parts of the world.

What do the images of death, of flying (or falling), of large cats, snakes, and eagles have in common? To me they seem to sum up the visual stimuli that elicited the most primordial fears in our primate lineage. The automatic response system of an infant living on the east African plains ten or twenty million years ago would have been most acutely attuned to the images of leopards and lions, snakes, and predatory birds; and the fear of falling is particularly deeply ingrained in any vertebrate species. My suggestion that residual primeval response circuits of the cerebellum are affected by harmaline (and perhaps certain other influences, such as trance?) sounds sensible on its own, but it derives much support from Seyfarth et al.'s (1980) observation that the three warning calls of vervet monkeys, which signal the sighting alternatively of a leopard, a snake, and an eagle, are visually stimulated, and each of

Figure 3. *Nine panels of typical petroglyph motifs at Toro Muerto, Peru. The site measures about 4 km and comprises some 5,000 large blocks covered with motifs. All scales are 10 cm long.*

these distinctive calls results in an appropriate *automatic* response. If it were true that the hallucinatory effects of certain narcotics, and perhaps of trance, excite residual neural pathways associated with reflexive action circuits originating in early primates, this would indicate an endurance of visual universals of quite a different order of magnitude than that I suggest elsewhere in this paper! But irrespective of this speculation (and it is pure speculation), palaeoarts exhibiting significantly high contents of the described iconic imagery are likely to be attributable to neural universals in humans.

There is one more possible scientific access to early arts via universals that I wish to mention. It is by way of what we contemptuously call doodles. In modern doodling behavior, graphics are produced without, or with a minimum of, conscious effort, and the artist is a mere spectator to his or her own spontaneous graphic production. The resulting patterns may be highly repetitive, while other doodles are rather complex and ornate. Those I find most interesting are the spontaneous responses to marks on a printed surface (e.g., the pages of a telephone book), which most frequently take the form of 'decorations', such as shading, fringing, stippling, emphasizing edges and boundaries, or filling given spaces with patterns. The inherent strategies often resemble those apparent in very early mark production. This may be attributable to the simplicity of such efforts, but the subconscious, or at least partly involuntary processes apparently responsible for modern doodle production do need to be explained. It seems not unreasonable to suggest that they are explainable in terms of underlying universals. I am not aware of any exhaustive studies of doodling behavior, but if large samples of such contemporary output were analyzed, the principles governing the spontaneous generation should become accessible. It would then be comparatively easy to determine whether such patterns can be detected in archaic art. I am not at all certain that they can, but I am sufficiently intrigued to draw attention to this possibility here. A potential connection between art origins and the neural arousal theory has been suggested before: optimal level of arousal is of survival value in any species (Bednarik 1988d).

Semiotic studies

A major purpose of this paper is to interest semioticians in palaeoart studies, because semiotic studies can clearly provide scientific access to palaeoart. One may, for instance, overcome a problem defined above, concerning the identification of specific motifs. It seems possible to determine the morphological variability of a valid motif type from syntactic context (Kubler 1967; Donnan 1976).

There are many examples in global rock art where specific associations of two or more motifs occur repeatedly. From them we can deduce the stylistic latitude of the participant motifs simply by recording it in all cases of such associations. Such syntactic relationships are far more likely to be culture specific than individual motif types. But they are not sufficiently common to offer adequate applications. Also, care is required in interpretation attempts on this basis, as it seems possible that a recurrent association of two motifs does have more than one meaning; or that its meaning is shared by another, dissimilar motif or motif association; or that it was adopted by a different culture for a different semantic context. Nevertheless, the identification of motifs on the basis of syntactic context seems significantly more secure than simple iconographic identification. The underlying principle is shown in Figure 4.

No doubt other and more productive semiotic approaches are possible, and this is where students of palaeoart require the assistance of semioticians. The possibilities that do exist have hardly been explored until now, and rock art research would benefit greatly from interdisciplinary collaboration in this area.

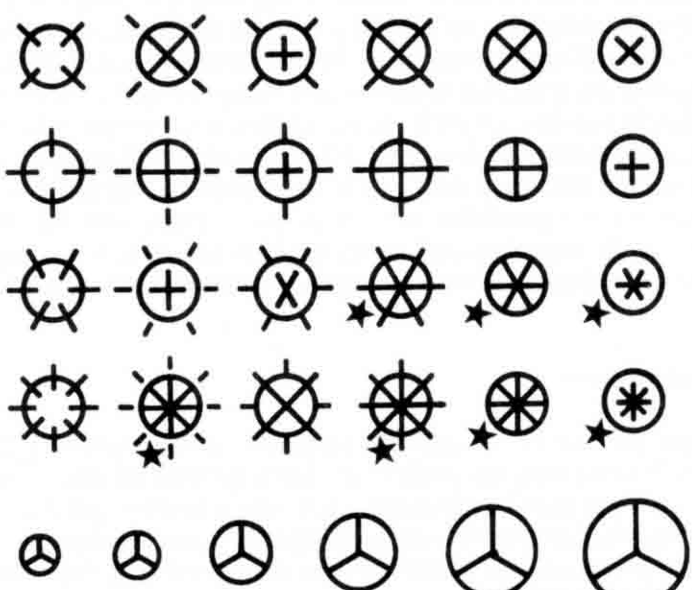

Figure 4. *The same spectrum of motifs as in Figure 1, except that small stars occur next to some motifs. The motifs in these syntactic relationships all have six or eight radiating lines which meet in the center. From this recurrent association of two motifs we can deduce the range of a specific motif type, because it is identified by the associative syntax.*

Material analysis and dating methodology

In another area such interdisciplinary collaboration is already proceeding most productively. The area bounded by geomorphology, geochemistry, and rock art studies has become the focus of much attention, with an entire new methodology of rock art dating in the making. This work is as scientific as any in the 'hard sciences', in that it is repeatable, falsifiable, and testable. Its accuracy and reliability are only limited by the technological restraints of the method concerned.

Most of the analytical attention has been focused on rock art paints recently: on their composition, the types of binders and extenders contained in them, and the microscopic inclusions often found in them. A variety of substances have been identified as binders, including blood, albumen, plant and animal oil, resins and plant juices (e.g., of orchids), milk, honey, urine, and 'animal proteins' (Bednarik 1992b). These organic substances are datable with currently available radiocarbon technology. Moreover, several paint pigments are themselves organic, such as charcoal, cochineal, bird droppings, and three other as yet unidentified pigments in India and Australia (Bednarik 1992b). At the time of writing, accelerator mass spectrometry (AMS) dating has been undertaken of rock art paints from Australia, Brazil, France, Spain, South Africa, the United States, and more will follow.

Samples from a Chinese rock painting at Cangyuan, Yunnan Province, have been found to contain pollen of forty plant species, supporting other dating evidence from the site (Li Fushun and Bednarik in press). Australian researchers have detected human blood protein in samples from two sites, and have used it for AMS dating (Loy et al. 1990). Clottes et al. (1990) analyzed numerous samples from the cave of Niaux, France, discovering complex paint recipes which were identifiable by their extender content. The extenders are mineral additives, which are still used in modern synthetic paint production. In another French study, Lorblanchet et al. (1990) identified the tree genus that provided the charcoal for a painting in Cougnac Cave, and found that the red pigments in the same site are apparently not of imported ochres, but were prepared from locally occurring siderolithic clays. It is thought that these were mixed with water, decanted to separate the sand fraction, dried and then roasted at a fire to dehydrate the iron minerals to a red colour. The complex preparation techniques in these and other Pleistocene paints suggest sophisticated production processes in the Palaeolithic period.

Some of the most promising analytical results from rock paints have been obtained by Alan Watchman and colleagues in Australia. For instance, they detected microscopic plant fibers in 26 paint samples from

Laura, north Queensland. Two plant species (orchid and kapok) were identified in several instances by Cole and Watchman (1992), who have compared the data with ethnographic information about plants used in painting and coloring, or as brushes. Watchman's discovery of up to ten layers of rock paint at sites that appear totally undecorated opens up extraordinary possibilities. These paintings are concealed by mineral deposit under which they survived, and they are not visible on the surface. The same mineral deposits, which might be of silicas, oxalates, etc., also separate various paint layers, thus presenting a definite stratigraphy (A. Watchman, personal communication). Not only does this suggest that there might be much more rock art in Australia than we thought, but it opens up considerable opportunities for rock art researchers. The stratigraphies of rock paintings are more reliable than those of sediment layers at archaeological sites, and we can reasonably expect that they will be explored by nondestructive methods in the near future. Moreover, rock art sequences provide cultural information, which the tool types and ecological patterns perceived by archaeologists do not. Perhaps palaeoart studies, the traditionally neglected poor relative of orthodox archaeology, will ultimately provide a true cultural framework of the past.

It will obviously be essential to provide this framework with chronological depth, and it is precisely in rock art dating that the greatest strides have been made in this discipline. No 'prehistoric' rock art in the world had been firmly dated by about 1980. A number of minimum dates obtained by archaeological means were available from most continents, but the chronological models of various regional art bodies were largely based on perceived styles, location, and association (Bednarik 1992b). Some of these essentially subjectively derived regional sequences have been rejected recently, such as those of the Levantine shelter art of Spain (Hernández et al. 1988), Saharan rock art (Muzzolini 1990), and Siberian rock art (Bednarik 1990f). Others, such as those of India, Scandinavia, and China may well need to be similarly revised.

Non-archaeological or 'direct' dating methods for rock art have been introduced only recently. In the first direct minimum dating (Bednarik 1981, 1984b: Fig. 3), carbonate speleothem deposited over petroglyphs in a cave in South Australia was radiocarbon dated by utilizing the organic content of the reprecipitated calcite. The same method has been used in China more recently. A rock painting at Huashan, Guangxi Zhuang Autonomous Region, has been dated via stalactite physically related to the art (Li Fushun 1991). Similarly, a painting at Cangyuan, Yunnan Province, was concealed under a series of flowstone laminae which have yielded several radiocarbon dates. The results agree with the ages of occupation layers and with the pollen spectrum obtained from the paint (Woo Sheh Ming, personal communication).

In the southwestern United States, Dorn and colleagues developed the cation-ratio dating method (Dorn 1982, 1986; Nobbs and Dorn 1988). Based on the selective leaching of cations from a ferromanganese accretion called rock varnish, this method was expanded to calibrating rates of leaching through radiocarbon dating of organic inclusions in the varnish. However, the method remains experimental and its reliability and accuracy are the subject of an ongoing debate.

Less controversial is the method of oxalate dating. In it, whewellite and weddelite, salts of an organic acid, are radiocarbon dated (Watchman 1990). Very recently, Watchman and Lessard (1992) have developed a new dating method, called focused laser extraction of carbonaceous substances. This system can be used on both paintings and varnish-coated petroglyphs. Under controlled conditions, localized combustion of organic matter is caused by a laser, and the carbon dioxide forming is then dated by AMS radiocarbon analysis. Finally, a nondestructive method has just been developed for petroglyphs, which offers the considerable benefits of being very cheap, providing field results, and being easy to learn. This method, microerosion dating, has been tried only once so far, in Karelia, Russia (Bednarik 1992e, 1993). It can be used only on certain types of rock (notably plutonic rocks) and involves the creation of calibration curves from rock surfaces or markings of known ages. It was designed specifically for use in developing countries, to counter the trend toward expensive high-technology methods in rock art dating which is threatening to widen the gap between different research traditions.

The principal tool in the dating of rock paintings is, as already indicated, the radiocarbon analysis of organic pigments, binders, or inclusions in the paint. The method was first used successfully in South Africa (Van der Merwe et al. 1987), on comparatively recent charcoal pigment. Lorblanchet obtained a Pleistocene date from black paint in Cougnac Cave, France (Lorblanchet et al. 1990). Ice Age dates were also secured in Australia, by Loy et al. (1990) and McDonald et al. (1990). An improved version of the AMS method produced a late Holocene date from a painting in Texas (Russ et al. 1990), and further results have recently become available from Spain and Brazil.

With these technological developments of the last few years routine dating of rock paintings has begun, enhancing the application of scientific method in this discipline. Petroglyph dating, by contrast, remains very much a challenge, an opportunistic pursuit demanding considerable methodological creativity. Nevertheless, palaeoart studies are now firmly set on a course of scientific relevance.

Conclusion

In the first part of this paper, most methods so far applied to the task of 'interpreting' palaeoarts are challenged, while in the second I describe several approaches that seem more epistemologically sound, even if some may appear a trifle far-fetched.

I am not proposing to cast off earlier methods entirely, being only too aware that the discipline cannot afford such drastic measures. I merely wish to explore and establish the limitations of statistical, iconographic, or other such approaches. Far from wanting to purge them, I perceive a need to ascertain their scientific relevance. I foresee a hierarchical pluralist methodology for 'prehistoric' art studies, in which methods of varying credibility, usefulness, and applicability can coexist and work together in accord. Those of 'scientific' ranking tend to produce precious little in actual progress, and may need to be supplemented by exploratory, less rigorous techniques, including traditional approaches. In such an integrated model it is most important to be fully conscious of the qualifications that should apply to each method admitted, which is why I have reviewed them somewhat harshly here.

My definition of art is not in terms of what it is, but what it does, and it challenges conventional notions of the role of science in this discipline. Art is not the only term empiricists are unable to define satisfactorily; the word 'style' is another example. Style is often seen as an analytical tool of archaeology, yet there is no agreement as to what it is, where it resides, and how it relates to archaeology. It is inevitable that such epistemological ambiguities should be subjected to scrutiny.

I have introduced the concept of utilizing falsifiable universals in art. While it may not be immediately apparent that this amounts to a great improvement over previous attempts to gain some scientific access to early art, I have argued that my proposals have the benefit of not having to rely on assumptions about reality. They compare two types of phenomena, both of which cannot have any significant characteristics that cannot be visually perceived by humans: they were created by humans specifically to be contemplated — which applies to no other phenomenon in the world. If we were to assume that Plato is right with his allegory of the cave, then art is the only experience humans have truly scientific access to. Despite their seemingly delicate semblance, the universals in art I have discussed here would then be more robust than any knowledge claim of the 'hard sciences'.

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