Art as information: explaining Upper Palaeolithic art in western Europe

C. Michael Barton, G. A. Clark and Allison E. Cohen

Introduction

Most studies of Upper Palaeolithic art are characterized by a focus on the interpretation of imagery and the (often implicit) view that temporal and spatial variability is primarily stochastic in nature. The art is taken to be adaptively neutral and, thus, serves to monitor chronology and cultural affinity. We take a different approach here, focusing on explaining the temporal and spatial distribution of Upper Palaeolithic art, rather than on interpreting images. We also see art, and more generally style, as performing an important social function – that of information exchange. It can, thus, affect the successful replication of social groups, and its distribution in space and time can, in turn, be affected by selective pressure. Our approach is evolutionary, drawing on neo-Darwinian theory as applied to human cultural systems (e.g. Dunnell 1978, 1980; Rindos 1989; Leonard and Reed 1993; O'Brien and Holland 1990, 1992). Within this broad perspective, we integrate the previous work of Barbara Bender (1978), Clive Gamble (1986, 1991), Michael Jochim (1983), Polly Wiessner (1983) and, to a lesser extent, that of David Braun and Steven Plog (1982), Christopher Carr (1994), Margaret Conkey (1985), Steven Mithen (1991) and Martin Wobst (1976).

Upper Palaeolithic art has intrigued archaeologists and those outside the profession since its discovery in the last century. Most attempts to explain it have centered on interpreting the images portrayed. The more widely accepted of these interpretations include sympathetic hunting magic (e.g. Breuil 1952), metaphors for gender, fertility magic and sex (e.g. Laming-Emperaire 1962, 1972; Leroi-Gourhan 1958a, 1958b), origin myths (Laming-Emperaire 1970), ethnic or social boundaries (e.g. Pales and St. Pereuse 1976, 1981), time-factored symbol systems (e.g. Marshack, 1972), socioeconomic context (e.g. Criado and Penedo 1993) and representations of the entoptic visions of altered states of consciousness (Lewis-Williams 1981, 1984). However, the elapsed time and the potential for demographic and social change since the creation of this art has made the extension of the direct historical approach (applied in North America, South Africa and Australia [Loendorf 1990; Lewis-Williams 1981, 1984; Morwood 1991, n.d.]) difficult to justify. Some workers have responded to this by invoking cultural or psychological

universals (e.g. Lewis-Williams and Dowson 1988), with varying degrees of success (Bahn and Vertut 1988). In the end, it may never be possible to know the meaning of imagery in Palaeolithic art without recourse to H. G. Wells' famous (and unfortunately fictional) time machine.

Studies that have dealt with the spatial and temporal distribution of art (e.g. Conkey 1985; Francis et al. 1993; Jochim 1983; Ucko and Rosenfeld 1967) have met with somewhat greater success, despite a lack of appeal outside the discipline, because they specify and examine cause beyond the workings of the Palaeolithic mind and are thus more accessible to scientific scrutiny. These studies can be grouped into two quite different explanatory paradigms, depending on the causal factors invoked to explain pattern (Clark et al. n.d.).

Art and social interaction

The first sees distributional patterning in Palaeolithic art, and more generally style, as a monitor of the degree of cultural affinity among social groups through time or in terms of shared cultural traditions. This 'social interaction' model has roots in both the Old and New Worlds. In North America, it dates back to A. L. Kroeber, Clark Wissler and the 'culture area' studies of the 1930s. Social interaction theory defines style in a strongly normative way as repetitive behavior that acts as a kind of psychological 'filter' to constrain variety and reduce information overload. Style functions at the level of the individual and is essentially passive; that is, it reflects normative constraints learned unconsciously through enculturation. In art and in artefact design, style is construed to exhibit modal properties taken to reflect, in a more or less direct way, group norms and values. These modal properties are often considered to be isomorphic with the temporal and spatial boundaries of identity-conscious social units – in other words, an ideational definition of style, but with alleged material correlates (Clark 1993).

Art and information exchange

The second approach to art is essentially a functionalist one that views it as the remains of communication systems involving the exchange of information (Braun and Plog 1982). As employed here, the 'information exchange' theory of style originated with Polly Wiessner (1983, 1984, 1985), who views art as an act of social communication defined, at various levels and scales, by style. Style, in turn, has its behavioral basis in a fundamental human cognitive process: the personal and social identification of images through visual comparison. In sharp contrast to the pattern searches of social interaction theory, style is defined here by its determining processes, rather than by its material conditions. Some of the more salient postulates and expectations that distinguish the social interaction and information exchange theories of style are contrasted in Table 1.

From an information exchange perspective, style is situational and functions to transmit information about group affiliation, individual states and ownership – in other words, aspects of status. The metalanguage of style makes social intercourse more predictable than would otherwise be the case. Style is also 'active', and is manipulated according to

Table 1 Theories of style (after Braun and Plog 1982)

Social interaction	*Information exchange*
normative and *ideational*, but with material correlates	*antinormative* and *contextual*, with material correlates
the referent is an *individual*	the referent is a *group*
has a *psychological function* – it reduces the amount of variety with which humans must contend, and thus minimizes information overload	has an *adaptive function* – it transmits information about group affiliation, individual state of being, ownership, etc. (i.e. aspects of status), and thus makes social intercourse more predictable
is *passive* – an unintentional consequence of learning (enculturation)	is *active* – manipulated according to social context
reflects *traditional norms* and values	reflects *active decision making*
variety minimizing – stylistic modalities a direct indicator of social interaction by groups of individuals who share norms	*variety emphasizing* – stylistic modalities at many different levels, scales indicate the volume of information flow

context in order to express something: current social conditions, individual needs, etc. As Hodder (1986) puts it, style is used to 'manage' the context by manipulating the message. In regard to artefacts, it reflects decisions about the social context of production and use. Style, therefore, might be called 'antinormative' from the information exchange perspective. It emphasizes, rather than constrains, variety, and uses the dissimilarities so exposed to monitor the volume of information flow both within and between societies. According to Wobst (1977), attributes of style related to group affiliation would be found almost exclusively on artefacts that are visible and used in contexts that ensure their visibility to potential observers. If Wobst is right, all surviving palaeolithic material culture, *except* for Upper Palaeolithic art, would *a priori* be unlikely media for the exchange of information via stylistic expression (Clark 1989). For this reason, we focus here on parietal art – painting and engravings on the walls of caves and rock shelters – and portable art – carved and engraved ornaments made from bone, antler, ivory and teeth – and their relation to the dynamics of information flow among late Pleistocene and early Holocene foragers in Europe.

Following Wiessner (1983), we also make a distinction between *assertive* and *emblemic* style. Portable art, mainly ornaments, probably represents assertive style – formal variation in material culture which is 'personally-based and which carries information supporting individual identity' (1983: 258). It functions on an idiosyncratic level to differentiate individuals from similar others. Parietal art, on the other hand, probably expresses Wiessner's emblemic style – 'formal variation in material culture that has a distinct referent and that transmits a clear message to a defined target population' (1983: 257). By definition, emblemic style always carries a symbolic loading, whereas assertive style does not necessarily do so (Clark 1989; Clark et al. n.d.).

Social interaction and information exchange approaches consider style to comprise two

very different classes of entities. These differences are critical to the way in which prehistoric art is explained. Social interaction theory considers style to be those forms (attributes, objects or object classes) that are selectively neutral and that vary stochastically in time and space (Dunnell 1978, 1980). That is, the state of a particular stylistic element is determined primarily by its preceding state and some amount of variability that can be considered analytically random. The degree of similarity/dissimilarity among stylistic elements is attributed to (1) noise (i.e. imperfect expression of a norm) and (2) the amount of divergence from a common, historically antecedent form. Temporal and spatial variability in the expression of style, then, is a passive *result* of social process, but style generally does not *affect* social process. Such stochastic variability serves only to measure the passage of time and/or the degree of cultural affinity.

Additionally, most adherents of the social interaction school tend to treat as inherently stylistic (i.e. selectively neutral) cultural manifestations, such as art, that have no obviously utilitarian function (but see Dunnell [1978] for an exception). In other words, the fact that an object is a spear thrower means that it is 'functional' and can therefore affect individual or group fitness; the fact that it is carved in the likeness of a horse is 'stylistic' and selectively neutral by definition. Because art is generally considered as an expression of style, the social interaction approach to art is limited by its inability to consider process questions, such as why change occurs, and by its tendency to isolate art from its broader social context.

Information exchange theory, on the other hand, considers elements to be stylistic if they primarily serve to convey information rather than to have a utilitarian purpose; it does not *a priori* designate such elements as selectively neutral. Whether or not an element, in this case art, affected fitness and was thus subject to selection is an assessment that must be evaluated independently. This allows us to address the *causes* of change in the distribution and expression of art in the archaeological record. Information exchange approaches have three additional advantages: (1) they move us beyond the highly subjective interpretative issues that have plagued art research since its inception; (2) they avoid problems with the 'affluent forager' models of Mellars (1985) and Price and Brown (1985), notably the idea that complexity manifest as art is simply a consequence of the bountiful environment in the Franco-Cantabrian heartland; and (3) they sidestep the reductionism implicit in the notion of a simple–complex dichotomy (e.g. Keeley 1988).

Art as adaptation

From an information exchange standpoint, temporal and spatial variability in the frequency of art and its mode of expression can be used to monitor the volume of information flow across and within regional systems maintained by alliance networks. Barbara Bender (1978, 1985) defines an alliance as an achieved social status based largely upon negotiation. It was Bender's contention that, in ethnographic contexts, alliances mediated the circulation, control and exchange of people, goods and ritual knowledge – or, most generally, information. Information will tend to flow along the channels defined and maintained through the negotiation of alliances. Alliances are of variable commitment and duration, are defined in many ways and at many scales, and have many functions, only
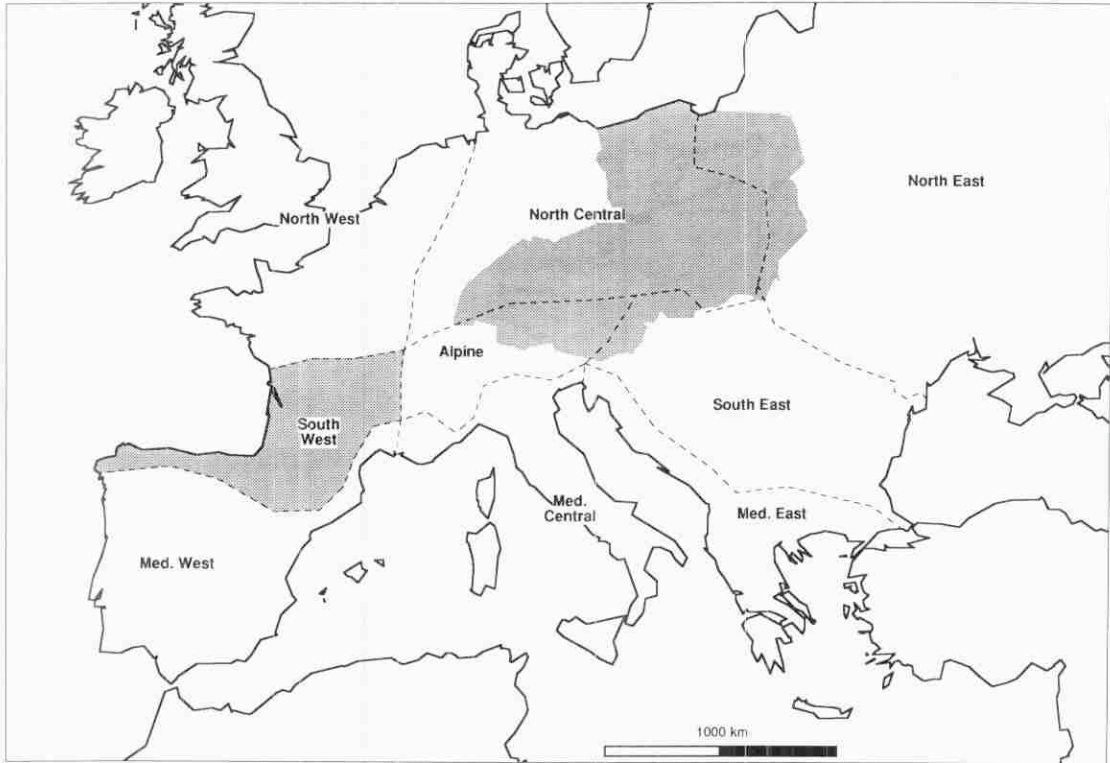
Figure 1 Gamble's (1986: 72) regional divisions of Europe outlined by dashed lines. Shaded areas are the south-western and central European regions discussed in the text.

some of which have material correlates. Gamble (1982) has argued that one function of alliances is to amplify the geographical and temporal 'reach' of ecological knowledge, and thereby grant access to alternative sets of resources. Since they increase variety, and therefore system flexibility, a network of alliances would clearly be adaptive for long-term occupation of the highly seasonal and unpredictable environments of glacial Europe. Channels of information flow cut by alliance networks of various kinds are thus under selective pressure, and will be de-emphasized, abandoned, strengthened or renegotiated according to the specifics of the situation (Gamble 1982, 1991).

We take the position, then, that art is symbolic behavior manifest in a variety of media, and that it had adaptive significance for those foragers that engaged in creating it. The functional nature of style in general and art in particular, when viewed from an information exchange perspective, means that it had the potential to affect the 'replicative' success (*sensu* Leonard and Reed 1993) of forager societies and, in turn, be acted upon by selective pressures. Art recorded in Palaeolithic archaeological contexts is taken to represent only a tiny fraction of that which existed more than ten millennia in the past, however. In this respect, variability in Palaeolithic art is only the tip of a very large iceberg.
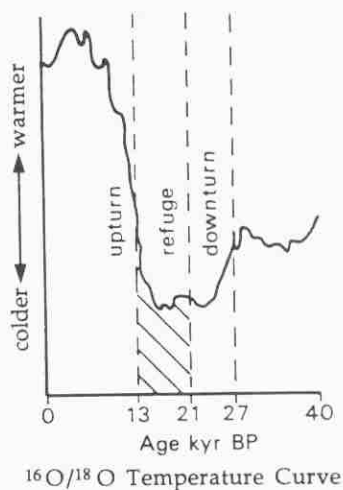
Figure 2   Oxygen isotope marine core V 19–30, indicating the downturn (27–21 kyr BP), refuge (21–13 kyr BP) and upturn (13–10 kyr BP) intervals (after Gamble 1991: 7).

Temporal and geographic frameworks

In this paper, we investigate the variability in art over the 30–7 kyr BP interval in Europe. Viewing art as a communication medium that monitors information flow allows us to propose an explanation for observed patterns in Palaeolithic and post-Palaeolithic art, and to model changing alliance networks in European forager populations from the late Pleistocene through the early Holocene. Previous efforts in this direction have tended to be data-driven and to focus on ecologically distinctive European subregions which are then characterized in terms of distinct historical trajectories (e.g. Conkey 1985, 1987; Soffer 1985a, 1987). Because we are interested in the manifestation of art *throughout* Europe, we use Gamble's (1986) spatial organization scheme, which divides Europe into nine geographic 'provinces' (Figure 1). These provinces are simply analytical units, with no ecologically distinctive properties; they provide a broad, regional framework within which to examine patterns defined by artistic, demographic and ecological data. We also employ a modified version of Gamble's Upper and Post-Palaeolithic temporal divisions – downturn (30–21 kyr BP), refuge (21–13 kyr BP) and upturn (13–7 kyr BP) phases (Figure 2). It appears reasonable to suppose that alliance networks and information flow would have been temporally as well as spatially dynamic, and that prevailing environmental conditions would have affected human demography differently in the various European subregions. Although temporal variability in both environmental and social systems was, in reality, continuous, the three rather broad divisions of Gamble's chronological system better match the resolution of data used to evaluate the model (see below) than would a finer temporal scale.

The downturn interval (30–21 kyr BP)

The *downturn* begins with the last significant interval of climatic deterioration and glacial advance in the Upper Pleistocene. It is marked by comparatively little art in south-western Europe, a low incidence of parietal art everywhere, and by structures, burials and portable

art in central and eastern Europe (Gamble 1986; Soffer 1985a, 1985b). The portable art, epitomized by female figurines, exhibits a number of subregional stylistic clines. Applying (often implicitly) the social interaction theory of style, these are usually interpreted as marking the boundaries and peregrinations of identity-conscious social units of some kind (e.g. 'Gravettians'). From an information exchange perspective, however, the clinal character of this art and its general distribution in eastern and central Europe is significant for other reasons, discussed below.

The refuge interval (21–13 kyr BP)

Corresponding to the late glacial maximum, the *refuge* interval is marked by virtual abandonment of the northern and central provinces and by population concentration in southern European refugia, the best known of which encompasses south-western France and Cantabrian Spain. Portable art becomes much more frequent in the Franco-Cantabrian refugium and large, complex 'aggregation' sites appear or become more common (Conkey 1980; White 1985, 1987). European parietal art, primarily a Franco-Cantabrian phenomenon, is heavily concentrated in this 21-13 kyr BP interval.

The upturn interval (13–7 kyr BP)

The *upturn* is marked by a recolonization of central and northern Europe from the southern European refugia (and, according to some, by one from the north east – Dolukhanov [1979], Desbrosse and Kozlowski [1988]), and by decreases in population density and/or a dispersal of population in the refugia. In the Franco-Cantabrian 'heartland', both parietal art and aggregation sites apparently disappear, signalling a return to more open systems of information flow as people spread out again over the surface of the land.

Explaining variability in Palaeolithic art

Conceptualizing art as a monitor of the volume of information flow channelled through regional and subregional alliance networks allows us to model relationships between palaeoenvironment, regional demography and the distribution of art that can be evaluated empirically. We propose that art, as a medium of inter- and intra-group information exchange, was under selective pressure from changes in demography in response to the major climatic fluctuations between 30 and 7 kyr BP. We emphasize Gamble's South West, North Central and Alpine provinces here, since we believe that data from these subregions are perhaps best able to sustain empirical testing.

The downturn

Following Wiessner (1984) and Gamble (1982, 1991), we suggest generally low population densities, open social networks and relatively unimpeded information flow across much of Europe for the downturn interval. The incidence of mobile art, representing elements of

assertive style, reflects the dynamic, personal nature of alliances – which likely cross-cut many identity-conscious social units – among these small, kin-based forager groups. The open topography of central and eastern Europe favored such systems, in contrast to the more variable and isolating terrain of south-western Europe. This is seen in the clinal nature of mobile art, which occurs in higher frequencies in eastern and central Europe (including Gamble's north central and alpine provinces) and is comparatively rare in the south-western province. Emblemic style, in the form of parietal art, played a relatively minor role in these low-density, open systems – especially in central and eastern Europe, where such systems are most favored – and is generally not visible in the archaeological record.

The refuge

The refuge phase sees the depopulation of the eastern and central Europe, a closing of social networks and more territorial behavior because of increases in population density in the Franco-Cantabrian refugium, and a high incidence in both portable and parietal art in this refugium. This scenario was originally proposed by Michael Jochim (1983, see also 1987) who argued that, as populations moved into south-western Europe from elsewhere, increases in population density would have led to socioeconomic problems of various kinds, as increasing numbers of people were packed into topographically constrained regions like the Dordogne and the north Spanish coastal strip. Art would have played a role in conflict resolution as the social geography of the region came to be characterized more and more by relatively closed social networks. This would have selected for alliance formation and negotiation, essentially because these populations would have had nowhere else to go (i.e., they couldn't have resolved conflicts in the traditional forager way – by emigration). Indeed, Conkey's (1980, see also 1984, 1985) studies of design attributes on Cantabrian mobiliary art suggest that sites with high diversity indices, called 'aggregation sites', were places where people from many distinct social units came together periodically for a multiplicity of reasons.

   Aggregation would have required mechanisms to maintain cohesion among kin-based sub-units within larger semi-corporate groups. With higher population densities in the Franco-Cantabrian refugium, a need would have arisen to enforce spatial and social boundaries in order to ensure an adequate resource base for continued group survival. From an information exchange standpoint, Palaeolithic art in general is linked to rituals of demarcation and boundary negotiation (possibly of economic territories), conflict resolution in general, the sharing of subsistence information and a host of other factors. With target referents at the group (as opposed to individual) level, a emblemic style was selected for in an increasingly 'crowded' social environment and thus achieved a higher level of visibility in the archaeological record than ever before. Parietal art, which served as a medium of group-level information exchange, would have become more common.

   We suggest, then, that the channels of information flow revealed in the distribution of parietal and mobiliary art are overlapping but distinct: the two broad art categories are monitoring two different aspects of Franco-Cantabrian social geography, and at two different scales. Assertive style, manifest in portable art, cross-cuts identity-conscious

social units, although statistical clustering of attributes of formal variation can sometimes be detected at the micro-scale. Since it functions on both intra- and inter-group levels, it is a universal phenomenon unconnected to the relative degree of social network closure. Emblemic style, manifest in parietal art, facilitates *inter*-group communication – messaging *across* social unit boundaries. Increased population density and social network closure, then, would tend to select for emblemic style and parietal art.

The upturn

The upturn interval sees the reappearance of more open social networks, the disappearance of the parietal art, a dispersal of the concentrated populations (and, apparently, the disappearance of aggregation sites) in the Franco-Cantabrian refugium, and the recolonization of the eastern and central Europe. These changes evidently took place over 3–4 millennia, and were probably accomplished through renewed opportunities for emigration and the gradual extension of foraging territories, as the well-documented succession of tardi-glacial and post-glacial floral and fauna communities came to dominate in the regional ecology. These trends continued into the Pre-Boreal and Boreal phases but even during the de-glaciation, Europe was coming to be characterized by a complex mosaic of distinct adaptations, marked by distinct mobiliary (and, at least initially, parietal) art distributions. The disappearance of parietal art in the refugium after ca. 10 kyr BP suggests that the conditions that selected for its appearance were no longer present after the last glacial maximum. The ornaments persist into the post-glacial, however (Newell et al. 1990). We suggest that a return to the more dispersed populations and open social networks characteristic of the 'downturn' phase selected for a renewed emphasis on assertive style (expressed as mobile art); selection for emblemic style (and parietal art) was relaxed.

Testing the model

Data from more than 3,500 late Pleistocene and early Holocene sites in south-western, eastern and central Europe were compiled to evaluate the credibiiity of the model just presented. Although this appears to be an impressive number, several caveats about the quality of the data must be stressed at the outset. First, the data come from a wide variety of published sources and represent collections made over the course of more than a century of research. Clearly, reliability varies considerably both within and among the data sets used.

Second, the chronological assignment of sites is very often based on the character of lithic industries. Despite decades of careful stratigraphic and cultural correlation by numerous workers (see, e.g., Laville et al. 1980), there is considerable margin for error, especially when assessing chronological relationships across the breadth of the European subcontinent. Because of this uncertainty, we think it more realistic to use Gamble's broad, three-part temporal framework than a more detailed scheme.

Third, we know of no comprehensive compilation of mobile art at the regional scale in Europe. We were thus compelled to use a very limited subset of this art, anthropomorphic

figurines, to monitor its distribution. Furthermore, the dates of figurines are often uncertain or based on stylistic considerations that may or may not be accurate indicators of age (see, e.g., Delporte 1979; Soffer 1987).

Fourth, there is reason to question the dates assigned to much of the parietal art in the Franco-Cantabrian refugium. Almost certainly, most (if not all) of this art is of Upper Palaeolithic age (but see Bednarik 1993). However, many examples have been dated by French workers only on the basis of 'stylistic progression' (e.g. Breuil 1952; Leroi-Gourhan 1982). Judging from the Cantabrian subregion, where there are more independent dates for parietal art sites, this stylistic dating may have resulted in an overrepresentation of downturn phase art sites and corresponding underrepresentation of refuge phase art sites in south-western France.

Finally, we have based our estimates of prehistoric population density on numbers of sites. This strategy, while unavoidable given currently available data, incorporates some inherent biases. Due to geomorphic factors, early sites tend to be underrepresented compared to later sites. Furthermore, archaeological research programs vary from one nation to the next, affecting the recovery and/or recognition rate of sites of different time periods. There is a strong suggestion of such variability in the data from central and eastern Europe. We have tried to make our data both more realistic and more comparable across the subcontinent by focusing on a time-factored measure of site density (sites/1,000 km.^{2}/ 1,000 yrs) rather than by relying on simple site counts. Nevertheless, some measure of site size should be factored in to obtain a more reliable estimate of population. Unfortunately, this has been possible only with a subset of the Cantabrian data. There is also the problem of land lost to Holocene marine transgression that may well affect site density (and thus population) estimates. This is less of a problem for Cantabria, with its narrow continental shelf, than for south-western France where some 40,000 km.^{2} has been lost off the coast of Aquitaine.

Expectations about pattern

With these caveats in mind, it is useful to summarize the testable implications of the model presented above:

- Population declined in central and eastern Europe during the refuge interval and increased again during the upturn. This should be reflected in site density statistics.
- Conversely, population increased in the Franco-Cantabrian refugium during the refuge interval and declined during the upturn. Again, site density figures should indicate this trend.
- Aggregation sites became most numerous during the refuge phase in the Franco-Cantabrian region; they disappeared altogether and sites became smaller during the upturn interval as population dispersed.
- Mobile art was concentrated geographically in central and eastern Europe, and temporally during the downturn and upturn intervals.
- Parietal art was concentrated in the refugium during the refuge phase and declined during the upturn phase.
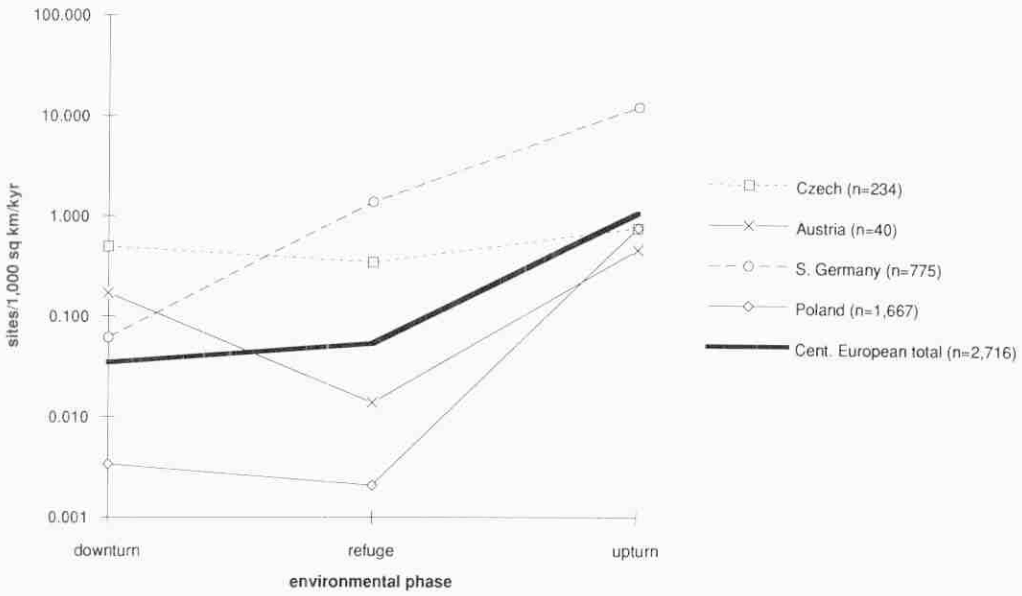
Central and Eastern Europe

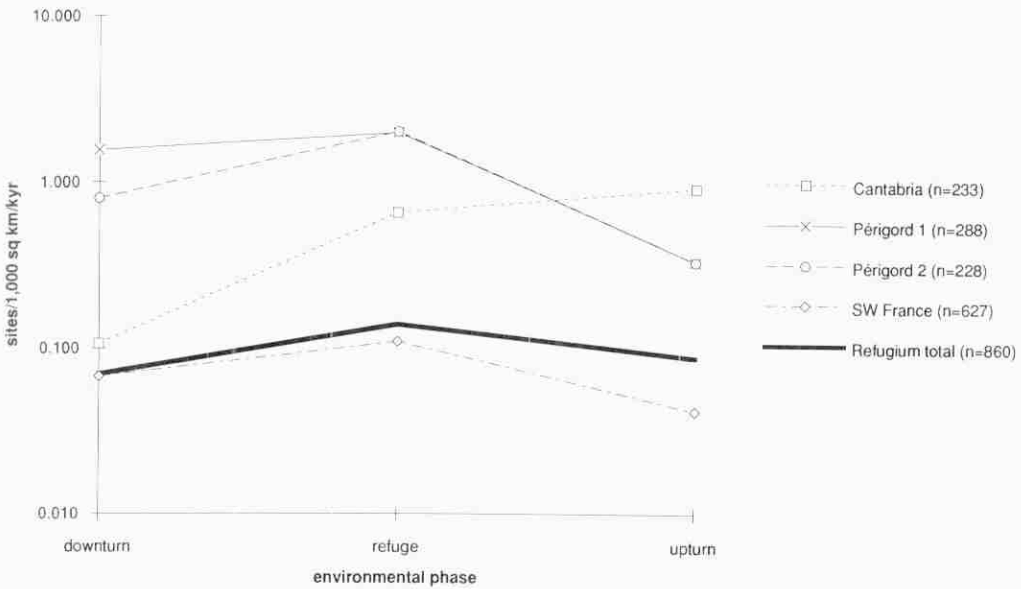*Figure 3* Site densities in central and eastern Europe.

Franco-Cantabrian Refugium

Figure 4 Site densities in the Franco-Cantabrian refugium.
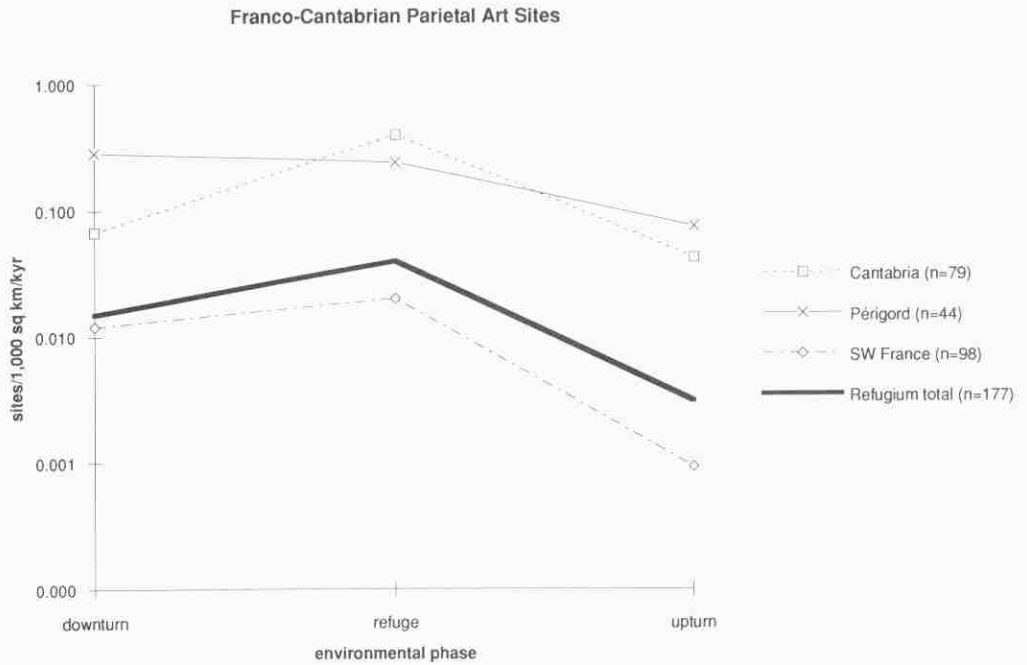
Franco-Cantabrian Parietal Art Sites

Figure 5   Parietal art site density in the Franco-Cantabrian refugium.

Table 2 Site densities in central and eastern Europe (data from Vencl 1991)

		Downturn 30–21 ky BP	Refuge 21–13 ky BP	Upturn 13–7 ky BP
Czech/Slovak	(127,700 sq. km.)			
	number of sites	89	55	90
	sites/1,000 sq. km./1,000 yrs	0.499	0.347	0.758
Austria	(83,850 sq. km.)			
	number of sites	14	1	25
	sites/1,000 sq. km./1,000 yrs	0.173	0.014	0.463
S. Germany	(50,000 sq. km.)			
	number of sites	5	100	670
	sites/1,000 sq. km./1,000 yrs	0.062	1.389	12.407
Poland	(150,000 sq. km.)			
	number of sites	11	6	1,650
	sites/1,000 sq. km./1,000 yrs	0.003	0.002	0.764
Combined central/eastern Europe	(411,550 sq. km.)			
	number of sites	119	162	2,435
	sites/1,000 sq. km./1,000 yrs	0.035	0.053	1.069

Table 3 Site densities in the Franco-Cantabrian refugium. Data from Laville et al. (1980), Newell et al. (1990), Rozoy (1978), White (1985). Parietal art site counts from various French classifications of age (e.g. Breuil 1952; Leroi-Gourhan 1982).

		Downturn 30–21 ky BP	Refuge 21–13 ky BP	Upturn 13–7 ky BP
Cantabria	(19,800 sq. km.)			
	number of sites	19	104	110
	sites/1,000 sq. km./1,000 yrs	0.107	0.657	0.926
	parietal art sites	12	62	5
	art sites/1,000 sq. km./1,000 yrs	0.67	0.391	0.42
	aggregation sites	0	5–9	0
Périgord 1	(9,000 sq. km.)			
	number of sites	127	143	18
	sites/1,000 sq. km./1,000 yrs	1.568	1.986	0.333
	parietal art sites	23	17	4
	art sites/1,000 sq. km./1,000 yrs	0.284	0.236	0.074
	aggregation sites	3–4	12–15	0
Périgord 2	number of sites	65	145	18
	sites/1,000 sq. km./1,000 yrs	0.802	2.014	0.333
South-western France	(360,000 sq. km.)			
	number of sites	219	317	91
	sites/1,000 sq. km./1,000 yrs	0.68	0.110	0.042
	parietal art sites	39	57	2
	art sites/1,000 sq. km./1,000 yrs	0.012	0.020	0.001
	aggregation sites	6–8	15–20	3–4
Entire Franco -Cantabrian refugium	(379,800 sq. km.)			
	number of sites	238	421	201
	sites/1,000 sq. km./1,000 yrs	0.70	0.139	0.088
	parietal art sites	51	119	7
	art sites/1,000 sq.km./1,000 yrs	0.015	0.039	0.003
	aggregation sites	6–8	20–29	3–4

Results

The results of our test of the model are presented in Figures 3–5 and in Tables 2–5. Note first, that a log scale is used for site density in Figures 3–5. This is to make the *pattern* in changing site density more apparent, and to correct for the considerable variability in actual numbers from one region to the next. Considering the very similar density figures for the upturn in Austria, Poland and the Czech/Slovak region (Figure 3), the number of upturn phase sites for south Germany seems overly high. Similarly, the downturn and refuge interval site densities seem low for Poland. Nevertheless, site densities per unit time clearly follow the pattern predicted by our model in three of the four regions represented. The region as a whole does not show a decline in refuge phase site density primarily because of the apparent anomalies in the south German and Polish data sets. All

Table 4 Retouched lithic tool counts from sites in the Cantabrian subregion. Data from Altuna et al. (1985), de Barandiarán (1962), Bernaldo de Quiros (1982), González Echegaray and Barandiarán (1981), González Echegaray et al. (1963), Hoyos et al. (1980), McCollough (1971), Straus (1992), Straus and Clark (1986), and Vega del Sella (1923).

Site name	Downturn	Refuge	Upturn
Aitzbitarte		131	455
Amalda	0	532	
Bolinkoba	670	1054	
Cueto de la Mina		1152	205
Ekain		322	1406
El Castillo	559	1207	
Entrefoces		195	265
Erralla		196	64
La Lloseta		1288	12
La Paloma		928	459
Morín	2577	119	669
Rascaño		856	196
Riera	57	1954	452
Urtiaga		130	1794
Sites with increases from previous phase		*4*	5
Sites with decreases from previous phase		1	6

subregions and the region as a whole show marked increases in site density from the refuge to the upturn phase.

For the Franco-Cantabrian refugium, three of four (somewhat overlapping) measures of site density again conform to the pattern predicted by our model. Note that we have used two different measures of site density for the Périgord (Table 3). The first (Périgord 1) includes open sites and is more representative of actual population distribution; the second (Périgord 2) is restricted to cave and rock shelter sites with more reliable chronological controls. There is a marked increase in site density from the downturn to the refuge for all data sets. The French data also show clear declines in site density from the refuge to upturn phases, while there is a slight increase in site density for the Cantabrian data set. This increase may be a function of a greater number of smaller Cantabrian sites in the upturn interval, representing a more dispersed, if not absolutely smaller, population. As shown in Table 3, the only more or less credible aggregation sites in Cantabria occur during the refuge interval; possible aggregation sites are likewise most heavily concentrated during the refuge phase in south-western France. Furthermore, four of five Cantabrian sites (80 per cent) with published artefact counts and assemblages spanning the downturn and refuge intervals show *increases* in tool counts (Table 4). Conversely, six of eleven Cantabrian sites (54 per cent) that span the refuge and upturn phases show *decreases* in tool frequency. Together, these data suggest an increase in site size (and by implication, the size of local groups) during the refuge interval and a corresponding decrease in site size during the upturn interval in Cantabria.

With respect to the distribution of art, the compiled data also closely fit the expectations

Table 5 Temporal and spatial distribution of anthropomorphic figurines and sites in which figurines have been found in Europe. Data on figurines from Delporte (1979); on figurine sites from Gamble (1986), Mussi (1989) and Weniger (1989).

	Figurines		Figurine sites	
	n	%	n	%
Downturn	19	43	21	84
Refuge	1	2	4	16
Upturn	24	54	0	
Eastern and central Europe	60	60	20	64
Central Mediterranean	13	13	5	16
South-western Europe	27	27	6	19

in the model we have proposed. As shown in Table 5, anthropomorphic figurines are most heavily concentrated temporally in the downturn and upturn phases, and geographically in central and eastern Europe. Parietal art, on the other hand, seems to be predominantly a phenomenon of the refugia. Only two such sites are known from central and eastern Europe (Bednarik 1993), while we have found reference to 177 in the Franco-Cantabrian refugium. Although we do not discount the possible existence of regional variation in the preservation of parietal art (e.g. Bednarik 1993), linked, as it is, to the density of caves and rock shelters, this difference seems too marked to be the result of geomorphic processes alone. As shown in Table 3 and Figure 5, the temporal distribution of cave art sites also closely conforms to the predictions of our model, with an increase in frequency in the refuge interval and a sharp decline during the upturn. The Périgord data set appears at first glance to be somewhat anomalous, with the highest frequency of art sites falling in the downturn phase. However, this may well be a function of the previously mentioned reliance on stylistic dating by French workers. In fact, the frequency of art sites is highly correlated with overall site frequency over the entire Franco-Cantabrian region ($r = 0.97$).

In sum, data on site densities, site size and the distribution of mobile and parietal art all conform very closely to the predictions of our model. Indeed, the fact that the data fit so well, despite a wide diversity of sources of and possibilities for error, indicates that the underlying patterning here is *extremely robust*. The ability of the model to account for variability in a large, diverse set of archaeological data, over the course of more than 20,000 years and across the subcontinent of Europe, suggests that we are dealing with a set of explanatory principles that may have considerably wider applicability.

Discussion

The information exchange approach taken here argues that parietal art is an example of Wiessner's emblemic style; that emblemic style is, among other things, a monitor of demographic stress, and that the appearance of parietal art in late Pleistocene Europe resulted from the closing of social networks under conditions of increasing population density. We do not suggest that the appearance of parietal art is the only response of

foraging peoples to demographic stress. However, its occurrence could mark episodes of accelerated demographic change, especially if those changes are in the direction of higher population densities relative to carrying capacity. The population/resource imbalances so created would select for increased emphasis on emblemic style traditions among foraging peoples to the extent that emblemic style becomes visible in the archaeological record.

We believe this process has generalizable properties, and propose two mechanisms to account for its operation. As noted, both assertive and emblemic style almost certainly existed among prehistoric foragers, but are not usually recoverable archaeologically. Ethnographic data indicate that emblemic style in forager contexts is often associated with features of the landscape (e.g. Denbow 1984; Lewis-Williams 1984). That is, it functions to identify sacred localities, prominent topographic features, the boundaries of more or less exclusive economic territories and other geographic landmarks. Under conditions of low population density, changing group membership and open social networks, the significance of such landscape features is transmitted from one generation to the next by means of the oral traditions of small, fluid social units; the physical marking of such features is rarely necessary. With aggregation, however, the need for more effective means of both inter- and intra-group communication arises. It becomes necessary to reinforce oral tradition within larger social units, whose members might not participate in a single tradition nor interact with one another on a regular basis. Increasing regional population densities might also encourage the physical demarcation of landmarks, especially those near important resources and territorial boundaries, in order to legitimize group rights to land and resources, and to alert other social groups to these claims of eminent domain.

Art produced during the Palaeolithic might thus have been involved with claims for property rights. The concept of property, however, emerges only when a good is perceived to be limited, and access to it is contested. An individual or group can claim rights to a limited good, but rights are honored only through mutual agreement and cannot exist apart from consensus. The negotiated reciprocity involved in the emergence of property rights is similar to that involved in symbolic communication in general in that both require mutual understanding, and neither can be maintained in the absence of sustained interaction among people. Conflicts that would probably have arisen over (social or natural) resource use in the refugium might have provided the conditions necessary for the emergence and perpetuation of property rights. Claims to these rights could have been expressed symbolically through art. While portable art could conceivably have served this function, parietal art would more effectively have communicated claims of eminent domain by visibly (and 'permanently') modifying the landscape. If art were indeed the means used to assert claims to natural resources, then we would expect a clustering of such signals in time and space reflecting the distribution of groups who recognized claims to property rights expressed through art. There is some evidence for this in Cantabria, where there is an apparent correlation between the locations of major parietal art sites and clusters of refuge phase habitation sites (Straus 1987).

A second mechanism that would lead to increasing emphasis on emblemic style is the transformation of elements of personal, assertive style into markers of public, emblemic style. In this process, best documented in chiefdom contexts (see, e.g., papers in Barker and Pauketat [1992]), stylistic elements associated with individuals or lineages come to represent collectivities of lineages. This might be one of the ways in which corporate group

markers (e.g. clan and lineage symbols) could develop. This process would also be selected for by aggregation, with the need to strengthen intra- and inter-group alliances, and to legitimize spatially extensive social units within aggregated, non-kin-based groups. Emblemic art created by means of such a process would, over time, come to be associated more with elements of social organization than with features of the landscape.

Conclusions and wider implications

Although the model presented here applies primarily to the European Upper Palaeolithic, its explanatory potential extends both earlier and later in time, and has implications for areas outside Europe. Prior to the last glaciation, human populations appear to have displayed a very different response to environmental stress and the loss of land area than is seen in the Late Pleistocene. Europe, and presumably other middle latitude temperate regions of the Old World, was largely abandoned by human populations during glacial maxima in the Middle Pleistocene. In the Upper Pleistocene, however, social mechanisms evolved that permitted the maintenance of higher population densities and that resulted in the appearance of extra-familial corporate groups. These mechanisms, along with a variety of more efficient technological and economic behaviors (e.g. blade and bladelet lithic industries, compound tools, specialized bone and antler tools, collective hunting of gregarious herbivores) permitted late Palaeolithic human populations to remain in temperate Eurasia during the last glacial maximum at higher densities than ever before. These behaviors represent important additions to the human adaptive complex that have had far-reaching consequences.

With the relaxation of selective pressures associated with the glacial maximum, centripetal tendencies reduced forager group size in early Holocene Europe. However, mechanisms for aggregation associated with the refuge phase were not lost. They appear to have survived as part of the diverse forager behavioral repertoire, available to respond to new selective pressures such as increased aridity at lower latitudes during the early Holocene (cf. McCorriston and Hole 1991; Olszewski 1993) or pressures from expanding food producing societies in the middle and late Holocene.

If emblemic style, manifest as parietal art, is one monitor of social response to demographic stress, two additional instances of its occurrence from the north-western Old World are of interest. The first is the Spanish Levant, where a consistent and well-documented tradition of parietal art seems restricted in time to the middle Holocene, and to the beginning of the south-eastern Spanish Neolithic (Hernández Pérez et al. 1988; Martí Oliver and Cabanilles 1987: 99–113; Martí Oliver and Hernández Pérez 1988). This art was the product of a population in transition from a foraging to a food-producing economy, and from a dispersed, mobile settlement pattern to a more aggregated, sedentary one.

The second instance – less clear, but still suggestive – is the parietal art of the Sahara and Maghreb. Several traditions might be represented here, and the dating is less secure than in Spain, but the scenes most clearly associated with forager populations appear to date to the early Holocene (Lhote 1964; Muzzolini 1986; Muzzolini and Boccazzi 1991). Macro-climatic change at the end of the Pleistocene resulted in more mesic environments

in the southern Sahara and the expansion of sub-Saharan fauna and flora into this region, but the early Holocene was characterized by increased aridity and desertification. In a scenario reminiscent of Childe's 'oasis theory' (e.g. 1928), forager populations in the southern Sahara would have been forced to aggregate around fewer and shrinking permanent water sources, with sharply localized but dramatic increases in population density and concomitant demographic stress.

Nor is the association of emblemic style, expressed in media other than parietal art, and demographic pressure limited to these isolated examples. With the increasing population densities and vastly increased social group size that mark complex societies, emblemic style becomes ubiquitous, if not always prevalent – from monumental architecture to horizon styles to religious iconography to national flags to the Levi's patch found on blue jeans throughout the world. In this sense, the mechanisms for coping with late Pleistocene environmental stress, that we suggest are monitored by Upper Palaeolithic parietal art, were preadaptations that later eventually played important roles in the growth of food-producing economies, sedentism and emergent social complexity. Many workers have suggested that the dramatic changes in human society that transpired in the early Holocene have their roots among late Pleistocene foraging adaptations (e.g. the numerous publications of the Cambridge Palaeoeconomy School). The explanatory model for Upper Palaeolithic art that we present here falls squarely in this research tradition.

10.iii.94

Department of Anthropology
Arizona State University
Box 872402
Tempe, Arizona 85287–2402
USA

References

Altuna, J., Baldéon, A. and Mariezkurrena, K. 1985. Cazadores Magdalenienses en Erralla (Cestona, País Vasco). *Munibe*, 37: 1–206.

Bahn, P. and Vertut, J. 1988. *Images of the Ice Age*. New York: Facts on File.

de Barandiarán, J. M. 1962. *Aitzbitarte*. Excavaciones Arqueológicas en España 6. Madrid: Inspección General de Excavaciones Arqueológicas.

Barker, A. and Pauketat, T. (ed.) 1992. *Lords of the Southeast: Social Inequality and the Native Elites of Southeastern North America*. Washington, DC: Archeological Papers of the American Anthropological Association No. 3.

Bednarik, R. G. 1993. European Palaeolithic art – typical or exceptional? *Oxford Journal of Archaeology*, 12(1): 1–8.

Bender, B. 1978. Gatherer-hunter to farmer: a social perspective. *World Archaeology*, 10(2): 204–22.

Bender, B. 1985. Emergent tribal formations in the American midcontinent. *American Antiquity*, 50(1): 52–62.

Bernaldo de Quirós, F. 1982. *Los Inícios del Paleolítico Superior Cantábrico*. Centro de Investigación y Museo de Altamira Monografías 8. Madrid: Ministerio de Cultura.

Braun, D. and Plog, S. 1982. Evolution of 'tribal' social networks: theory and prehistoric North American evidence. *American Antiquity*, 47(3): 504–25.

Breuil, H. 1952. *Four Hundred Centuries of Cave Art*. Montignac: Centre d'Études et de Documentation Préhistoriques.

Carr, C. 1994. A unified middle-range theory of artifact design In *Style, Society and Person* (eds C. Carr and J. Neitzel). New York: Plenum (in press).

Childe, V G. 1928. *The Most Ancient East: The Oriental Prelude to European Prehistory*. London: Kegan Paul.

Clark, G. A. 1989. Romancing the stones: biases, style and lithics at La Riera. In *Alternative Approaches to Lithic Analysis* (eds D. Henry and G. Odell). Washington, DC: Archeological Papers of the American Anthropological Association, No. 1, pp. 27–50.

Clark, G. A. 1993. Paradigms in science and archaeology. *Journal of Archaeological Research*, 1(3): 203–34.

Clark, G. A., Barton, C. M. and Cohen, A. E. n.d. Explaining art in the Franco-Cantabrian refugium. In *Debating Complexity* (ed. D. Meyer). Calgary: Archaeological Association of the University of Calgary.

Conkey, M. 1978. Style and information in cultural evolution: toward a predictive model for the paleolithic. In *Social Archeology: Beyond Subsistence and Dating* (eds C. L. Redman et al.). New York: Academic Press, pp. 61–86.

Conkey, M. 1980. The identification of prehistoric hunter-gatherer aggregation sites: the case of Altamira. *Current Anthropology*, 21(5): 609–30.

Conkey, M. 1984. To find ourselves: art and social geography of prehistoric hunter-gatherers. In *Past and Present in Hunter Gatherer Studies* (ed. C. Schrire). New York: Academic Press, pp. 253–76.

Conkey, M. 1985. Ritual communication, social elaboration, and the variable trajectories of paleolithic material culture. In *Prehistoric Hunter-Gatherers: the Emergence of Cultural Complexity* (eds T. D. Price and J. Brown). New York: Academic Press, pp. 299–323.

Conkey, M. 1987. Interpretive problems in hunter-gatherer regional studies: some thoughts on the European Upper Paleolithic. In *The Pleistocene Old World: Regional Perspectives* (ed. O. Soffer), New York: Plenum, pp. 63–77.

Criado, F. and Penedo, R. 1993. Art, time, and thought: a formal study comparing palaeolithic and postglacial art. *World Archaeology*, 25(2): 187–203.

Delporte, H. 1979. *L'Image de la Femme dans l'Art Préhistorique*. Paris: Picard.

Denbow, J. 1984. Prehistoric herders and foragers of the Kalahari: the evidence for 1500 years of interaction. In *Past and Present in Hunter Gatherer Studies* (ed. C. Schrire). New York: Academic Press, pp. 175–94.

Desbrosse, R. and Kozlowski, J. 1988. *Hommes et Climats à l'Age du Mammouth: le Paléolithique Supérieur d'Eurasie Centrale*. Paris: Masson et Cie.

Dolukhanov, P. 1979. Evolution des systèmes éco-sociaux en Europe durant le Pleistocène récent et le début de l'Holocène. In *La Fin des Temps Glaciaires en Europe* (ed. D. de Sonneville-Bordes). Paris: Centre National de la Recherche Scientifique, pp. 869–76.

Dunnell, R. C. 1978. Style and function: a fundamental dichotomy. *American Antiquity*, 43(2): 192–202.

Dunnell, R. C. 1980. Evolutionary theory and archaeology. In *Advances in Archaeological Method and Theory*, vol. 3 (ed. M. B. Schiffer). New York: Academic Press, pp. 35–99.

Francis, J. E., Loendorf, L. L. and Dorn, R. I. 1993. AMS radiocarbon and cation-ratio dating of rock art in the Bighorn Basin of Wyoming and Montana. *American Antiquity*, 58(4): 711–37.

Gamble, C. 1982. Interaction and alliance in palaeolithic society. *Man*, 17(1): 92–107.

Gamble, C. 1986. *The Palaeolithic Settlement of Europe*. Cambridge: Cambridge University Press.

Gamble, C. 1991. The social context for European palaeolithic art. *Proceedings of the Prehistoric Society*, 57(1): 3–16.

González Echegaray, J. and Barandiarán, I. 1981. *El Paleolítico Superior Cantábrico*. Centro de Investigación y Museo de Altamira Monografías 3. Madrid: Ministerio de Cultura.

González Echegaray, J., García Guinea, M.-A. and Begines, A. 1963. *La Cueva del Otero*. Excavaciones Arqueológicas en España 53. Madrid: Inspección General de Excavaciones Arqueológicas.

Hernández Pérez, M., Ferrer i Marset, P. and Catalá Ferrer, E. 1988. *Arte Rupestre en Alicante*. Alicante: Fundación Banco Exterior.

Hodder, I. 1986. *Reading the Past: Current Approaches to Interpretation in Archaeology*. Cambridge: Cambridge University Press.

Hoyos, M., Martínez, M. I., Chapa, T., Castaños, P. and Sanchíz, F. 1980. *La Cueva de la Paloma: Soto de las Regueras (Asturias)*. Excavaciones Arqueológicas en Espanā. Madrid. Inspección General de Excavaciones Arqueológicas.

Jochim, M. 1983. Palaeolithic cave art in ecological perspective. In *Hunter Gatherer Economy in Prehistory* (ed. G. N. Bailey). Cambridge: Cambridge University Press, pp. 212–19.

Jochim, M. 1987. Late Pleistocene refugia in Europe. In *The Pleistocene Old World: Regional Perspectives* (ed. O. Soffer). New York: Plenum, pp. 317–32.

Keeley, L. 1988. Hunter-gatherer economic complexity and 'population pressure': a cross-cultural analysis. *Journal of Anthropological Archaeology*, 7(4): 373–411.

Laming-Emperaire, A. 1962. *La Signification de l'Art Rupestre Paléolithique*. Paris: Picard.

Laming-Emperaire, A. 1970. Système de penser et organisation sociale dans l'art rupestre paléolithique. In *l'Homme de Cro-Magnon* (ed. A. Leroi-Gourhan). Paris: Arts et Metiers Graphiques, pp. 197–211.

Laming-Emperaire, A. 1972. Art rupestre et organisation social. In *Santander Symposium* (eds M. Almagro and M. A. García Guinea). Madrid: UISPP, pp. 65–82.

Laville, H., Rigaud, J.-P. and Sackett, J. 1980. *Rock Shelters of the Périgord*. New York: Academic Press.

Leonard, R. D. and Reed, H. E. 1993. Population aggregation in the prehistoric American Southwest: a selectionist model. *American Antiquity*, 58(4): 648–61.

Leroi-Gourhan, A. 1958a. La fonction des signes dans les sanctuaires paléolithiques. *Bulletin de la Société Préhistorique Française*, 55(3): 307–21.

Leroi-Gourhan, A. 1958b. Le symbolisme des grandes signes dans l'art parietal paléolithiques. *Bulletin de la Société Préhistorique Française*, 55(4): 515–28.

Leroi-Gourhan, A. 1982. *The Dawn of European Art*. New York: Cambridge University Press.

Lewis-Williams, J. D. 1981. *Believing and Seeing: Symbolic Meanings in Southern San Rock Art*. New York: Academic Press.

Lewis-Williams, J. D. 1984. Ideological continuities in prehistoric southern Africa: the evidence of rock art. In *Past and Present in Hunter Gatherer Studies* (ed. C. Schrire). New York: Academic Press, pp. 225–52.

Lewis-Williams, J. D. 1991. Wrestling with analogy: a methodological dilemma in Upper Paleolithic art research. *Proceedings of the Prehistoric Society*, 57(1): 149–62.

Lewis-Williams, J. D. and Dowson, T. A. 1988. The signs of all times: entoptic phenomena in Upper Paleolithic art. *Current Anthropology*, 29: 201–45.

Lhote, H. 1964. Faits nouveaux concernant la chronologie relative et absolue des gravures et peintures pariétales du Sud oranais et du Sahara. In *Prehistoric Art of the Western Mediterranean and the Sahara* (eds L. Pericot García and E. Ripoll Perello). Barcelona: Ediciones Catalans, pp. 191–214.

Loendorf, L. L. 1990. A dated rock art panel of shield bearing warriors in south central Montana. *Plains Anthropologist*, 35(1): 45–54.

McCollough, M. 1971. *Perigordian Facies in the Upper Palaeolithic of Cantabria*. Doctoral dissertation. Department of Anthropology, University of Pennsylvania, Philadelphia.

Marshack, A. 1972. *The Roots of Civilization*. London: Weidenfeld & Nicolson.

McCorriston, J. and Hole, F. 1991. The ecology of seasonal stress and the origins of agriculture in the Near East. *American Anthropologist* 93: 46–69.

Martí Oliver, B. and Cabanilles, J. J. 1987. *El Neolític Valencià: els Primers Agricultors i Ramaders*. Valencià: Servei d'Investigació Prehistòrica de la Diputaciò de Valéncia.

Martí Oliver, B. and Hernández Pérez, M. 1988. *El Neolític Valencia: Art Rupestre i Cultural Material*. Valencià: Servei d'Investigació Prehistòrica de la Diputaciò de Valéncia.

Mellars, P. 1985. The ecological basis of social complexity in the Upper Paleolithic of southwestern France. In *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity* (eds T. D. Price and J. Brown). New York: Academic Press, pp. 271–97.

Mellars, P. 1989. Major issues in the emergence of modern human. *Current Anthropology*, 30(3): 349–84.

Mithen, S. 1991. Ecological interpretations of palaeolithic art. *Proceedings of the Prehistoric Society*, 57(1): 103–14.

Morwood, M. 1991. Rock art in southeast Cape York Peninsula, Australia. In *Ancient Images, Ancient Thought: The Archaeology of Ideology* (eds A. S. Goldsmith et al.). Calgary: Archaeological Association of Calgary, pp. 417–26.

Morwood, M. n.d. Sex, lies, and symbolic behavior. In *Debating Complexity* (ed. D. Meyer). Calgary: Archaeological Association of the University of Calgary.

Mussi, M. 1989. Continuity and change in Italy at the last glacial maximum. In *The World at 18,000 BC*, vol. 1 (eds O. Soffer and C. Gamble). London: Unwin Hyman, pp. 126–47.

Muzzolini, A. 1986. *L'Art Rupestre Préhistorique des Massifs Centraux Sahariens*. Oxford: British Archaeological Reports International Series 291.

Muzzolini, A. and Boccazzi, A. 1991. The rock-paintings of Tikadiouine (Tassili n'Ajjer, Algeria) and the Iheren-Tahilahi Group. *Proceedings of the Prehistoric Society*, 57(2): 21–34.

Newell, R., Kielman, D., Constandse-Westermann, T., van der Sanden, W. and van Gijn, A. 1990. *An Inquiry into the Ethnic Resolution of Mesolithic Regional Groups*. Leiden: E. J. Brill.

O'Brien, M. J. and Holland, T. D. 1990. Variation, selection, and the archaeological record. In *Archaeological Method and Theory*, vol. 2 (ed. M. B. Schiffer). Tucson: University of Arizona Press, pp. 31–79.

O'Brien, M. J. and Holland, T. D. 1992. The role of adaptation in archaeological explanation. *American Antiquity*, 57(1): 36–59.

Olszewski, D. I. 1993. Subsistence ecology in the Mediterranean forest: implications for the origins of cultivation in the Epipaleolithic southern Levant. *American Anthropologist*, 95: 420–35.

Pales, L. and St. Pereuse, M. 1976. *Les Gravures de La Marche: II, Les Humains*. Paris: Ophrys.

Pales, L. and St. Pereuse, M. 1981. *Les Gravures de La Marche: III, Equidés et Bovidés*. Paris: Ophrys.

Price, T. D. and Brown, J. 1985. Aspects of hunter-gatherer complexity. In *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity* (eds T. D. Price and J. Brown). New York: Academic Press, pp. 3–20.

Rindos, D. 1989. Undirected variation and the Darwinian explanation of cultural change. In *Archaeological Method and Theory*, vol. 1 (ed. M. B. Schiffer). Tucson: University of Arizona Press, pp. 1–45.

Rozoy, J.-G. 1978. *Les Derniers Chasseurs* (3 vols). Charleville-Mezières: Société Archéologique Champenoise.

Soffer, O. 1985a. Patterns of intensification as seen from the Upper Paleolithic of the Central Russian Plain. In *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity* (eds T. D. Price and J. Brown). New York: Academic Press, pp. 235–70.

Soffer, 1985b. *The Upper Paleolithic of the Central Russian Plain*. New York: Academic Press.

Soffer, O. 1987. Upper Paleolithic connubia, refugia, and the archaeological record from Eastern Europe. In *The Pleistocene Old World: Regional Perspectives* (ed. O. Soffer). New York: Plenum, pp. 333–48.

Straus, L. 1987. The palaeolithic cave art of Vasco-Cantabrian Spain. *Oxford Journal of Archaeology*, 6(1): 149–63.

Straus, L. 1992. *Iberia before the Iberians*. Albuquerque: University of New Mexico Press.

Straus, L. and Clark, G. A. 1986. *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*. Tempe: Arizona State University Anthropological Research Papers No. 36.

Ucko, P. J. and Rosenfeld, A. 1967. *Paleolithic Cave Art*. New York: McGraw-Hill.

Vega del Sella, R., Conde de la 1923. *El Asturiense, Nueva Industria Pre-neolítica*. Madrid: Comisión de Investigaciones Paleontógicas y Prehistóricas, Memoria 32, Museo Nacional de Ciencias Naturales.

Vencl, S. 1991. On the importance of spatio-temporal differences in the intensity of Palaeolithic and Mesolithic settlement in Central Europe. *Antiquity*, 65: 308–17.

Weniger, G.-C. 1989. Germany at 18,000 BP. In *The World at 18,000 BC*, vol. 1 (eds O. Soffer and C. Gamble). London: Unwin Hyman, pp. 172–92.

White, R. 1985. *Upper Paleolithic Land Use in the Périgord*. Oxford: British Archaeological Reports International Series 253.

White, R. 1987. Glimpses of long-term shifts in late Paleolithic land use in the Périgord. In *The Pleistocene Old World: Regional Pespectives* (ed. O. Soffer). New York: Plenun, pp. 263–78.

Wiessner, P. 1983. Style and social information in Kalahari San projectile points. *American Antiquity*, 48(2): 253–76.

Wiessner, P. 1984. Reconsidering the behavioral basis for style: a case study among the Kalahari San. *Journal of Anthropological Archaeology*, 3(3): 190–234.

Wiessner, P. 1985. Style or isochrestic variation? A reply to Sackett. *American Antiquity*, 50(1): 160–6.

Wobst, H. M. 1976. Locational relationships in palaeolithic society. *Journal of Human Evolution*, 5(1): 49–58.

Wobst, H. M. 1977. Stylistic behavior and information exchange. In *Papers for the Director* (ed. C. Cleland). Ann Arbor: University of Michigan Museum of Anthropology, Anthropological Papers No. 61, pp. 317–42.

Abstract

Barton, C. Michael, Clark, G. A. and Cohen, Allison E.

Art as information: explaining Upper Palaeolithic art in western Europe

Proceeding from the information exchange theory of style, we argue that the changing temporal and spatial distributions of mobile and parietal art in Paleolithic Europe are related aspects of a single evolutionary process: alternating selective pressures differentially favoring the expression of assertive and emblemic style over the 30-7 kyr BP interval. These pressures result from demographic and social change across the European subcontinent in the late Pleistocene and early Holocene. We develop a model of cultural selection for symbolic behavior manifest as art that proceeds from and parallels natural selection in neo-Darwinian evolutionary theory.