Defining Magdalenian cultural groups in Franco-Cantabria by the formal analysis of portable artworks

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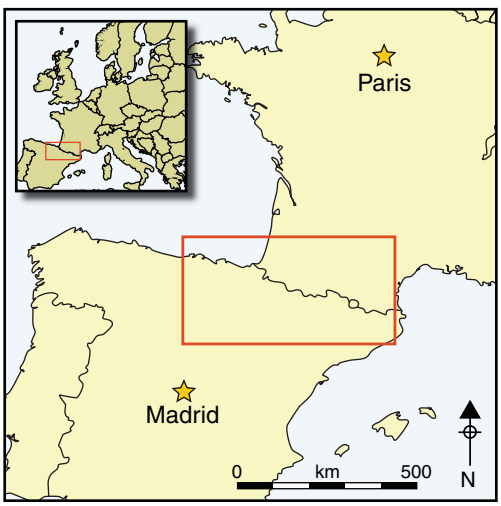

The motifs, techniques and stylistic features of Upper Palaeolithic art offer enormous potential for the investigation of social and cultural interactions in south-western France and northern Spain during the later stages of the last ice age. The key regions of Aquitaine, Cantabria and the Pyrenees clearly share an overall family resemblance, but detailed analysis of horse heads on portable objects of bone, antler and stone from Magdalenian contexts reveal that particular features can be attributed to different regions at different periods. Furthermore, the patterns of interconnection are structured very differently in the Upper Magdalenian than in the Middle Magdalenian, perhaps as rising temperatures in the latter period led to territorial expansion and social realignment.

Keywords: France, Spain, Upper Palaeolithic, Magdalenian, mobiliary art, cave art, stylistic analysis, correspondence factor analysis, ascending hierarchical clustering

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Introduction

Style in archaeology may be used in different ways and serve various purposes (Conkey & Hastorf 1990). The pioneers in the study of Palaeolithic art used it as a chronological marker within an evolutionary perspective (Breuil 1952). Leroi-Gourhan (1965) subsequently proposed a chronocultural scheme of four stages, based on the evolution of animal representations using features such as the perspective of horns and hooves, the number of legs by pair and the presence of anatomical details and conventions. In this culture-historical approach, a unique evolution was assumed to take place everywhere and to follow

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the same direction of technical progress from the first clumsy geometric schemes in the Aurignacian to the 'photographic realism' reached in the Magdalenian. However, recent discoveries such as Chauvet Cave (Ardèche, France) have shown the difficulty of accepting this linear view of stylistic evolution over a period spanning tens of millennia.

Moreover, this external approach is misleading because it sets aside the role of style in society. Style should be considered as the particular form and design given to manufactured objects by individuals or groups of individuals to inform others about their identity, affiliation and status. Style acts as a visual sign playing an active role in the processes of information exchange, communication and social interactions (Wobst 1977). Therefore, it may be used also by archaeologists to identify the cultural and social relationships between groups of hunters-gatherers during the Upper Palaeolithic (Ucko 1987: 65–70). Interpreted from this viewpoint, a formal and morphological analysis of Palaeolithic art is able to improve our knowledge of exchange networks and inform us about their dynamics and evolution through time. Studies based on this premise have already been pursued and have led to a renewed vision of the social relationships between northern Spain and southern France during the Upper Palaeolithic (Fortea *et al.* 2004; Fritz *et al.* 2007; Sauvet *et al.* 2008, in press; Rivero & Álvarez-Fernández 2009). Here chronology is no longer the goal, but a chronological framework is still required, since only contemporaneous stylistic variations are meaningful. Portable art, when found in a reliable stratigraphic context, offers therefore the best support for this approach.

In this study, we examine a large set of portable artworks on bone, antler and stone found in well-defined archaeological levels. We have concentrated our attention on representations of horses (the most frequently represented animal in Palaeolithic art) and on the Magdalenian period, which is the richest in artworks. The number of occurrences allowed us to conduct a statistical analysis offering the possibility of examining quantitatively the geographical distribution of morphological stylistic features and their level of interpenetration due to cultural exchanges. In addition, the variability of the networks through time shows their dynamics in relation to other archaeological data (lithic and bone industries, origin of raw materials, etc.).

Materials and methods

Correspondence factor analysis (CFA) is one of the most powerful multivariate analyses; because objects and properties are symmetrically treated, their proximity in the various graphical representations is significant (Benzécri & Benzécri 1984). Objects with similar profiles are clustered together and the characteristic features of these objects appear in the vicinity of the cluster. Associating sets of objects with sets of features, CFA is well designed to address questions of typology with minimal subjectivity.

CFA is usually applied to multi-parameter datasets in which each object is described by a set of attributes taking a determined range of values (noted as 0/1 for their absence or presence). Each individual is denoted by a set of 0/1 representing its coordinates in an *n*-dimensional space. The axes of inertia of the cloud of points are calculated mathematically and projections of the points in the planes defined by the principal axes of inertia lead to representations easy to visualise and interpret. Clustering of the objects is achieved by

ascending hierarchical clustering (AHC), using their factorial coordinates and the second-order central moment of a maximum partition as criteria of aggregation (Jambu & Lebeaux 1978). The dendrogram could be easily divided into three groupings that were distinguished in the early steps of the clustering process. Statistical tests were used to determine the features specifically attached to each group. Only associations between a feature and a group having a significance level higher than 95 per cent (with respect to a random distribution), were retained for discussion (Chenorkian 1996).

CFA has been used in various archaeological domains and was found particularly useful in the case of artistic items when the objective was to correlate formal features with the human groups who produced them in order to study their differences, degree of independence and interrelationships (Villaverde Bonilla 1994: 203–209; Buisson *et al.* 1996; Tosello 2003: 507–15; Pigeaud 2005; Bourrillon 2009; Petrognani 2009).

In the present study, a set of 273 horse representations from Magdalenian portable art was selected. Portable art (i.e. engravings on small pieces of bone, antler or stone) was chosen because it affords a much better account of chronology than parietal art, which is mainly dated by stylistic appreciation, leading often to circular reasoning. The Magdalenian period was chosen because it is the richest in artworks and because a large set of independent data is already available concerning the use of territories by hunters during this period (flint supply, Mediterranean and Atlantic shells used as personal ornaments, etc.).

Very often, animals are represented in Palaeolithic art by their head or foreparts alone. In addition most pieces are broken, so we have focused our attention on the head and the neck, which are the parts of the body most frequently represented. This drawback is counterbalanced by the fact that the head is particularly rich in distinctive features.

To be able to study the evolution of form through time, we have used the common distinction between Middle Magdalenian (MM) and Upper Magdalenian (UM) according to the archaeological horizons from which they come. Only 10 pieces could not be assigned precisely and were left as 'Indefinite Magdalenian' (IM). It is worth noting that the term 'Middle Magdalenian' was used without further subdivision owing to the rarity of pieces from the lower part of the MM in our corpus. For example, pieces from the so-called 'Magdalenian III' from La Marche were discarded due to the difficulty of describing them accurately from publications, and horses are almost absent in the 'Cantabrian Lower Magdalenian'. In respect to geography, we have used only very large regional areas, taking the Cantabrian region as a whole and Aquitaine in a broad sense, including the Aveyron Valley and Quercy (Figure 1). Chronological and regional assessments are summarised in Tables 1 and 2.

For the present study, the formal features used for the description of horse heads were not determined *a priori* but were specially adapted to the corpus by a recursive process in order to obtain the best description. We retained 17 formal attributes, each with two or more values or modalities according to the variability and distinctiveness of the feature (Table 3). In other studies dedicated to the formal analysis of horse representations, the metrical proportions between the body and the head were found useful (Pales & Tassin de Saint-Pereuse 1981; Apellaniz & Calvo 1999; Pigeaud 2007), but measurements were found meaningless, in our study, for the analysis of heads alone. Our purpose being to highlight the criteria on which stylistic appreciation and differentiation could be made, we found that the most

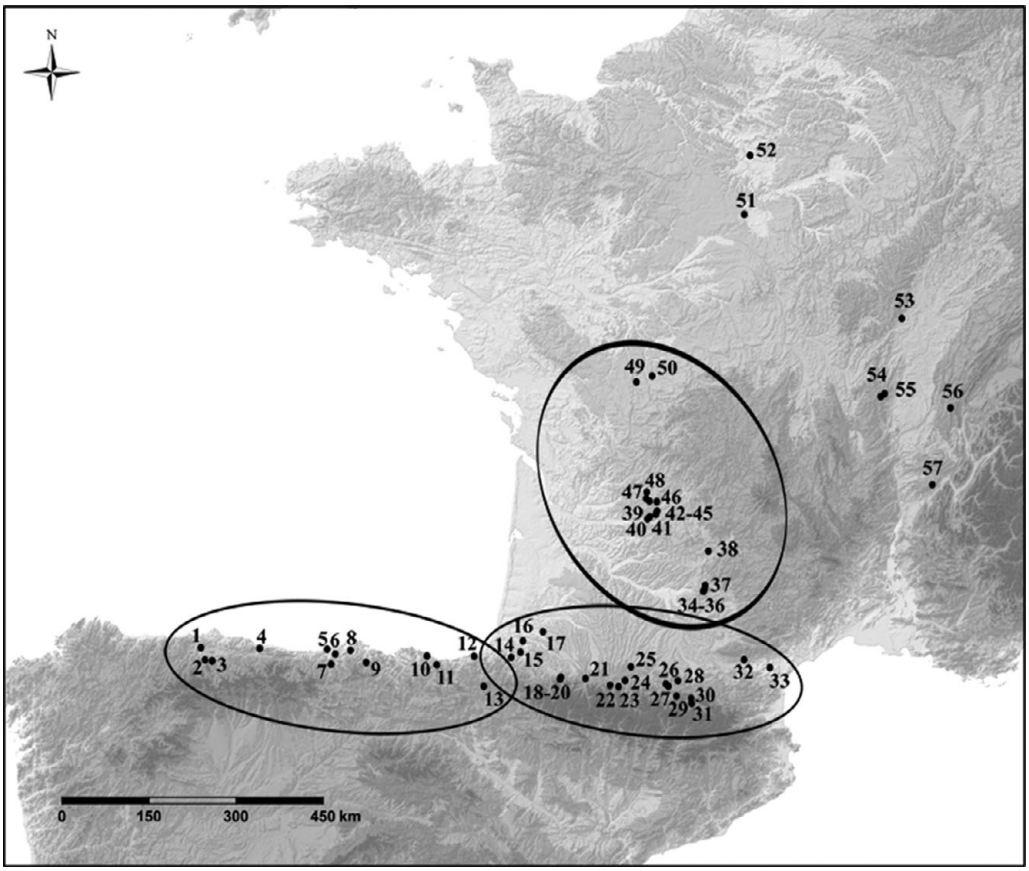

Figure 1. Map of northern Spain and southern France showing the areas discussed in this study and the sites with horse depictions analysed by CFA: 1) La Paloma; 2) Las Caldas; 3) La Viña; 4) Tito Bustillo; 5) La Pila; 6) El Pendo; 7) El Castillo; 8) La Garma; 9) El Valle; 10) Lumentxa; 11) Urtiaga; 12) Torre; 13) Abauntz; 14) Isturitz; 15) Arancou; 16) Dufaure; 17) Brassempouy; 18) Saint-Michel; 19) Espalungue; 20) Poeymaü; 21) Les Espélugues; 22) Labastide; 23) Lortet; 24) Gourdan; 25) Lespugue; 26) Enlène; 27) Le Tuc d'Audoubert; 28) Le Mas d'Azil; 29) Le Ker de Massat; 30) Bédeilhac; 31) La Vache; 32) Gazel; 33) La Crouzade; 34) Montastruc; 35) Le Courbet; 36) Lafaye; 37) Fontalès; 38) Sainte-Eulalie; 39) Lalinde; 40) Le Soucy; 41) Limeuil; 42) La Madeleine; 43) Laugerie-Basse; 44) Villepin; 45) Les Eyzies; 46) Peyrat; 47) Raymonden; 48) Rochereil; 49) La Marche; 50) Taillis des Coteaux; 51) Cepoy; 52) Étiolles; 53) La Baume Noire; 54) Rocher de la Caille; 55) La Goutte Roffat; 56) La Colombière; 57) Campalou.

Table 1. Chronological and regional distribution of the corpus of Magdalenian horses.

	Cantabrian region	Pyrenees	Aquitaine	Northern and eastern France	Total
Middle Magdalenian	24	75	52	8	159
Upper Magdalenian	14	15	66	9	104
Indefinite Magdalenian	3	2	5	–	10
Total	**41**	**92**	**123**	**17**	**273**

Table 2. Sites used for CFA and the number of horses analysed in each one.

Cantabrian region	Pyrenees	Aquitaine	Northern and eastern France
Las Caldas (20)	Arancou (1)	Courbet (5)	La Baume Noire (1)
La Viña (1)	Brassempouy (7)	Les Eyzies (2)	La Colombière (7)
La Paloma (1)	Bédeilhac (3)	Fontalès (1)	Cepoy (1)
Tito Bustillo (3)	La Crouzade (1)	Lalinde (1)	Campalou (1)
La Pila (1)	Dufaure (1)	Laugerie-Basse (11)	Étiolles (1)
La Garma (2)	Espalungue (7)	Lafaye (1)	La Goutte Roffat (1)
El Pendo (5)	Enlène (2)	Limeuil (24)	Rocher de la Caille (5)
El Castillo (1)	Les Espélugues (1)	La Madeleine (48)	
El Valle (2)	Gourdan (7)	Montastruc (22)	
Lumentxa (1)	Gazel (1)	La Marche (1)	
Urtiaga (1)	Isturitz (12)	Peyrat (1)	
Torre (1)	Lortet (4)	Rochereil (1)	
Abauntz (2)	Labastide (8)	Raymonden (1)	
	Lespugue (2)	Sainte-Eulalie (1)	
	Le Mas d'Azil (22)	Le Soucy (1)	
	Le Ker de Massat (1)	Taillis des Coteaux (1)	
	Poeymaü (3)	Villepin (1)	
	Saint-Michel (2)		
	Le Tuc d'Audoubert (1)		
	La Vache (6)		

useful formal characteristics were the manner of drawing the different parts of the outline (frontal line, mane, neck, mandible)—by a continuous line or a series of oblique hatchings, and sometimes by a mixture of both—and the attention paid to anatomical details such as the sense organs (eye, nostril, mouth, ears). For the eye, different modalities were observed (oval, point, stroke) and for the mouth a particular motif in the form of a hook was often found in the cut-out contours on hyoid bone (*contours découpés*) (Buisson *et al.* 1996). Care was taken to indicate other anatomical details, such as the superior and inferior arches of the eye; the hairless zones around the snout or around the nostrils were also considered relevant. Other traits such as the indication of the lacrimal caruncle and/or the external commissure; the presence of a prominent crest and a forelock mane; a prolongation of the mandible at the rear of the head, going up to the ears in some cases; the presence of invasive hatching on the jaw and the cheek to indicate the facial coat; and the conventional delimitation of the mane by a double outline were also taken as potential markers of groups of artists.

Results

For the CFA analysis, a table of 273 rows (the 273 representations of horses) and 53 columns (the values of the 17 attributes in Table 3) was used. Four columns (*Foh, Moa, Fdm, Rmm*) were classified as supplementary elements (SE) and did not participate in the construction of the axes of inertia, because they are very rare (less than 2 per cent of the objects have these properties).

Table 3. Attributes and values used for the description of horse heads in Magdalenian portable art.

Attribute	Value	Code	Attribute	Value	Code
Fronto-nasal outline	linear	Fol	Snout demarcation	linear	Sdl
	hatching	Foh		hatching	Sdh
	natural edge	Fne		absent	Sda
Mane	simple linear	Msl	Nostril demarcation	linear	Ndl
	simple hatching	Msh		hatching	Ndh
	simple mixed	Msm		mixed	Ndm
	double linear	Mdl		absent	Nda
	double mixed	Mdm	Rear of mandible	linear	Rml
	indefinite	Mna		hatching	Rmh
Mane in crest	yes	Mcp		mixed	Rmm
	no	Mca		absent	Rma
Maxillary outline	linear	Mol	Lacrimal caruncle	present	Lcp
	hatching	Moh		absent	Lca
	mixed	Mom	Ear	present	Erp
	absent	Moa		absent	Era
Neckline	linear	Nkl	Nostril	present	Nop
	hatching	Nkh		absent	Noa
	mixed	Nkm	Mouth	simple	Ms
	absent	Nka		hook-shaped	Mh
Arch of the eye	linear	Eal		absent	Ma
	hatching	Eah	Eye	punctiform	Eyp
	absent	Eaa		oval	Eyo
Fronto-nasal demarcation	linear	Fdl		stroke	Eys
	hatching	Fdh		absent	Eya
	mixed	Fdm	Forelock	hatching	Flh
	absent	Fda		absent	Fla
			Facial coat	present	Fcp
				absent	Fca

CFA applied to this table gives the straightforward result shown in Figure 2 by the projection in the main factorial plane [1,2]. Three well-defined groups (A, B and C) were found by AHC. Axis 1 separates group A clearly from groups B and C. Group A (115 examples) includes the most detailed horses with indication of the eye (often represented by an oval with the lacrimal caruncle; Table 3, attributes *Eyo, Lcp*), the ear, the nostril, and a simple or hook-shaped mouth (attributes *Erp, Nop, Ms, Mh*). The technique of hatching is the principal defining feature of this group, since it is used not only for the outline (*Rmh, Flh, Nkh, Moh*), but also for internal anatomical demarcations (*Ndh, Sdh, Eah*) and the filling of the whole face (*Fcp*). Group A also includes a hybrid technique using both hatching and lines (*Mom, Nkm).*

Groups B and C extend along axis 2. Group B (100 examples) is characterised by representations showing little elaboration, deprived of sense organs (*Eya, Noa, Ma*), with no indication of snout or demarcation of nostrils (*Sda, Nda*) and no arches above or below the eye (*Eaa*). Most of these figures are probably simple sketches while others may be deliberately unfinished, and some of them might be attributed to inexperienced artists (Rivero 2011).

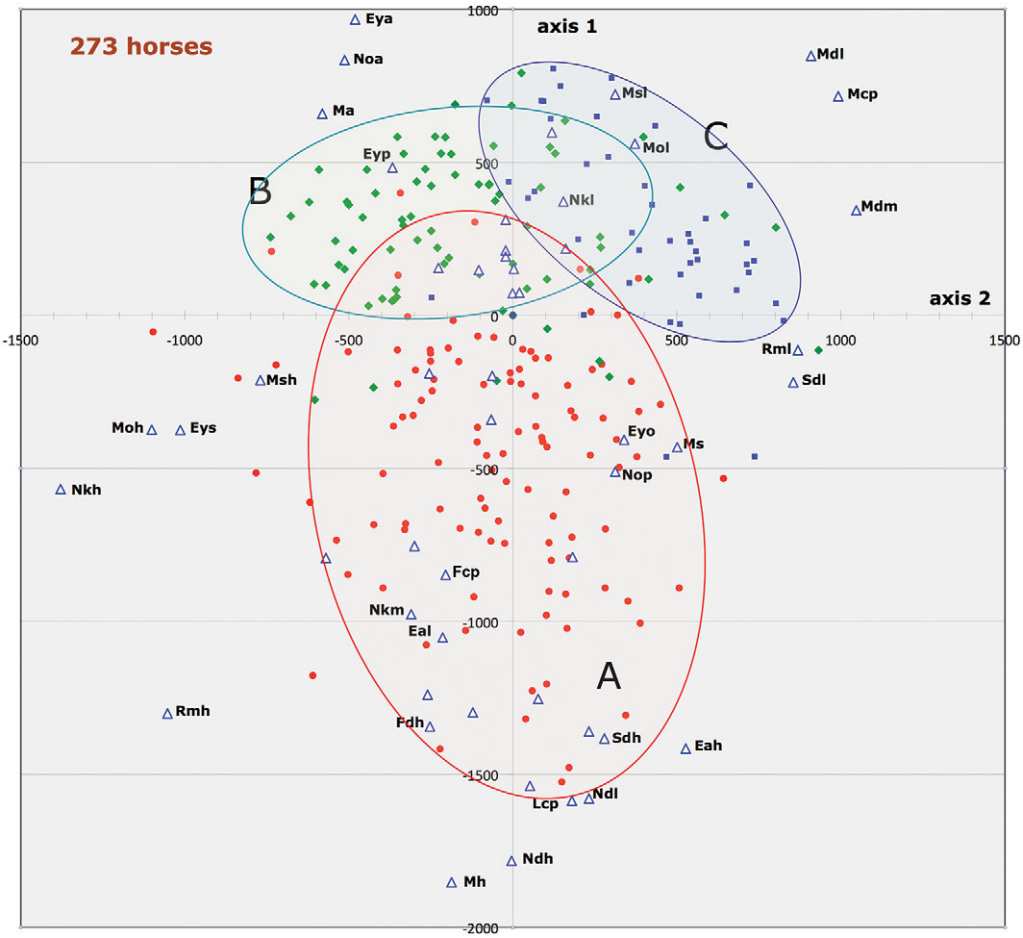

Figure 2. CFA multivariate plot of the studied corpus of 273 horses from Magdalenian portable art in the main factorial plane [1,2]. The three coloured groups A, B and C are generated by ascending hierarchical clustering.

Group C (58 examples) comprises horses with a mane formed by a double line (*Mdl)*, sometimes with hatching in between (*Mdm*), and horses with a prominent mane in the form of a crest (*Mcp*), these two features being frequently associated. In group C, hatching is no longer employed, and the outline is made by simple lines (*Mol*) as well as internal demarcations where they are present (*Sdl*).

Thus, CFA applied to a corpus of horses from Magdalenian portable art led us to distinguish three main groups of figures characterised by sets of formal parameters that could be assimilated to *formal concepts*. The first of these, and the most elaborate, is constituted by figures making extensive use of hatching both for the outline and internal details (Figure 3). The second employs simple linear outlines without sense organs (Figure 4) and the third group contains horses with special features such as the so-called 'double mane' (i.e. represented by a double line), and/or a prominent crest (Figure 5).

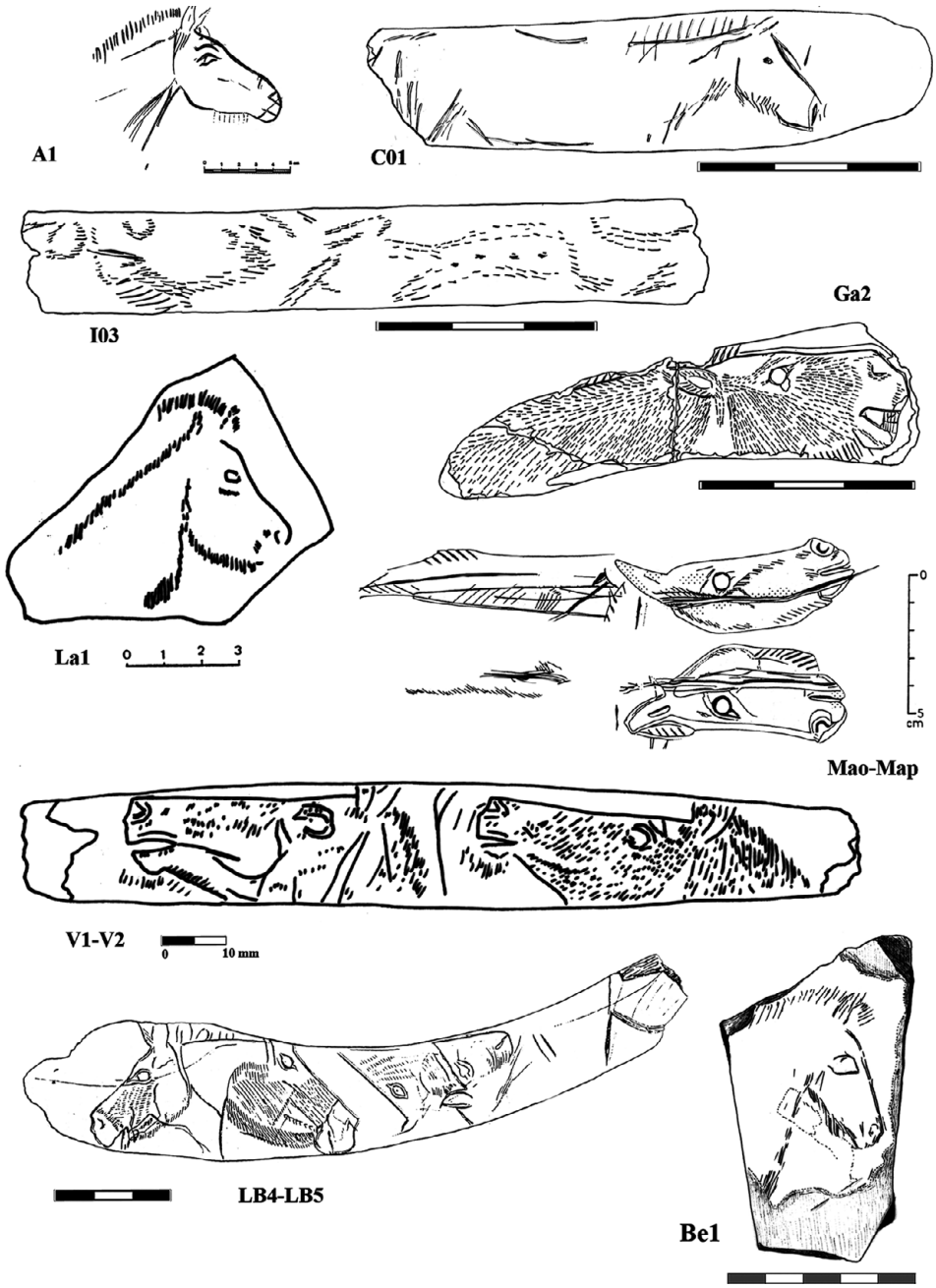

Figure 3. Examples of horses belonging to group A: A1) Abauntz (after Utrilla & Mazo 1996); C01) Las Caldas (after Rivero 2010); I03) Isturitz (after Rivero 2010); Ga2) La Garma (after Rivero 2010); La1) Labastide (after Simonnet et al. *1989); Mao-Map) Le Mas d'Azil (after Clottes* et al. *1981); V1–V2) La Vache (after Clottes & Delporte 2003); LB4–LB5) Laugerie-Basse (after Maury 1914); Be1) Bédeilhac (after Jauze & Sauvet 1991). All scales in cm unless otherwise indicated.*

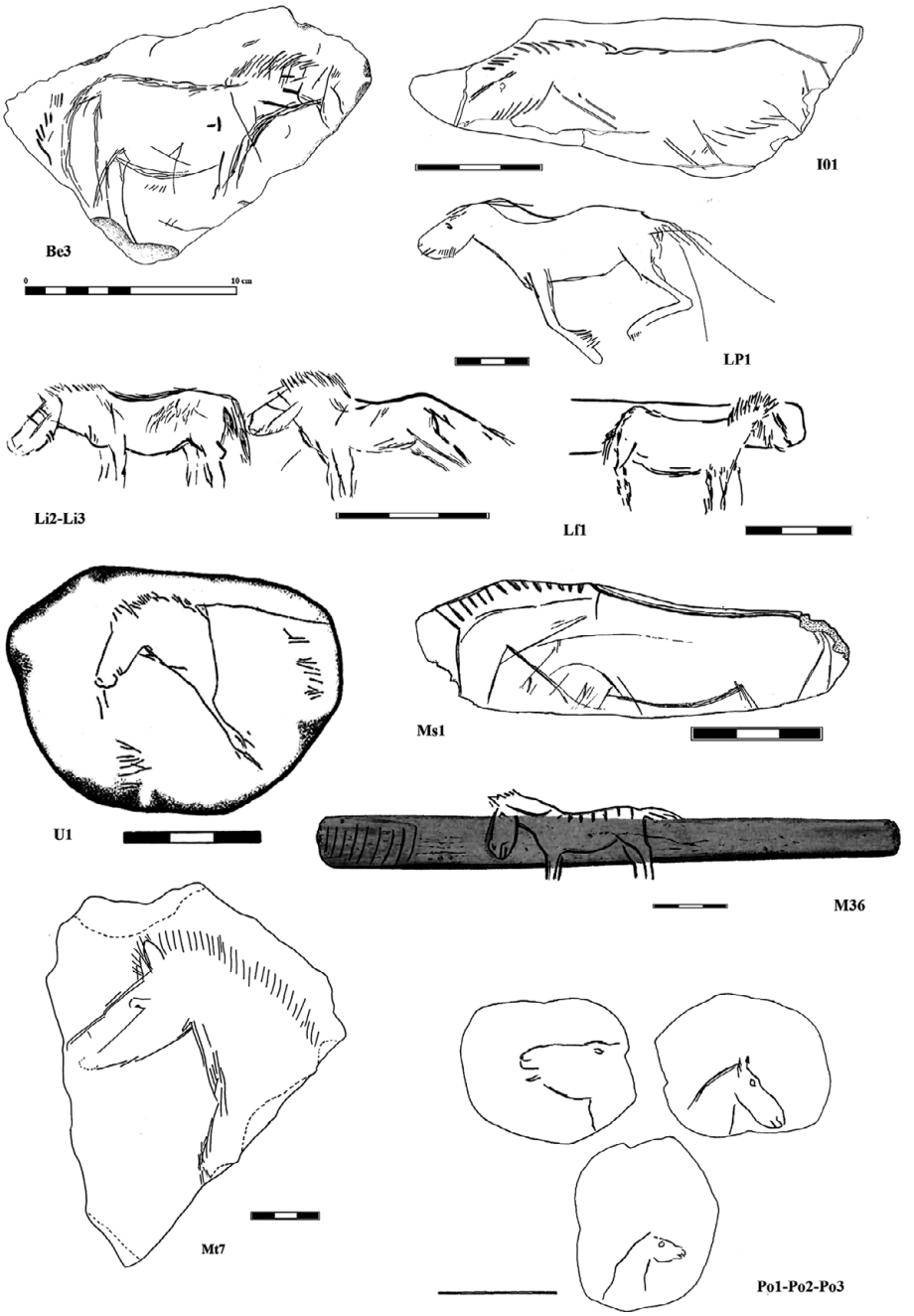

Figure 4. Examples of horses belonging to group B: Be3) Bédeilhac (after Jauze & Sauvet 1991); I01) Isturitz (after Rivero 2010); Lf1) Lafaye (after Ladier & Welté 1991); Li2–Li3) Limeuil (after Tosello 2003); LP1) La Paloma (after Corchón 1986); U1) Urtiaga (after Barandiarán 1973); Ms1) Le Ker de Massat (after Barrière 1990); M36) La Madeleine (after Sieveking 1987); Mt7) Montastruc (after Sieveking 1987); Po1-Po2-Po3) Poeymaü (after Barandiarán & Laplace 2000). All scales in cm unless otherwise indicated.

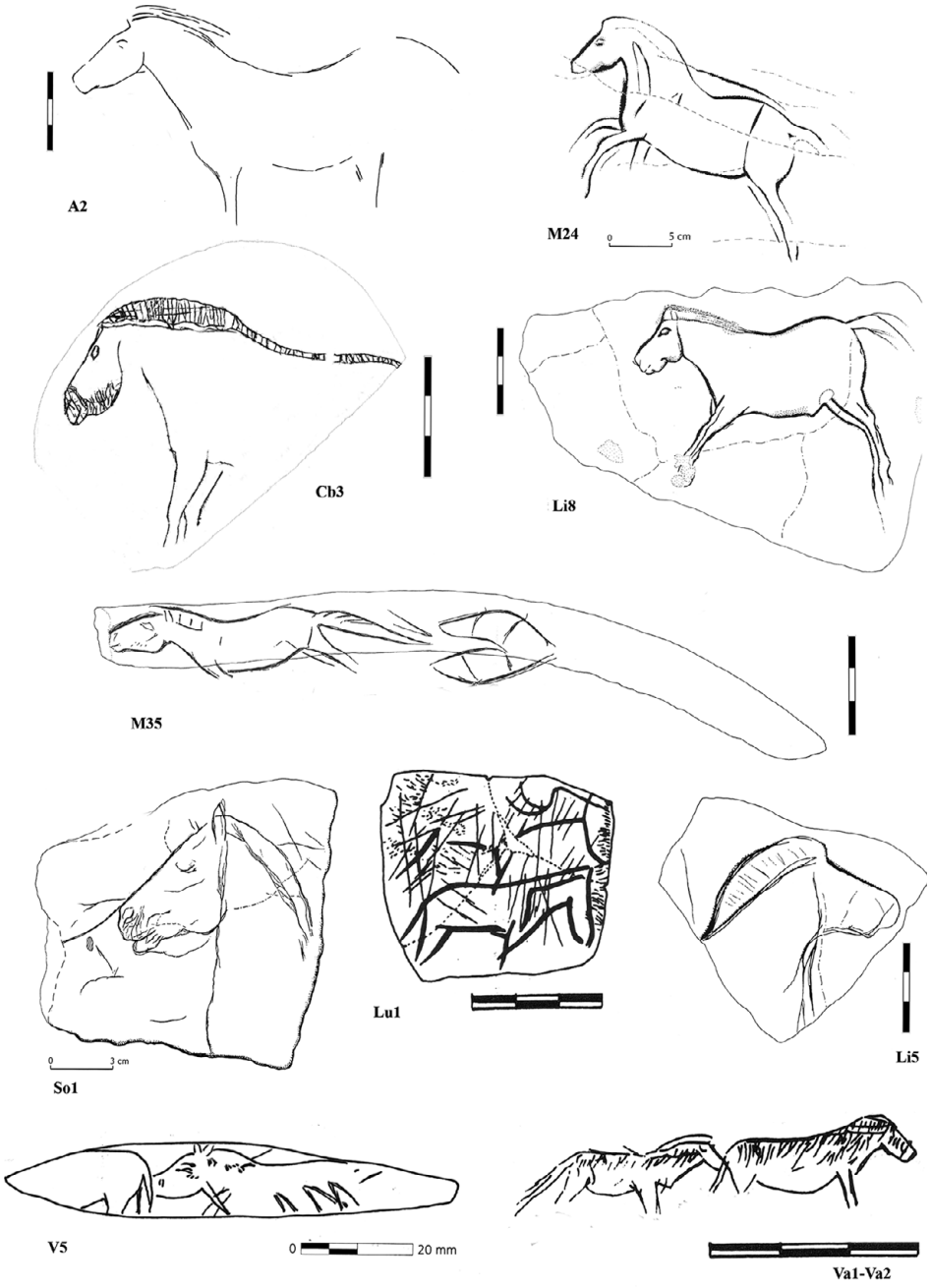

Figure 5. Examples of horses belonging to group C: A2) Abauntz (after Utrilla & Mazo 1996); M24) La Madeleine (after Tosello 2003); Cb3) La Colombière (after Paillet & Man-Estier 2010); Li8) Limeuil (after Tosello 2003); M35) La Madeleine (after Sieveking 1987); So1) Soucy (after Tosello 2003); Lu1) Lumentxa (after Corchón 1986); Li5) Limeuil (after Tosello 2003); V5) La Vache (after Clottes & Delporte 2003); Va1–Va2) El Valle (after Corchón 1986). All scales in cm unless otherwise indicated.

Discussion

Having established the nature and content of these formal groups through CFA and AHC, our next objective was to analyse the chronological and regional composition of these groups, looking for differences that could be linked to different artistic traditions. To make the study as objective as possible, we have used a χ^2 test in order to determine whether the composition of the formal groups identified by AHC obeys a normal distribution or shows significant trends. The result of this test is unambiguous: the distribution of the various spatio-temporal subsets in the three groups is, at a very high probability level, clearly non-random (Tables 4 & 5). In other words, the groups distinguished by their component features are predominantly linked to a specific period and/or region. To summarise the main points of interest, group A mainly comprises figures belonging to the Middle Magdalenian (84 per cent), with the Pyrenees making the major contribution. Conversely, more than 90 per cent of the horses in group C come from the Upper Magdalenian, and in very large measure from Aquitaine. Two sites (Limeuil and La Madeleine) are particularly responsible for the dominance of Aquitaine in group C, since 22 of the 35 occurrences of the 'double mane' (*Mdl*) come from these two sites, as do 28 of the 57 occurrences of prominent crest (*Mcp).* Group B does not seem to be linked specifically to a region or period, but that is not surprising since linear outlines without any detail are not stylistically remarkable. The only striking point is the abundance of examples falling within group B, which represents one third of the total. The reason lies probably in the simplicity of these forms, avoiding technical difficulties, and could be executed by a relatively large number of individuals. The other, more complex, forms could be achieved only by skilled artists.

The Cantabrian region shows a fairly balanced participation in the three groups with no clear trend towards any one of them in particular, but the small number of examples prevents reliable interpretation (Tables 4 & 5).

The data provided by the statistical analysis must be interpreted as a contribution to the social anthropology of Upper Palaeolithic hunters-gatherers. In recent years, evidence from lithic and bone industries and from the circulation of flint and shells has highlighted the importance of mobility and emphasised the long-distance exchange networks between the groups of hunter-gatherers living in south-western Europe between 14 500 and 11 500 BP (17 700–13 400 cal BP). Most investigations, including those dedicated to symbolic representations, have concluded that the principal regions of southern France and northern Spain were closely connected during the Middle and Upper Magdalenian (Fritz *et al.* 2007; Sauvet *et al.* 2008; Rivero & Álvarez-Fernández 2009). The intensity and variability of the interregional links, however, remain difficult to determine. It is not easy to understand why some types of object (technical tools or symbolic artefacts) and some formal features in portable or parietal art are widespread throughout the whole domain, while others remain confined to narrow territories. How do we reconcile the wide spatial diffusion observed on the one hand with the independence and individuality of small regional entities observed on the other?

The results of our statistical analysis confirm this double and contradictory trend. For instance, we can assume that the formal model for depicting horses with extensive hatching (group A) was created and developed in the Pyrenees during the Middle Magdalenian since

Table 4. Number of objects belonging to each spatio-temporal subset in the three AHC groups. CR: Cantabrian region, Py: Pyrenees, Aq: Aquitaine, MM: Middle Magdalenian, UM: Upper Magdalenian.

Group	CR-MM	CR-UM	Py-MM	Py-UM	Aq-MM	Aq-UM
A	9	4	50	6	28	7
B	13	3	22	7	23	22
C	2	7	2	3	1	37

Table 5. χ^2 test applied to the data in Table 4. The value $\chi^2 = 100.9$ for 10 degrees of freedom shows that the contribution of each spatio-temporal subset to the three groups is far from random with a significance greater than 99.9%. The contribution of each subset to the χ^2 value was evaluated in percentages of the global value and expressed symbolically: <2%: negligible (neg); 2–10%: + (excess) or – (deficit); 10–20%: ++ (excess) or – – (deficit); >20%: +++ (excess) or – – – (deficit).

Group	CR-MM	CR-UM	Py-MM	Py-UM	Aq-MM	Aq-UM
A	neg	neg	++	neg	neg	– –
B	neg	neg	neg	neg	neg	neg
C	neg	+	– –	neg	–	+++

it is numerically very dominant in this region (Table 3). Aquitaine is also well represented in group A (Laugerie-Basse, La Madeleine, Montastruc, Le Courbet), however, which indicates that the Pyrenean model was widely diffused and adopted. The penetration of this model into the Cantabrian region during the Middle Magdalenian is more localised, but seven instances from Las Caldas and two from La Garma confirm a Pyrenean influence that is particularly clear at these two sites, as several authors have already noted (Arias *et al.*1999; Corchón 2005–2006). The exchange networks were probably at their maximum extent during the Middle Magdalenian. This is confirmed by a large range of evidence, including the circulation of flint and shells (Álvarez-Fernández 2002; Lacombe 2005; Simonnet 2007; Corchón *et al.* 2009). It is also shown by the geographical distribution of features such as horse heads depicted in *contours découpés* mode which display exactly the same behaviour as the group A engravings, i.e. a Pyrenean origin with a wealth of details and hatching, and a widespread expansion towards the Cantabrian region and Aquitaine (Buisson *et al.* 1996). It is noteworthy that the features of group A are largely limited to the Middle Magdalenian and become very rare in the Upper Magdalenian, which demonstrates that important socio-cultural changes occurred at that time.

On the other hand, horses from group C (with 'double mane' and prominent crest) are highly characteristic of Aquitaine during the Upper Magdalenian. The model spreads to Quercy and the valley of Aveyron (Sainte-Eulalie, Fontalès) and reaches the Cantabrian region (Abauntz, El Pendo, La Pila, Lumentxa, El Valle). The Pyrenees, however, seem to remain outside this zone of influence with only a few instances of double manes (Isturitz, Le Mas d'Azil, La Vache). The double mane exists also in parietal art and presents a similar distribution: most numerous in Aquitaine and Quercy (Font-de-Gaume, Les Combarelles, Rouffignac, Teyjat, Lagrave), it is relatively frequent in the Cantabrian region (Hornos de

la Peña, Las Monedas, El Buxu, Candamo, Tito Bustillo) but very scarce in the Pyrenees (Niaux, Le Portel).

The rarity of the cultural exchanges between Aquitaine and the Pyrenees during the Upper Magdalenian is in keeping with other observations. For instance, two typical Upper Magdalenian motifs such as horses with hypertrophied heads and schematic feminine figurines are abundant in Aquitaine and very rare in the Pyrenees (Cartailhac & Breuil 1907: 22; Bourrillon 2009). The links between the Pyrenees and Aquitaine are very slight at the end of the Magdalenian, whereas the links with the Cantabrian area seem relatively persistent, as shown by the motif of caprids in frontal view, which is mainly found in the Cantabrian region (57 per cent), is also abundant in the Pyrenees (33 per cent), but is rare in Aquitaine (10 per cent) (Rivero *et al.* in press).

Together, these observations suggest that during the Upper Magdalenian the networks between the three main regions underwent a deep reorganisation. The relationships between the Pyrenees and Aquitaine appear much looser than in the previous period, because Aquitaine seems now to be engaged in new economic and cultural relationships with northern and eastern groups. The extension of schematic feminine figurines to Germany (Gönnersdorf) is just one example of these new networks (Bosinski 2011).

The major changes between the Middle and Upper Magdalenian that we perceive through our formal analysis of horse representations are also found in many other domains of portable and parietal art, and are confirmed by concomitant changes in lithic and bone industries. These relatively rapid changes seem to be correlated with an important redistribution of the exchange networks. The causes of this social and cultural reorganisation are not known. We can hypothesise, however, that the climatic improvement accompanying the Bölling interstadial played a role in the circulation of big game and the expansion of new settlement sites, maybe in relation to a significant demographic increase. Eastward and northward movements of Aquitainian groups were probably linked to these phenomena, as well as an expansion of Cantabrian groups toward the interior of the Iberian peninsula via the Ebro Valley, where numerous Upper Magdalenian sites are known.

Conclusion

Results presented in this work are based on the formal analysis of a representative corpus. Statistical tools such as correspondence factor analysis and ascending hierarchical clustering show that Magdalenian horse representations may be split into three formal groups according to specific features and that these groups present geographic and chronological distributions that are far from random. It is highly probable that the observed pattern reflects real tendencies and is worth discussion from an archaeological and anthropological point of view. The fact that a large number of horse figures using abundant hatching and anatomical details come from the Pyrenean Middle Magdalenian, and that a large number of much simpler figures, with linear tracing, 'double mane' and scarcity of detail, come from the Aquitainian Upper Magdalenian, may be seen as an indication of their territory of origin and development. The directions of diffusion and expansion are probably representative of the driving forces acting in society during the Magdalenian in south-western Europe.

Nowadays, multivariate analysis using tools such as CFA and AHC is probably the most objective way to extract knowledge from a large set of raw data. The broad stylistic characteristics of the Pyrenean Middle Magdalenian and Aquitainian Upper Palaeolithic were already recognised by specialists more or less intuitively, but it was important to isolate objectively the main distinctive features. Of course, these results are statistical and should be treated in terms of probability. Examples falling outside the main trends are particularly interesting and should be carefully analysed in their own context, because exceptions may be more instructive than those which fall within the rules. For instance, a typical feature of a given region found in another region should be considered, without making *a priori* assumptions, as a clue to cultural exchanges between groups. Graphical features have probably circulated much more widely than we think, and it seems probable that their point of origin was not forgotten during the transfer. If we accept that style should be considered a marker of group identity, its usefulness is that it acts as a label in intergroup relationships. For instance, the presence of a bison conforming perfectly to the Aquitainian morphotype was found in the cave of Niaux (Ariège) and interpreted in this way (Fortea *et al.* 2004; Sauvet *et al.* in press) (Figure 6). It is interesting to note that, in immediate proximity to the bison, there is also a horse with a 'double mane', a treatment that as the present study shows is particularly frequent in Aquitaine, but exceptional in the Pyrenees. Together, these figures are archetypically Aquitainian in style. Their presence in the same panel among figures of pure Pyrenean style is undoubtedly meaningful and we may suppose that the mixing of styles aimed to symbolise the relationships between groups with different traditions.

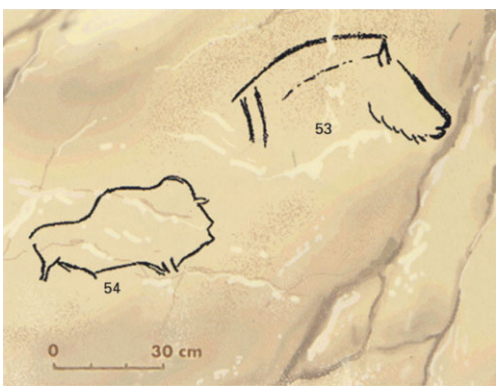

Figure 6. Bison and horse presenting typical Aquitainian features found in Niaux Cave (Ariège, Pyrenees). Drawing after G. Tosello in Clottes 1995.

Many other stylistic features not examined in this study, such as stripes on the hind legs, the *M*-shaped belly or the double line on the withers, would probably lead to similar conclusions. What we interpret generally as global stylistic markers probably carry regional distinctiveness that we are currently unable to recognise.

The chronological trends shown by the formal analysis are also marked, with some features clearly dominant during the Middle Magdalenian and others during the Upper Magdalenian, but again it should be stressed that they represent only statistical trends. For instance, the 'double mane' shows its maximum expansion during the Upper Magdalenian with 75 per cent of the occurrences falling within this period, but a few examples are also found at sites attributed to the Middle Magdalenian (Las Caldas, La Colombière). The case of cave art is even more complicated because most sites are undated and chronological attributions are quite uncertain. A careful discussion, beyond the scope of the current paper, would be necessary in each case, taking into account the particular context. For instance, in the case of the horse and bison of Aquitainian style in the Pyrenean cave of Niaux discussed above

(Figure 6), the bison has a direct ^{14}C date of 13 850±150 BP (GifA-92501) that sets it unambiguously in the Middle Magdalenian. Thus, the 'double mane' of the adjacent horse should probably be assigned also to the Middle Magdalenian, despite the fact that double manes are much more frequent in the Upper Magdalenian.

To go further into these questions of style, local origin and long-range diffusion of motifs and the related problems of acculturation, appropriation and reinterpretation, the next step of this research will require a careful examination of the technical characteristics of a vast series of objects from different areas. It is in the skill and originality of the artists in the manufacture of these objects that the answers to these difficult anthropological questions are to be found (Rivero 2011).

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