Wounded Animals and Where to Find Them. The Symbolism of Hunting in Palaeolithic Art

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Representations of wounded animals and humans in European Upper Palaeolithic art have traditionally been conceived as figures related to the hunting activities of hunter-gatherer societies. In this paper, we propose an analysis of Franco-Cantabrian figurative representations showing signs of violence between 35,000 and 13,000 cal. BP to qualify the interpretations of hunting and death in Palaeolithic art. To this end, both multivariate statistical analyses and hypothesis tests have been used to highlight the formal, thematic, chronological and regional similarities and differences in these types of artistic representations. The results show that wounded graphic units are mythograms coded by different variables that do not seem to reflect the actual hunting of the animal, but rather a more complex meaning. It was also discovered that, in early times, the artist preferred to wound secondary or less frequent animals, like deer. This changed in more recent times, when the main animals, such as bison, are wounded under greater normativity and homogeneity in the Pyrenees or the Cantabrian region.

Introduction

Palaeolithic art consists of abstract and figurative images comprising both zoomorphs and anthropomorphs. Some of them are directly related to signs and have been interpreted as wounded figurative representations. This interpretation originated in the early twentieth century when the magical theory of hunting and fertilization was the prevailing paradigm. The article 'L'art et la magie' by Salomon Reinach was the driving force behind the propitiatory functionality of art (Reinach 1903, 263) by analogy with the religiosity observed in contemporary primitive groups, such as the Aruntas in Australia or the Bushmen in the Kalahari desert, who perform their representations in places hidden from the eyes of the young and the uninitiated.

This theory has gained wide currency without having been demonstrated as a basis for argumentation. The propitiatory explanation converted graphic representations into sacred elements and the decorated caves into invocation shrines. As mentioned above, one of the main arguments in favour of this type of interpretation is the existence of Palaeolithic artistic representations associated with signs that were identified with the hunting or death of the animal (Bégouën 1939). These artistic representations have traditionally been analysed from an ethnographic point of view as visual examples of the theories to be corroborated. Various authors have approached this subject as a unitary whole (e.g. Baffier 1990; Delluc & Delluc 1989; D'Huy & Le Quellec 2010). However, the observation of art in the open air (e.g. Siega Verde, Foz Côa, Domingo García), in rock-shelters (e.g. La Viña, Laussel, Castanet) and cave entrances (e.g. Hornos de la Peña, La Garma Galería Inferior, La Pasiega B), implied daily access to the figures, contradicting the discourse based on the mystery of darkness (Balbín & Alcolea 1999). Likewise, it is now widely accepted, in the absence of new studies, that there is no correspondence between the fauna consumed and the fauna represented (Altuna 1983;

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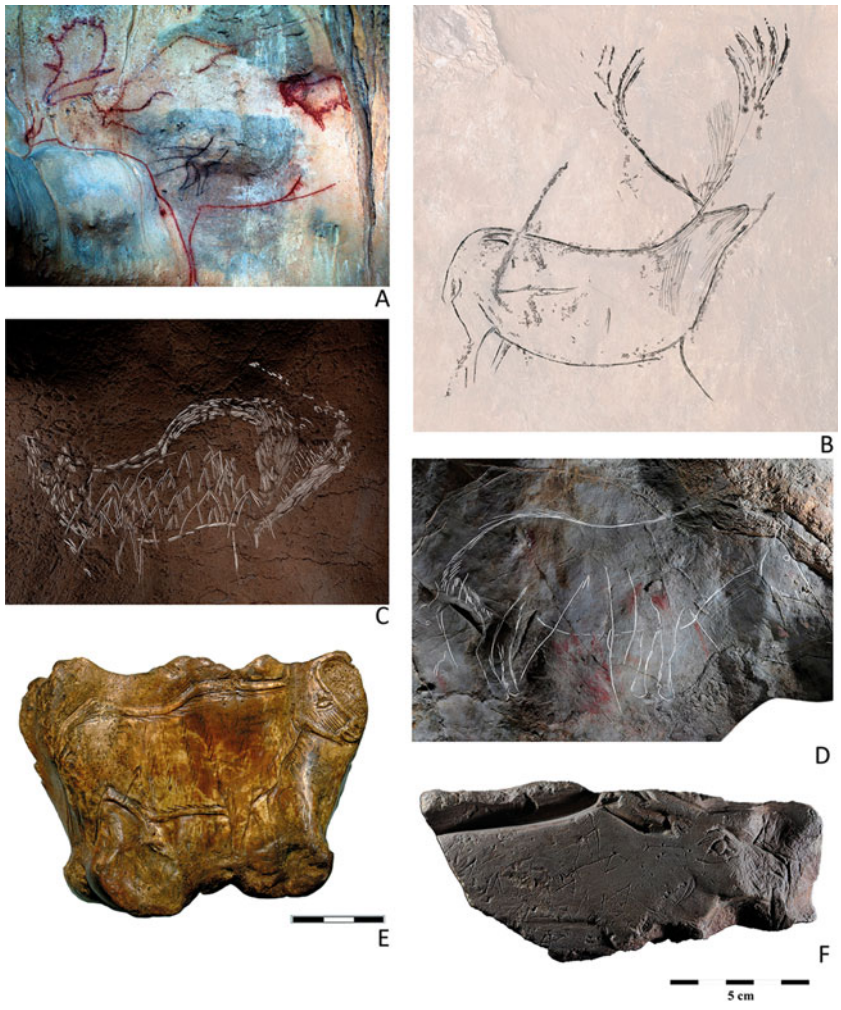

Figure 1. *Wounded animals and anthropomorphs from European Palaeolithic art. (A) Cougnac (@Wendel collection); (B) La Peña de Candamo (photograph and tracing: O. Rivero); (C) Atxurra (photograph and tracing: O. Rivero); (D) Pindal (photograph and tracing: O. Rivero); (E) La Garma Galería Inferior (photograph: O. Rivero); (F) Isturitz (photograph: O. Rivero).*

1984; 1994; 1995; Lorblanchet 1995; Moure 1990). This is why art conceived as sympathetic magic is nowadays considered outdated, with no alternative interpretation for those manifestations.

This paper analyses 'wounded' representations from the point of view of their context, temporality and associated characteristics. It is also based on the observation that there are representations of wounded animals and anthropomorphs (Fig. 1), without assuming the premise that these representations can be understood literally as expressions of hunting propitiation. Our aim is to define the category 'wounded' and then, using statistical tools, to analyse the diachrony and regionalization of parietal and portable wounded motifs in the Palaeolithic of southwestern Europe and to compare them with the rest of the contemporary artistic record, with a view to proposing an alternative interpretation for these graphic manifestations.

Materials and methods

The first stage of our work consists of defining the concept of 'wounded animal' and creating a database. We have compiled figurative motifs that are clearly associated with signs which seem to evoke weapons and wounds. This association implies the superposition of the sign in the body of the animal (either superimposed on the contour lines or positioned inside the figure) (Fig. 2). The final corpus contains a total of 295 parietal and 64 portable graphic units (Supplementary material, tables S1 and S2). The geographical area of study comprises the Iberian peninsula (Cantabrian region and the rest of the Iberian peninsula) and France (Pyrenees, Quercy, Aquitaine, Rhône and northern France). This database has temporal limits from 35,000 cal. BP, the date attributed to the first artistic manifestations documented in Chauvet Cave (Delannoy &

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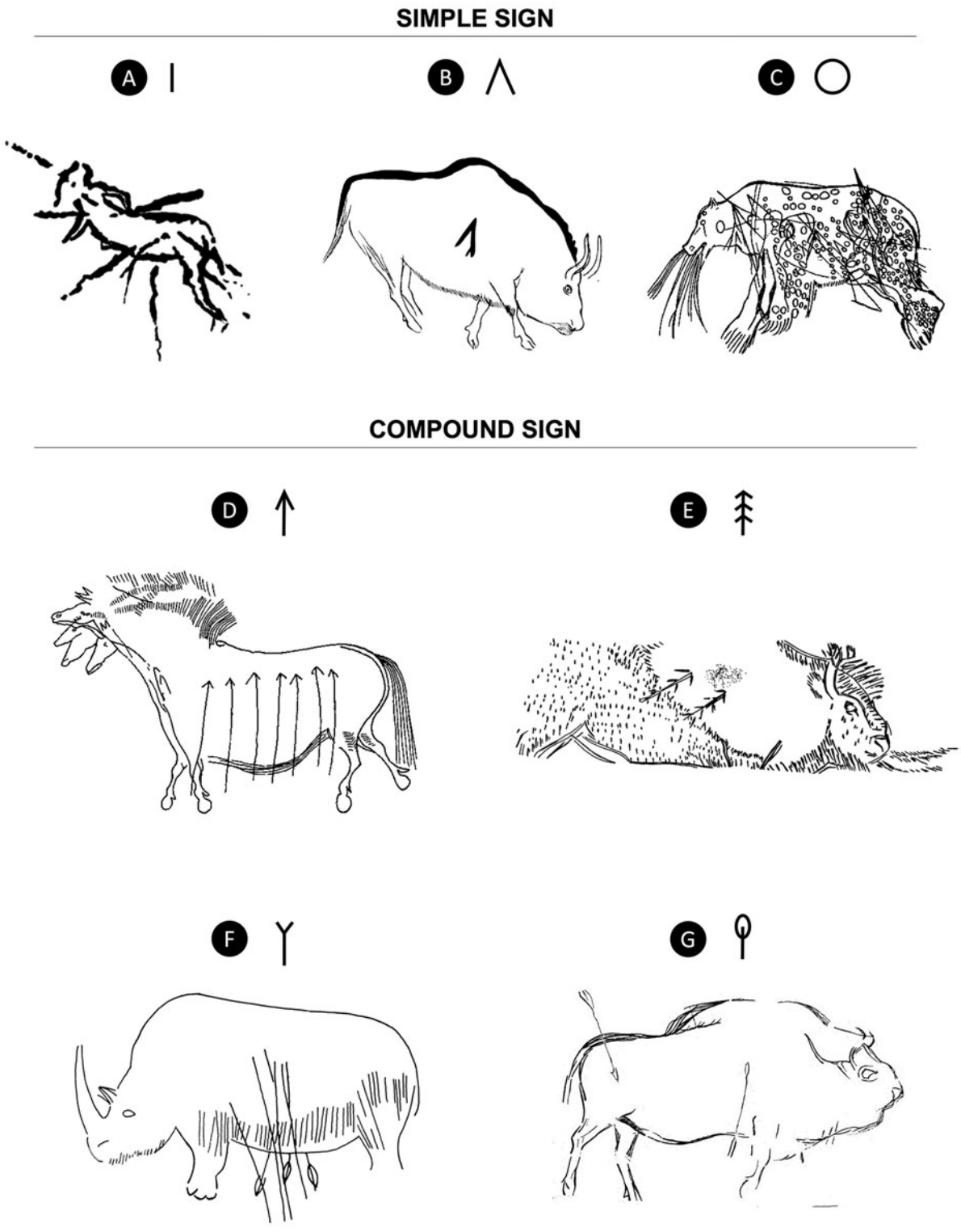

Figure 2. *Typology of signs associated with wounded animals. (A) Lines: Cougnac (Lorblanchet 2010, 270); (B) Angles: El Pindal (Alcalde del Río* et al. *1911, 76); (C) Circles: Les Trois-Frères (Leroi-Gourhan [1965] 1971); (D) Lascaux (Leroi-Gourhan & Allain 1979, 308); (E) Isturitz (Rivero 2010, 331); (F) La Colombière (Leroi-Gourhan [1965] 1971); (G) Laugerie-Basse (Tosello 2003, 74).*

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Geneste 2020; Quiles *et al.* 2016; Valladas 2003) to 13,000 cal. BP, when the Magdalenian technocomplex came to an end. For a better understanding, we have analysed the samples in two temporal blocks: the 'Pre-Magdalenian' (PM), which spans from the Aurignacian to the Lower Magdalenian (35,000 cal. BP–16,000 cal. BP), and the 'Recent Magdalenian' (RM), corresponding to the middle and upper phases of this industrial technocomplex (16,000 cal. BP–13,000 cal. BP). From the Middle Magdalenian onwards, it has been demonstrated that a process of cultural homogenization occurs in the western-most part of Europe, which can be observed not only in art (Rivero 2010; Sauvet & Wlodarczyk 2000–2001; Sauvet *et al.* 2008; 2014; Sieveking 1979) but also in other areas such as lithic and osseous industries (e.g. Cazals 2005; Langlais *et al.* 2016; Lefebvre *et al.* 2021). For this reason, this bipartition has been considered relevant in the present research work.

The elements that can possibly identify representation of a wounded, hurt or dead figure are often controversial. The juxtaposition of certain signs or traces to a figure does not necessarily imply a thematic association. In fact, in the literature there is a certain laxity in what is considered to be a wounded animal/human and the visual elements that define them often depend on subjective criteria (e.g. Baffier 1990; Lejeune 2000; Utrilla & Martínez Bea 2005). To avoid this drawback, we have defined a series of analytical attributes that make it possible to narrow down the criteria for defining wounded motifs and to analyse their variability over time and space. The discriminating elements that are possibly indicative of a wounded or fallen representation refer mainly to the typology and morphology of the associated signs and the existence of certain animations and attributes present in the figures.

With regard to the former, the classification of possible weapons or wound marks linked to the figures has been carried out according to morphological criteria (regardless of the dimensions), distinguishing two basic types (Fig. 2). The first includes the so-called elementary signs: the line (represented transversally, horizontally or obliquely), the angle (which can also appear in different positions) and the circle/point/hole. This last category includes both circular pigment stains and the perforations that are present, for example, in certain figures sculpted or moulded in clay, as in the case of the Montespan bear (Trombe & Dubuc 1947) or the Trois-Frères bear (Bégouën & Breuil 1958, 48). A second category is made up of so-called composite signs, i.e. those formed by the association of two or more elementary signs and forms derived from these. All these signs can be interpreted as weapons (spears, arrows, etc.) or wounds. However, other structured signs such as claviform, tectiform or quadrilateral are more difficult to interpret, since most of the time these signs are not associated with animal representations (Sauvet *et al.* 2014). In an attempt to be cautious, we have preferred to dispense with these types of signs.

Another element that merits methodological reflection is the location of the sign in relation to the figure. In our inventory, we have only included those signs that are either represented within the figure or superimposed on its outline, as is more usually the case with lines. Sometimes, the criterion of juxtaposition is not sufficient, since for an animal to be shown as 'wounded', the sign representing the weapon or wound must be superimposed on the figure. This is particularly important in cases where a single line has been depicted which may predate the figure, invalidating the interpretation of the figure as a wounded animal (Supplementary material, Fig. S1).

Another of the criteria used to define the wounded character of an animal/antropomorph is the animation that the figure may sometimes present, which shows the animal expelling blood from its mouth, sticking out its tongue or having an attitude that can be interpreted as suffering or death. However, we have only analysed those in which the primary element (weapons or wounds) is present, and therefore the animation is regarded as a complementary element. In this case, the criteria considered are the representation of a closed eye, the animation in the limbs (retracted or extended), the representation of blood by means of strokes next to the nose and mouth (Barandiarán 1984), a bent head and an open mouth. We have also included other animations, apparently unrelated to the suffering inherent in the wound, such as the raised tail or the backwards-turned head, since these also appear in the analysed representations of wounded animals (Fig. 3).

Despite the definition of these criteria, the identification of wounded figures is sometimes not clear due to multiple factors such as the conservation of the representations, the quality of the photographs and tracings available or the existence of multiple superimpositions. Sometimes, traces that could be considered weapons are actually traces of fur, cutting or fragments of other figures, or are found underneath the motif. This problem is particularly evident in the cases of complex palimpsests such as those at Les Trois-Frères (Ariège, France) (Bégouën & Breuil

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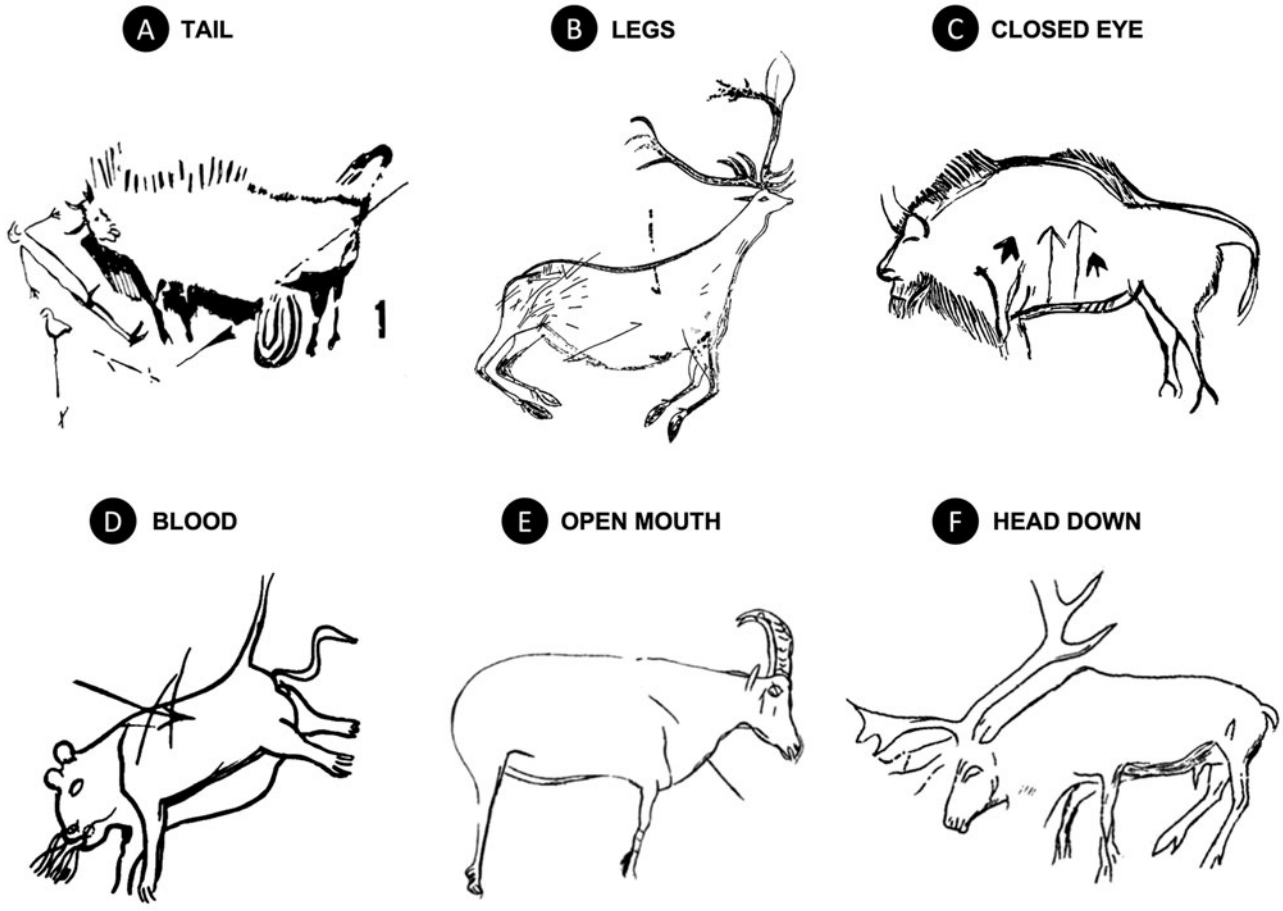

Figure 3. *Animation of the wounded theme. (A) Lascaux (Leroi-Gourhan [1965] 1971); (B) Lascaux (Leroi-Gourhan & Allain 1979, 276); (C) Niaux (Clottes 2010, 104); (D) Lascaux (Leroi-Gourhan & Allain 1979, 325); (E) Pergouset (Lorblanchet 2001, 72); (F) Limeuil (Tosello 2003, 216).*

1958; Vialou 1986) and Lascaux (Aquitaine, France) (Leroi-Gourhan & Allain 1979). On other occasions, the absence of animations and the presence of only a simple sign, especially a line or a pigment stain, superimposed on the motif do not make it possible to determine clearly whether it is a wounded figure. These are, for example, representations such as the equid and bovid at La Pileta filled with paired strokes (Breuil *et al.* 1915, pls XIII and XIV) and plaque no. 16182 from Parpalló, which have been excluded from the final inventory (Fig. 4). However, it must be said that while the fur conventionally occupies the same place, the signs seem to be arranged indistinctly in the contour or the interior of the figurative motif, as in La Pileta cases (Tosello 2003).

Once the corpus was constructed, it was first studied by means of multivariate statistics through a Correspondence Factor Analysis (CFA). This technique decomposes the data into a contingency table on which the position of each element within the factorial plane is determined. The projection of the point cloud onto the inertia plane provides a graphical representation that allows the degree of similarity and divergence between individuals to be visually explained. This method has been complemented by Hierarchical Clustering (HC), a technique that groups individuals according to their affinity. It has also been possible to determine which criteria have the greatest weight in determining the groups using this clustering method.

The criteria considered in the analysis include the different species represented, the typology of the associated signs, the artistic technique used, the type of animation and the chronological attribution and geographical location (see Supplementary material, Table S3). Specifically, 13 thematic categories have been defined for wounded figures, which include the most represented species of herbivores and carnivores, anthropomorphs (Ant) and

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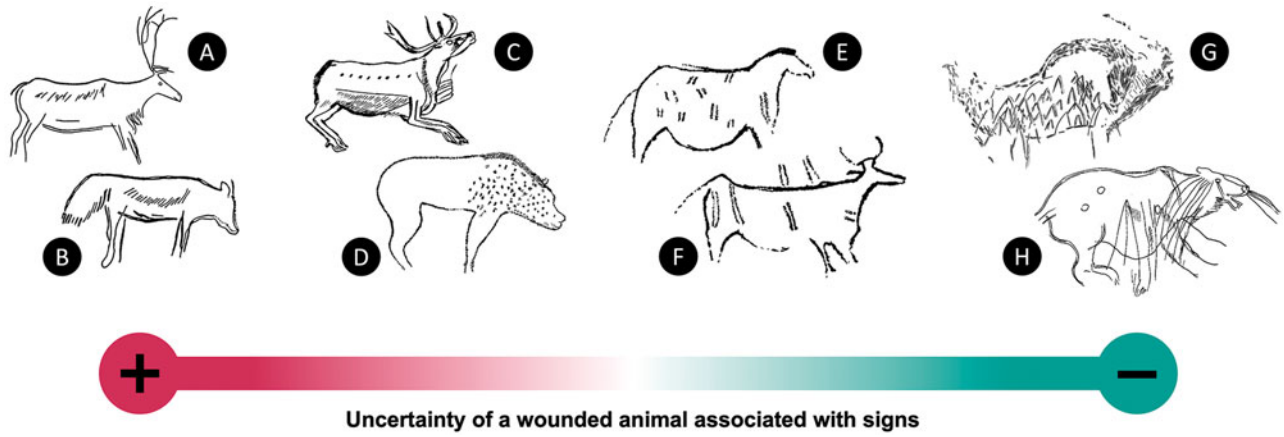

Figure 4. *Gradation in the certainty of attribution of signs as weapons and/or wounds. (A) Altxerri; (B) Altxerri; (C) Les Trois-Frères; (D) Chauvet; (E) La Pileta; (F) La Pileta; (G) Atxurra; (H) Les Trois-Frères.*

indeterminate figures (Ind). The different technical categories have been coded through four variables: painting (Pai), engraving (Eng), the combination of painting and engraving in the same graphic unit (Pye) and sculpture, digital tracing or modelling in clay, which are unified under the same criterion (Mod). The categories referring to signs include the types defined according to their morphology. These are linear signs (Ln), circular signs (spots, domes and/or impacts) (Cr), angular signs (Ag) and composite signs (Cp). On the other hand, the combination between the techniques of these signs and that of the wounded theme has also been recorded. Thus, if the technique of execution of both elements is the same, it is coded as 'homogeneous technique' (Sam), while if the technique of the sign differs from that applied for the figure, the selected criterion has been 'mixed technique' (Mxt).

The reduced deviation test or Z-score was also applied to these data. This test compares two proportions to know if they differ significantly (Chenorkian 1996). It has been used it to determine if there is an excess or deficit of a type of wounded animal associated with a specific region and chronology that is not due to chance. For this purpose, the overall figures in the work of Sauvet and Wlodarczyk (2000–2001) and Sauvet (2019) have been used. Likewise, the Z-score has been applied to find out if in a territory and chronology, there is a greater predilection for representing wounded figurative themes. The Z-score test allows us to analyse the proportion between samples, even with a few numbers of them, and to know whether this representativeness is significant or due to sample fluctuation.

Finally, in the particular study of the differences between two dichotomous categories (e.g. stag and hind or Pre-Magdalenian and Magdalenian), a binomial test has been used to determine whether the frequencies are the result of chance (Dodge 2006). The result of both tests is considered statistically significant if the 95 per cent threshold is exceeded.

Results

The corpus contains a total of 359 graphic units distributed across 70 sites (Fig. 5). There are territorial, chronological and thematic differences between the wounded iconographies depending on the support on which they are depicted. For this reason, we will now approach the study of wounded themes in different sections according to the support.

Wounded animals in parietal art

Our database contains 295 wounded graphic units represented on the wall, floor, or ceiling in a total of 57 sites (see Fig. 6 and Supplementary material, tables S4, S5 and S6, to see the distribution of each animal by region and chronology).

From Fig. 6A we can see that there are a few sites with a high number of wounded animals. Those that do not exceed 10 hurt graphic units total 51 caves (128 graphic units). If we count those that exceed this number (6 caves with 167 graphic units), sites such as Tuc d'Audoubert, Cosquer or Atxurra stand out, but above all Niaux, Lascaux and Les Trois-Frères, where at least 23, 51 and 54 wounded animals can be distinguished in their graphic production, respectively.

In terms of iconography (Fig. 6B), two large groups can be distinguished overall: a minority one formed by the overwhelming number of wounded

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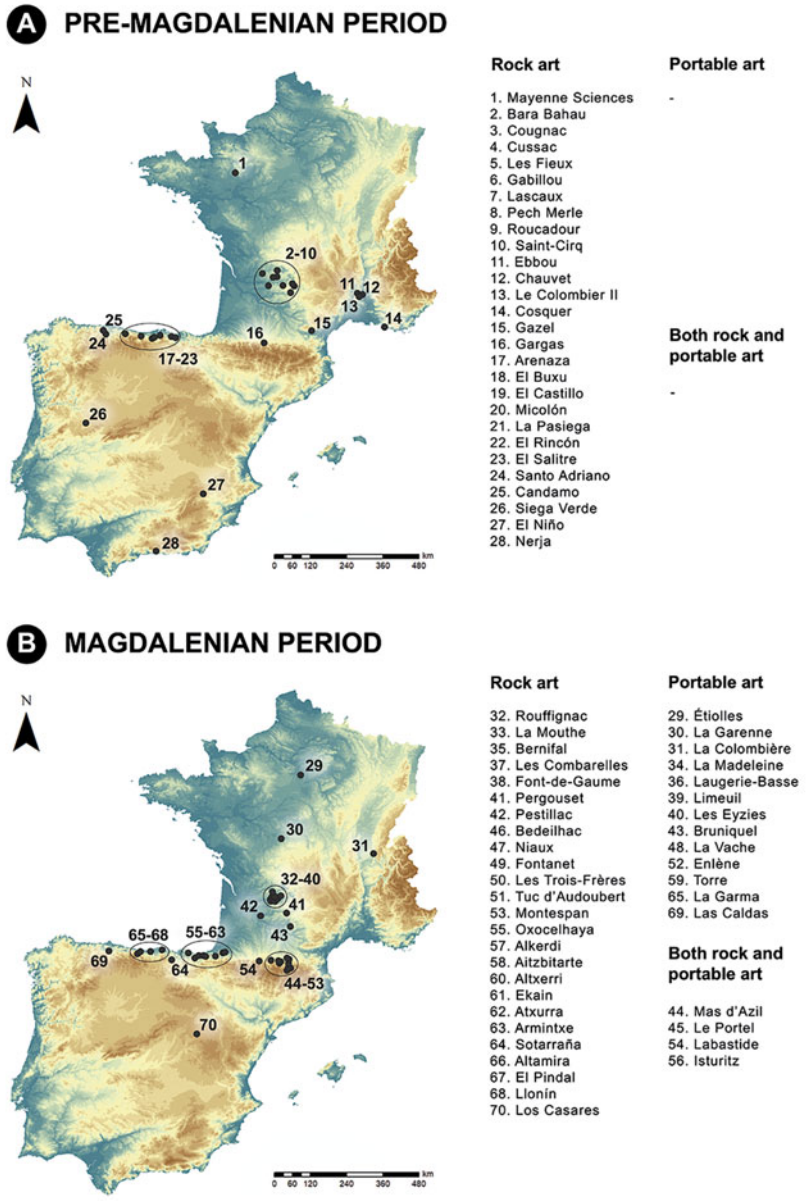

Figure 5. *Distribution of sites with wounded figurative iconography.*

bisons and horses, and another with the rest of the variety of themes, which are below 24 graphic units. However, depending on the chronology, the frequency varies drastically. While in the pre-Magdalenian period horse, deer, bison and aurochs are the most wounded animals (40.2, 17.3, 9.4 and 8.7 per cent samples respectively), from the Magdalenian period onwards this order is altered and the differences between the first and the second are greatly accentuated. Thus, from 14,500 BP (16,500 cal. BP) onwards, the bison is positioned as the animal of choice when it comes to representing wounded animals with a total of 94 graphic units (56 per cent), far behind the 24 horses (14.3 per cent), 17 goats (10.1 per cent) and 14 reindeer (8.3 per cent) that follow it on the list. It is worth highlighting a fundamental aspect: motifs with little representation during the Upper Palaeolithic such as anthropomorphs, those normally defined as dangerous (bears and lions) and macrofauna (mammoths, megaceros and rhinoceroses) are scarcely depicted wounded. Neither are indeterminate figures, which leads us to believe that the artist's desire was to identify the chosen taxon correctly by including some specific anatomical characteristic in most of them.

As far as signs are concerned (Fig. 6C), the Palaeolithic artist used the simplest signs more frequently (67 per cent) as opposed to composite signs

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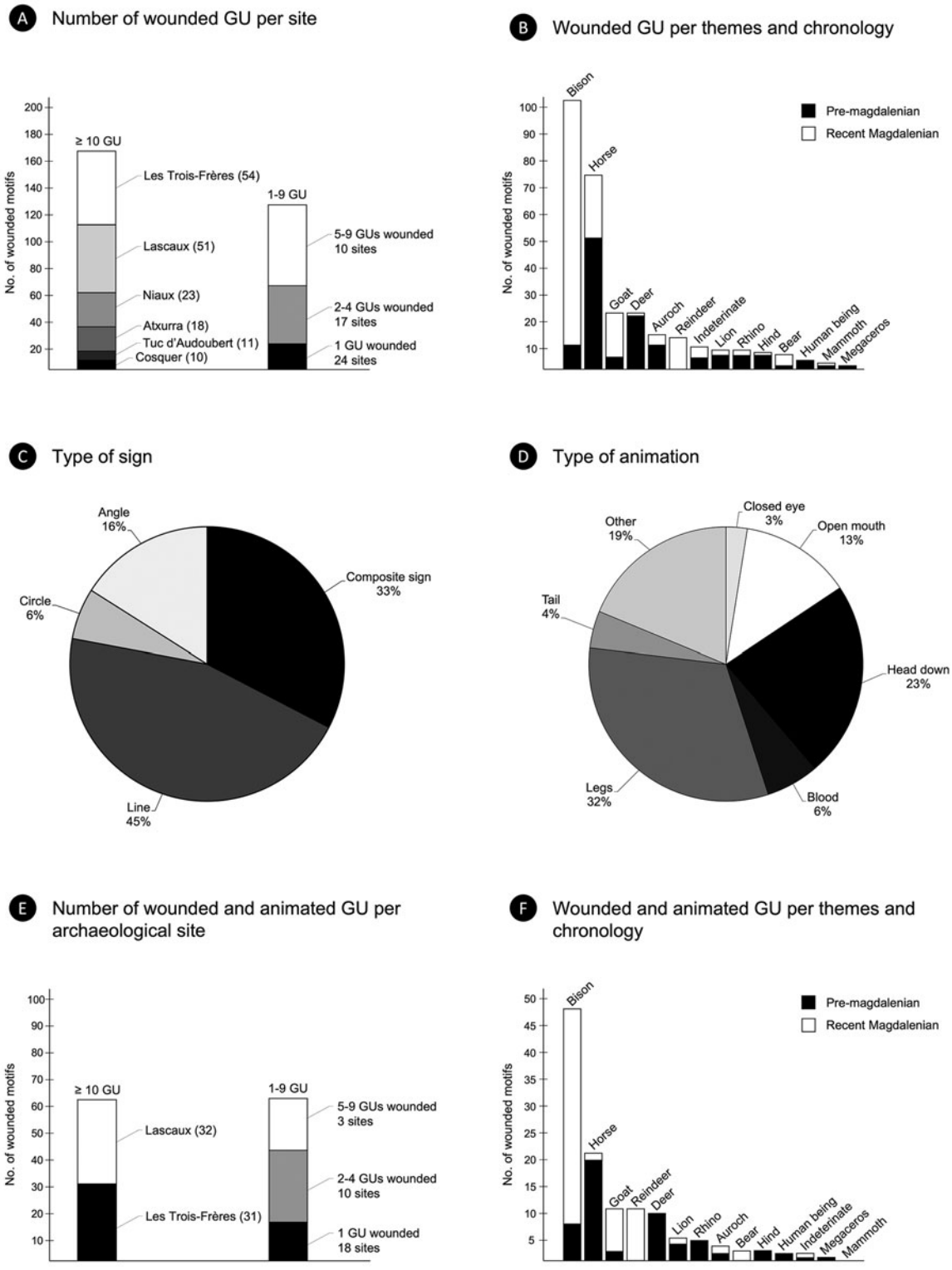

Figure 6. *Charts of wounded iconography on rock art. (A) Bar chart showing the number of wounded graphic units (GU); (B) Bar chart showing the number of wounded GU per themes and chronology; (C) Circular chart showing the percentage of the different types of signs; (D) Circular chart showing the percentage of the different types of animation; (E) Bar chart showing the number of wounded and animated GU; (F) Bar chart showing the number of wounded and animated GU by themes and chronology.*

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Table 1. *Comparison between the different proportions of each type of sign according to chronology in rock art.*

Sign	Pre-Magdalenian	%	Magdalenian	%	Probability
Compound	45/133	33.8	63/198	31.8	not significant
Line	73/133	54.9	77/198	38.9	99.6
Circle	4/133	3	16/198	8.1	not significant
Angle	11/133	8.3	42/198	21.2	99.8

(33 per cent), although there is an imbalance between the main sign, the line (45 per cent), and the angle and circle (22 per cent). The use of circle and composite signs is stable over time, but not that of line and angles. A comparison of the proportion using the Z-score test indicates that there is a predilection for the use of the first sign in the pre-Magdalenian period (p-value = 99.6 per cent) and the second sign during the Magdalenian (p-value = 99.8 per cent) (Table 1).

In terms of animation, wounded figures are more frequently represented in static form (57 per cent) than in movement (43 per cent), a difference that is not due to chance, as shown by the binomial test applied (p-value = 98 per cent). If we study the distribution of animated motifs among the sites, they are more concentrated in places where there is a greater number of wounded animals, such as Lascaux and Les Trois-Frères, which have as many animated graphic units as the other sites combined (Fig. 6E). At both sites, more than half of the hurt representations are animated. The main subjects that are represented with some movement coincide in turn with those that most frequently appear wounded (Fig. 6F). Thus, bison and horses are the most representative animals in this respect, followed by goats, reindeer and deer, which account for around 10 representations. The only anomaly that can be noted concerns reindeer during the Magdalenian, which seem to be animated more than other species (11/14), while horses, on the contrary, are animated in a small proportion (21/75).

Finally, of all the animations found, three stand out: the limbs (32 per cent), the inclination of the head (23 per cent) and the open mouth (13 per cent) (Fig. 6D). The animations do not show significant differences between the two periods: they are percentage-wise equivalent in the Pre-Magdalenian and Recent Magdalenian (*c.* 50 per cent), although it is true that the type of animation represented changes. In the Pre-Magdalenian, a large majority of the animated wounded motifs show movement in the legs (retracted, extended, in a walking attitude, etc.). The reduced deviation test has confirmed that this animation is statistically significant (99.7 per cent) during that period. In the case of the Magdalenian wounded figures, the animations are more diverse, highlighting not only movement in the limbs (22.22 per cent), but also other gestures such as in the head (25.56 per cent) or the mouth (16.67 per cent), without any of them being statistically specific in this chronology.

To find out how these issues relate to the other variables chosen, a CFA has been used. The projection on the principal factorial plane [1,2] of the different attributes and individuals can establish the value they contribute to the inertia of each axis. Six of the samples representing rare animals in the corpus (bears and rhinoceroses) distort the factorial distribution, so they have been placed as Supplementary Elements (SE), i.e. they do not participate in the constitution of the axes but are projected on the factorial plane.

The result provided by the CFA highlights the existence of two well-differentiated groups by Hierarchical Clustering as can be seen in the representation of the factorial plane [1,2] (Fig. 7). There is a blue group formed by 129 individuals and 15 categories in which we find the Middle–Upper Magdalenian (MR) and a red group of 160 graphic representations and 36 categories in which we find the Pre-Magdalenian (PM). Thus, the clear opposition of the PM and MR attributes on axis 1 confirms this structuring based on the chronological criterion.

The categories that contribute most to the creation of each group, revealed by the Hierarchical Clustering, show that the difference lies in regional, chronological and thematic criteria that are common to Palaeolithic art as a whole and do not appear, at first glance, to be particular to wounded animals. Thus, in the Pre-Magdalenian group, the main categories are the regional Aquitanian and Rhone criteria and the symbol of the line as a wound. In the Magdalenian, the main categories are the Pyrenean regional criterion, the bison and the angular symbol.

On the other hand, the results of the reduced deviation test show statistically significant

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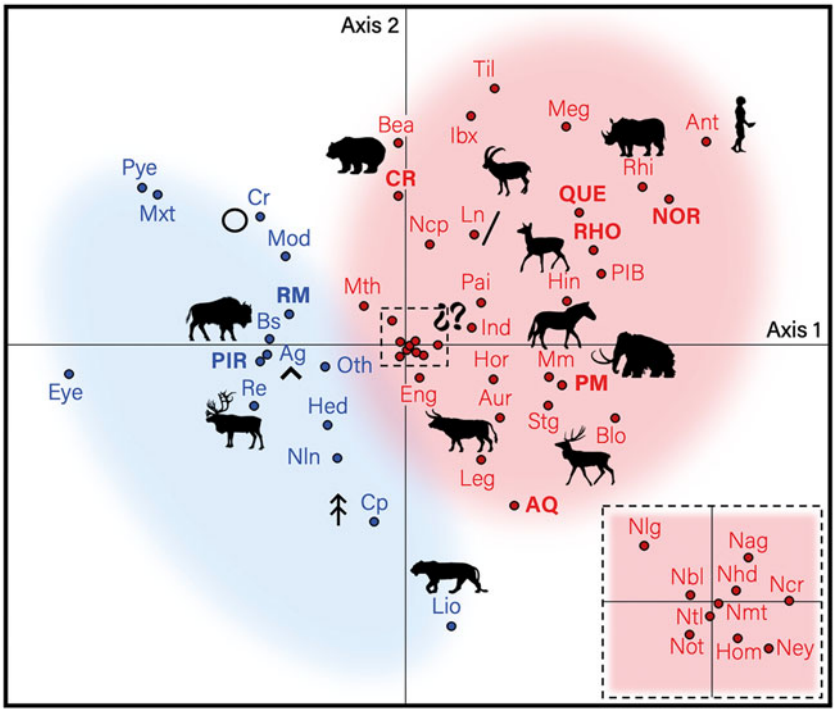

Figure 7. *Analysis of the 295 wounded parietal graphic units. Projection on the factorial plane [1,2]: axis 1 (inertia: 7.91 per cent); axis 2 (inertia: 6.58 per cent).*

Table 2. *Animal themes that present significant results in the Z-Score test concerning the proportion between wounded/not wounded animals. *According to Sauvet & Wlodarczyk (2000–2001) and Sauvet (2019).*

Region	Global number*	Hurt number	Global (%)	Hurt (%)	Probability
Pre-Magdalenian Cantabrian region stag	86/674	9/22	12.76	40.91	99.9 (excess)
Recent Magdalenian Aquitaine reindeer	47/698	6/13	6.73	46.15	99.9 (excess)
Recent Magdalenian Pyrenees region bison	355/753	71/111	47.14	63.96	99.9 (excess)
Recent Magdalenian Pyrenees region horse	205/753	17/111	27.22	15.32	99.3 (deficit)

differences between some of the most numerous themes and the chronology of certain regions studied (Table 2). Firstly, a significant trend is observed in the case of deer in the Cantabrian region. The number of these motifs out of the total number of animals represented in pre-Magdalenian parietal art in the Cantabrian region is 86 out of 674 (Sauvet & Wlodarczyk 2000–2001, 227), while the number of wounded deer is 9 compared to the 22 wounded animals documented in this region. The test shows that the excess of deer among the wounded animals in Cantabrian region is significant with a probability of 99.9 per cent and confirms the hypothesis proposed by González Sainz (2007, 320) regarding the idiosyncrasy of this type of representation in the Solutrean period and during the Lower Magdalenian in the Cantabrian territory.

This element, which corroborates the difference in gender and behaviour of the representations of *Cervus elaphus*, is noteworthy. Hinds, widely represented in pre-Magdalenian times, are not wounded except on rare occasions such as at Santo Adriano (Fortea 2005, 36, fig. 6) and Micolón (García Guinea & Puente 1982). In the case of males, although their quantitative presence is lower, they show a high probability of being

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Table 3. *Number of wounded animals in parietal art per region during the Pre-Magdalenian and Recent Magdalenian compared to the overall number of figural motifs. *According to Sauvet & Wlodarczyk (2000–2001) and Sauvet (2019).*

Region	Global number*	Hurt number	Global (%)	Hurt (%)	Probability
Pre-Magdalenian Cantabrian region	674/2069	22/126	32.58	17.46	99.9 (deficit)
Magdalenian Cantabrian region	359/1912	38/169	18.78	22.49	not significant
Pre-Magdalenian Aquitaine	412/2069	59/126	19.91	46.83	99.9 (excess)
Recent Magdalenian Aquitaine	698/1912	13/169	36.51	7.69	99.9 (deficit)
Pre-Magdalenian Pyrenees region	107/2069	2/126	5.17	1.59	not significant
Recent Magdalenian Pyrenees region	753/1912	111/169	39.38	65.68	99.9 (excess)

represented as wounded. A binomial test comparing the proportion of the total of 23 wounded parietal stags in all Palaeolithic art *versus* the six hinds indicates that, indeed, the presence of signs of wounding in the former is significantly higher by 99.8 per cent.

In the Magdalenian, there are several geographically significant differences (Table 2). In Aquitaine, the reindeer is the only wounded animal that stands out from the proportions of the rest of the iconography, while in the Pyrenees the picture is somewhat more complex. Thus, while the excess of wounded bison is clearly significant in the latter territory, wounded horses show the opposite trend, as they are greatly under-represented in the Pyrenean region, with a 99.3 per cent probability that their absence is significant.

It should be noted that the representations of hurt animals, considered as a whole, do not show a homogeneous distribution according to the periods and regions analysed (Table 3). It can be seen that during the Pre-Magdalenian, in the Cantabrian region, the proportion of wounded animals in relation to the overall total is very low, with a significant under-representation of 99.9 per cent. On the other hand, and with the same percentage, in Aquitaine the number of wounded motifs is very high: 59 out of 126 animals throughout this chronology. However, when the chronology changes, this proportion undergoes a drastic change and becomes a statistically significant deficit: only 13 animals in the Périgord are wounded out of the 169 documented during the recent Magdalenian period. The Pyrenean region takes over in this period, with a 99.9 per cent excess of wounded animals in relation to the overall total.

Our analysis also considered the presence of animations or adjacent details that can be associated with the representation of pain or death of the animal or anthropomorph. To address this relationship, we have calculated the number of each of the animations present in the wounded representations analysed in relation to the two chronological periods defined and in relation to the themes depicted.

These data corroborate and complement those provided by the CFA and the reduced deviation test applied to themes, regions and periods. They show that the animations are linked to the themes that characterize each period in a given region, as we saw earlier. All this together shows us that the concept of each wounded representation is in fact a compendium of characters: theme, technique, animation, type of associated sign; and that these characters are relatively uniform and stable for a given region and a given period. They are therefore true 'mythograms', i.e. visual representations that symbolize something other than what is actually depicted, acting as a 'conceptual template' (Lewis-Williams 2002, 219) in which it is the set of criteria that has meaning.

Wounded animals in portable art

The corpus of samples from portable supports amounts to 64 graphic units from 17 caves (3 Spanish and 14 French) (Fig. 8 and Supplementary material, tables S7, S8 and S9). When studying the portable art in which the Palaeolithic artist depicted wounded figurative motifs, two aspects must be considered: it is mainly art from the Middle–Upper Magdalenian period and executed exclusively using the engraving technique (except for one piece from Isturitz, which is combined with sculpture). It is therefore only possible to study this area from a thematic and regional point of view, according to the

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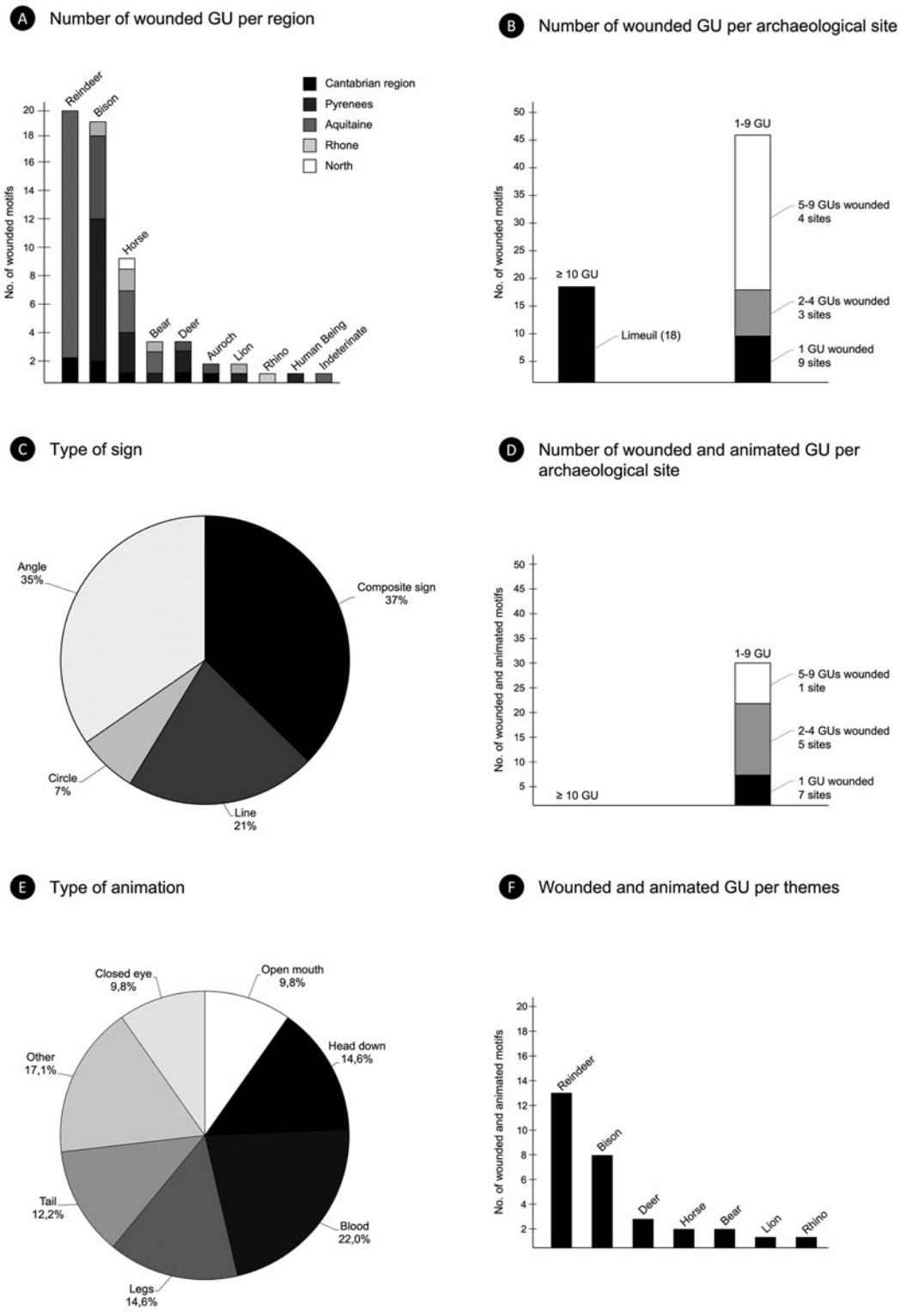

Figure 8. *Charts of wounded iconography on portable art. (A) Bar chart showing the number of wounded GU per region; (B) Bar chart showing the number of wounded GU per site; (C) Circular chart showing the percentage of the different types of signs; (D) Bar chart showing the number of wounded and animated GU per site; (E) Circular chart showing the percentage of the different types of animation; (F) Bar chart showing the number of wounded and animated GU per theme.*

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morphology of the weapon or wound and the animation.

The iconography on this type of support is even more restricted than that on the wall, floor, or ceiling (Fig. 8A). No animals such as ibex, mammoth, or hind have been documented and others are only of testimonial value, such as aurochs, bear, feline, stag, rhinoceros and anthropomorph. In this context, and parallel to what is found during this chronology in parietal art, bison and reindeer are the preferred species to be wounded. However, their geographical distribution differs completely. While the bison is the predominant animal in the Pyrenees (Isturitz and Mas d'Azil), the reindeer is the predominant animal in Aquitaine (Limeuil and La Madeleine), the latter animal being 99.9 per cent representative. On the other hand, only Limeuil has a large number of pieces in which wounded graphic units have been represented, but it is common to find sites in which only one support has been found with a single wounded figurative motif (Fig. 8B).

As for the type of sign, the simplest ones are more common (63 per cent) than the composite ones (37 per cent), with the angle prevailing over the rest (Fig. 8C). As already indicated in the CFA, this is a parallel with the parietal art from the Recent Magdalenian, which indicates that in both supports there was the same predilection for using this symbol to wound the animal. However, the Palaeolithic artist used at least two of these abstract motifs in different proportions depending on the type of support. Thus, while the composite signs and the circle were used interchangeably, the line seems to have been used more for parietal art and the angle for portable art (Table 4).

In the case of animation, 46.6 per cent of the figures are represented with some kind of movement, a percentage very similar to that of parietal art. Three aspects can be highlighted with respect to this variable. Firstly, the animation is a widespread formalism in slightly more than half of the sites (53 per cent), although none contains more than 10 wounded and animated graphic units (Fig. 8D). It should also be added that in those sites where there is only one wounded representation, it is frequently animated (67 per cent), as is the case at Labastide, La Garenne, Étiolles, Bruniquel, Torre and Le Portel. In other places such as La Colombière, La Vache or Las Caldas, half of the wounded animals are also animated. Secondly, the types of animation appear in a similar proportion, with the presence of blood and the movement of limbs and the head (Fig. 8E). Finally, of all the iconography only the bison and the reindeer can be singled out as the species most frequently linked to some kind of animation (Fig. 8F).

Discussion

If we compare the results highlighted by the AFC with those presented in the work of Sauvet and Wlodarczyk (2000–2001) and in Sauvet (2019), we can observe that the wounded representations broadly participate in the global scheme of Palaeolithic art. In particular, we can highlight the importance of wounded bison during the recent Magdalenian, which links the Cantabrian region and the Pyrenees, places where this mammal accounts for more than half of the wounded animals represented.

The reduced deviation test complements and qualifies this first impression, showing that there are certain preferences when it comes to representing a wounded figurative theme: for example, the pre-eminence of the theme of the wounded stag on the Cantabrian coast during the PM, as opposed to the hind, which is the dominant theme in the region during this period and which very rarely appears wounded. The presence/absence of wounded animals and the characters associated with them in each region and period studied also seem to show their own dynamics. This is why we find, for example, certain surprising peculiarities such as the virtual absence of wounded horses during the RM in the Pyrenees, even though horses are the second most represented animal in the region's parietal art (Sauvet & Wlodarczyk 2000–2001).

Table 4. *Comparison between the different proportion of each type of sign according to chronology in both supports.*

Sign	Parietal art	%	Portable art	%	Probability
Compound	63/198	31.8	28/75	37.3	Not significant
Line	77/198	38.9	16/75	21.3	99.7
Circle	16/198	8.1	5/75	6.7	Not significant
Angle	42/198	21.2	26/75	34.7	97.8

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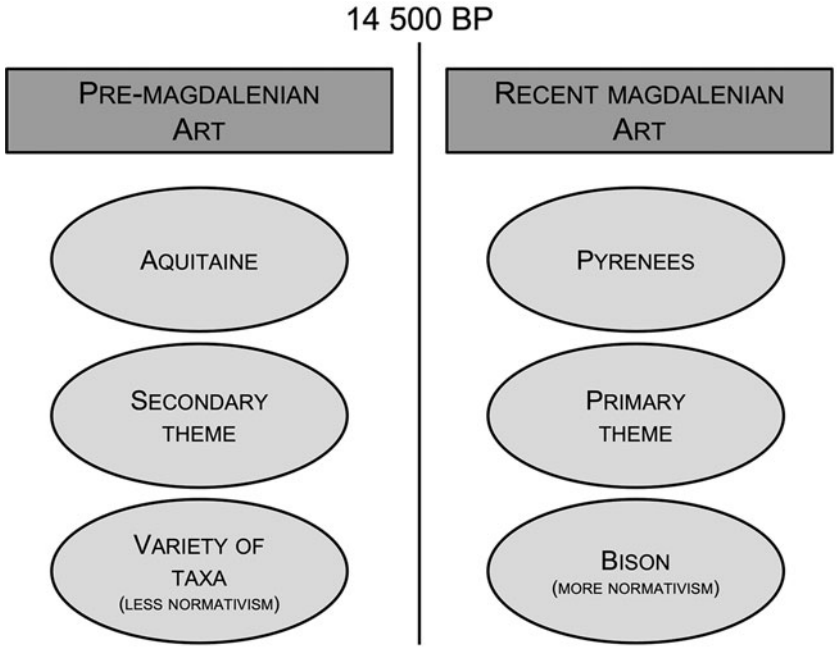

Figure 9. *Synthesis of the transformations observed in the representations of animals and wounded anthropomorphs between Pre-Magdalenian and Recent Magdalenian art.*

The analyses also allow us to point out a series of interpretations linked to the formal, chronological and regional variability of this type of representation. The determinations as primary and secondary established by André Leroi-Gourhan ([1965] 1971, 86–7) for the zoomorphs represented, by virtue of their quantitative and qualitative presence, can be introduced for a more complete interpretation of the phenomenon being studied, since something similar has been concluded by Sauvet in his recent work (2019). In this paper, through the Kruskal Algorithm, the hierarchy of animal themes in Palaeolithic art is observed, with some themes dependent on others, as in the case of the reindeer (dependent on the bison) or the deer as a theme dependent on the aurochs. This analysis confirms Leroi-Gourhan's hypothesis while qualifying his results and demonstrating that the position of animal themes in Palaeolithic art is hierarchical and is conditioned by the presence or absence of the main themes. Thus, according to Kruskal's Algorithm, the horse heads the animal hierarchy, with goat, bison and aurochs depending directly on it. These themes in turn have other themes depending on them, such as deer or hind on aurochs, or mammoth and reindeer on bison.

Starting from this hierarchical structure, stag can be analysed as secondary (or complementary) and bison can be considered fundamental (or primary) in the graphic record. Thus, a change can be deduced between them regarding the depiction of pain, violence and wounded zoomorphs and anthropomorphs (Fig. 9).

During the oldest period, Palaeolithic societies kept the theme of the wounded animal in the background, without applying it to the most recurrent figurative motifs or using it in large panels with a high density of figures. These were executed using only a few techniques (painting and engraving to a lesser extent) and are associated with elementary signs (linear) and animations focused on the legs. From a regional point of view, it seems that the theme of the wounded animal is particularly linked to the Aquitaine region (47 per cent of the wounded animals from this period belong to this region, which, however, accounts for only 20 per cent of the total number of pre-Magdalenian parietal art figures).

From the Magdalenian period onwards, the theme of the wounded animal was brought to the foreground of the scene, involving zoomorphs that play a quantitatively primary role, such as bison. Variability in the techniques or the type of animation does not refute the strong normative condition of the graphic constructions, which are assumed in the themes of wounded animals. The associated signs change, showing from this point onwards a preference for angular and circular signs. The same occurs in the case of the animations, which are especially oriented towards representing a closed eye. Finally, it should be noted that during this stage the theme of the wounded animal reached a very significant over-representation in the Pyrenean region (78 per cent of the Magdalenian wounded animals are in the Pyrenees).

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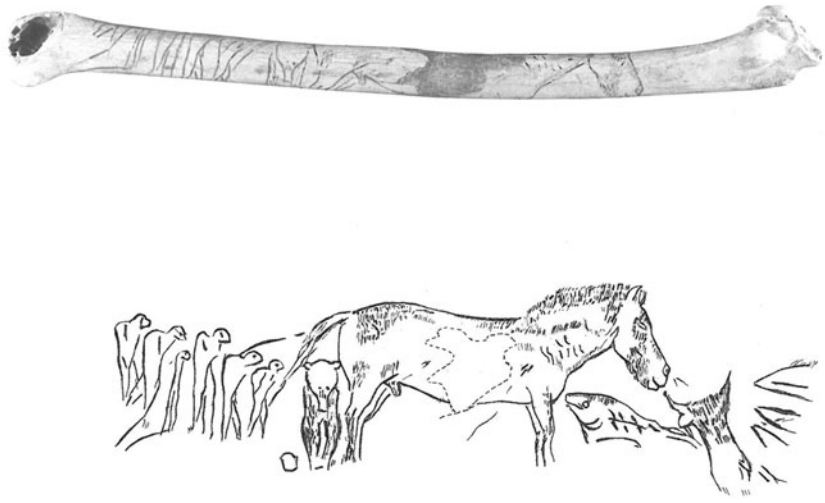

Figure 10. *One rare example from Upper Magdalenian portable art scene from La Vache, with depictions of anthropomorphic figures and animals with no signs of violence or hunting (Clottes & Delporte 2003, 361).*

This imbalance between the two chronological periods should be interpreted as a reflection of a change at a social and cultural level, which invalidates the traditional thesis that wounded animals seemed to reflect propitiatory hunting activity. This theory, put forward by Reinach in 1903 and seconded by Breuil, arose from the need to give Palaeolithic art a function by analogy with other primitive groups (Cartailhac & Breuil 1906). However, this study has demonstrated that the presence or absence of hunting scenes in art does not depict everyday life or subsistence activities, a fact that seems to be corroborated by the different treatment of the representations of wounded animals in different regions and periods, which undoubtedly reflect the cultural and ideological idiosyncrasies of the societies that inhabited them.

Comparison with the iconography of rock art at other sites and in other chronologies corroborates the distinctive identity of wounded representations during the Palaeolithic of Western Europe. According to Aubert *et al.* (2019), the theme of hunting may appear from the very beginnings of art. It has been interpreted that the Leang Bulu' Sipong 4 (Indonesia) paintings depict a hunting scene where several therianthropes attempt to shoot down pigs and an anoa. This panel has been dated to at least 43,900 bp by U/Th dating of a speleothem overlying the painting.

In Levantine art, hunting is one of the most common and easily identifiable narrative resources (Beltrán 1982; Blasco Bosqued 1974; Jordá 1975; Rivero 2020). The representation of hunting activity was focused more on caprids and stags, although wild boars, bulls and horses also appear (Blasco Bosqued 1974; López-Montalvo 2018). On occasions, the prey is shown shot or lacerated, possibly by arrows, and oversized in comparison with the human figures. The latter, often armed with a bow, are highly dynamic and are an essential part of the composition. The activity reflected in the panel may involve a single anthropomorphic figure, pairs, a large group of hunters and even the participation of possibly domesticated canids (Ruiz-López 2009). Although they can be interpreted as historicist scenes, they have also been interpreted as symbolic activities that perpetuate a tradition (Ruiz-López 2009) or a certain prestige that has repercussions for various privileges (López-Montalvo 2018).

Numerous examples of hunting scenes were also created in Scandinavia, the precise chronology of which is not entirely certain. While these could be analysed both descriptively (the everyday activity of hunting) and symbolically (the idealization of hunting activity) (Skoglund *et al.* 2022), their main characteristic is also the narrative component where often a large group of armed anthropomorphs confront or encounter the prey. Their significance has usually been linked to magico-religious (e.g. Brøgger 1925; Gjessing 1936; Helskog 2012; 2014; Simonsen 1979) or totemistic (e.g. Hesjedal 1992; Magnus & Myhre 1986; Mikkelsen 1977; Tilley 1991) interpretations linked to hunting expeditions focusing on large, difficult-to-track prey such as reindeer and elk or dangerous prey such as bear (Ranta *et al.* 2020). It is noteworthy that the weapons remain in the hands of the hunters and do not seem to represent the very moment of the animal's death. The fact that agricultural societies did not necessarily require hunting for group survival signifies that it may represent an activity that had some social benefit (Ranta *et al.* 2020), likely to be counted as epic if in the face of large prey.

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Finally, hunting scenes are also present in more recent cultural manifestations, between the first century BC and the first century AD, in the Black Desert of Jordan. In this artistic tradition, hunting is the most common scene depicted (Brusgaard 2019; Brusgaard & Akkermans 2021). Panels may contain many motifs, but the scene itself is most often a single hunter who appears to be standing or mounted on an animal. Sometimes the human is even accompanied by predators such as dogs, and the focus is usually on animals such as goats, gazelles, or wild asses.

If we consider the different representations of hunting in rock art across different chronologies and geographical regions, three major differences can be found between European Palaeolithic art and these later cases. In European Palaeolithic art, there are no actual scenes inasmuch as there are no human representations in interaction with animal figures. Human–animal scenes can only be found in a few representations in Lascaux cave (Fig. 3A), and in late Upper Palaeolithic portable art, such as at La Vache (Clottes & Delporte 2003) (Fig. 10). On the other hand, in cases where there is a possible scene, the anthropomorphic figure does not carry weapons, and the protagonism falls on the wounded animal, not on the man or the hunting action *per se*, as in the famous Lascaux scene. This shows that Franco-Cantabrian art has a singular character with an idiosyncrasy that differentiates it from the narrative characteristic of art produced not only in other remote places such as Sulawesi but also during later chronologies. In short, the absence of a correlation between the fauna consumed and represented and the lack of similarity with the scenes shown in other types of cultures are indicative of the great symbolic load that the wounded animal of the Franco-Cantabrian Palaeolithic possesses. This challenges the idea that they represent the everyday action of hunting and argues more for an interpretation of the wounded animal/human as a subject in its own right, distinct from the unwounded animal/human, and possessing its own meaning within Palaeolithic narrative discourse.

Conclusion

Information provided by the analysis carried out shows that the treatment of wounded animals is not uniform in Palaeolithic art, and that, on the contrary, there are changes in the subject matter, technique, degree of animation and support depending on periods and regions. It is, therefore, one more facet of Palaeolithic graphic expression that must be studied in conjunction with the rest of the characteristic aspects of this art. The changes are reflected in the preponderance of certain themes, such as the wounded bison in Cantabrian-Pyrenean Magdalenian art, or in the change from secondary animals to primary animals that seem to have taken place between the Pre-Magdalenian and Magdalenian periods (Fig. 5).

In short, the data provide a new approach to the subject that goes further than the interpretations provided in the last century. Beyond the fact that the representations of wounded animals reflect the death of the animals because of hunting, they seem to possess another meaning which is linked to the rest of the artistic discourse, and which is in turn a reflection of the complex culture of Palaeolithic society.

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Supplementary materials

Supplementary material may be found at https://doi.org/10.1017/S0959774323000471.

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References

Alcalde del Río, H., H. Breuil & L. Sierra, 1911. *Les cavernes de la région cantabrique (Espagne)* [The caves of the Cantabrian region (Spain)]. Monaco: Imprimerie Vve A. Chêne.

Altuna, J., 1983. On the relationship between archaeofaunas and parietal art in the Cantabrian region, in *Animals and Archaeology: 1. Hunters and their prey*, eds J. Clutton-Brock & C. Grigson. (BAR International series S163.) Oxford: Archaeopress, 227–38.

Altuna, J., 1984. Relación entre la fauna cazada por los pobladores del yacimiento y las figuras representadas en el santuario [Relationship between the fauna hunted by the site's settlers and the figures represented in the sanctuary], in *El yacimiento prehistorico de la Cueva de Ekain (Deba, Guipuzcoa)* [The prehistoric site of Ekain Cave (Deba, Guipuzcoa)], eds J. Altuna & J.M. Merino. San Sebastian: Eusko Ikaskuntza, 281–6.

Altuna, J., 1994. La relación fauna consumida-fauna representada en el Paleolítico Superior Cantábrico [The relationship fauna consumed-fauna represented in the Upper Palaeolithic of Cantabria]. *Complutum* 5, 303–11.

Altuna, J., 1995. Faunas de mamíferos y cambios ambientales durante el Tardiglaciar cantábrico [Mammalian faunas and environmental changes during the Cantabrian Late Glacial period], in *El Final del Paleolítico Cantábrico: transformaciones ambientales y culturales durante el Tardiglacial y comienzos del Holoceno en la Región Cantábrica* [The end of the Cantabrian Palaeolithic: environmental and cultural transformations during the Late Glacial and early Holocene periods in the Cantabrian region], eds A. Moure & C. González-Sainz. Santander: Universidad de Cantabria, 77–117.

Aubert, M., R. Lebe, A.A. Oktaviana, *et al.*, 2019. Earliest hunting scene in prehistoric art. *Nature* 576, 442–5.

Baffier, D., 1990. Lecture technologique des représentations paléolithiques liées à la chasse et au gibier [Technological interpretation of Palaeolithic representations of hunting and game]. *Paléo* 2, 177–90.

Balbín, R. de & J.J. Alcolea, 1999. Vie quotidienne et vie religieuse: les sanctuaires dans l'art paléolithique [Daily life and religious life: sanctuaries in Palaeolithic art]. *L'Anthropologie* 103(1), 23–50.

Barandiarán, I., 1984. Signos asociados a hocicos animales en el Arte Paleolítico [Signs associated with animal muzzles in Palaeolithic Art]. *Veleia* 1, 7–24.

Bégouën, H., 1939. Les bases magiques de l'art préhistorique [The magical foundations of prehistoric art]. *Scientia* 33(65), 202–16.

Bégouën, H. & H. Breuil, 1958. *Les Cavernes du Volp. Trois Frères, Tuc d'Audoubert à Montesquieu-Avantès (Ariège)* [The Volp caves. Trois Frères, Tuc d'Audoubert at Montesquieu-Avantès (Ariège)]. Paris: Arts et Métiers Graphiques.

Beltrán A., 1982. *De cazadores a pastores. El arte rupestre del Levante español* [From hunters to shepherds. Cave art in the Spanish Levant region]. Madrid: Ediciones Encuentro.

Blasco Bosqued, M.C., 1974. La caza en el arte rupestre del levante español [Hunting in the rock art of eastern Spain]. *Cuadernos de Prehistoria y Arqueología* 1, 29–55.

Breuil, H., H. Obermaier & W. Verner, 1915. *La Pileta a Benaoján (Málaga)* [La Pileta to Benaoján (Málaga)]. Mónaco: Institut de Paléontologie Humaine, Fondation Albert-I Prince de Monaco.

Brøgger, A.W., 1925. *Det norske folk i oldtiden* [The Norwegian people in ancient times]. Oslo: Instituttet for sammenlignende kulturforskning.

Brusgaard, N.Ø., 2019. *Carving Interactions: Rock art in the nomadic landscape of the Black Desert, north-eastern Jordan*. Oxford: Archaeopress.

Brusgaard, N.Ø. & K.A. Akkermans, 2021. Hunting and havoc: narrative scenes in the Black Desert rock art of Jebel Qurma, Jordan, in *Making Scenes: Global perspectives on scenes in rock art*, eds I. Davidson & A. Nowell. New York (NY): Berghahn, 134–49.

Cartailhac, E. & H. Breuil, 1906. *La Caverne d´Altamira à Santillana près Santander (Espagne)* [The Altamira cave in Santillana near Santander (Spain)]. Monaco: Imprimerie de Monaco.

Cazals, N., 2005. Le début du Magdalénien de part et d'autre des Pyrénées. Quelques réflexions au travers des techniques de taille et des modes d'exploitation des ressources [The early Magdalenian on either side of the Pyrenees. A few thoughts on cutting techniques and ways of exploiting resources], in *Territoires, déplacements, mobilité, échanges durant la Préhistoire. Actes du 126ème congrès national des sociétés historiques et scientifiques* [Territories, movements, mobility, exchanges during prehistory. Proceedings of the 126th National Congress of Historical and Scientific societies], eds M. Barbaza & J. Jaubert. Paris: CTHS, 295–309.

Chenorkian, P., 1996. *Pratique archéologique, statistique et graphique* [Archaeological, statistical and graphic practice]. Paris: Errance & Adam.

Clottes, J., 2010. *Les cavernes de Niaux: Art préhistorique en Ariège-Pyrénées* [The Niaux caves: prehistoric art in the Ariège-Pyrénées region]. Paris: Errance.

Clottes, J. & H. Delporte, 2003. *La grotte de La Vache (Ariège)* [La Vache Cave (Ariège)]. Paris: Éditions de la Reunión des Musées Nationaux.

D'Huy J. & J.L. Le Quellec, 2010. Les animaux «fléchés» à Lascaux: nouvelle proposition d'interprétation [The 'arrowed' animals at Lascaux: a new interpretation proposal]. *Bulletin Préhistoire du Sud-Ouest* 18(2), 161–70.

Delannoy, J.-J. & J.-M. Geneste (eds), 2020. *Monographie de la grotte Chauvet-Pont d'Arc 1: Atlas de la grotte Chauvet-Pont d'Arc*. Paris: Éditions de la Maison des sciences de l'homme.

https://doi.org/10.1017/S0959774323000471 Published online by Cambridge University Press

Delluc, B. & G. Delluc, 1989. Le sang, la souffrance et la mort dans l'art paléolithique [Blood, suffering and death in Palaeolithic art]. *L'Anthropologie* 93, 389–406.

Dodge, Y., 2006: *The Oxford Dictionary of Statistical Terms*. Oxford: Oxford University Press.

Fortea, J., 2005. Los grabados exteriores de Santo Adriano (Tuñón. Santo Adriano. Asturias) [The exterior engravings of Santo Adriano (Tuñón. Santo Adriano. Asturias)]. *Munibe* 57, 23–52.

García Guinea, M. & M.Á. Puente, 1982. El arte rupestre de la cueva de Micolón (Riclones, Santander) [The rock art of the Micolón cave (Riclones, Santander)]. *Sautuola* 3, 131–9.

Gjessing, G., 1936. *Nordenfjelske Ristninger og Malinger av den Arktiske Gruppe* [Nordenfjelske carvings and paintings of the Arctic Group]. Oslo: H. Aschehoug.

González Sainz, C., 2007. El tema del 'ciervo herido' en el arte parietal paleolítico de la región cantábrica. Evaluación iconográfica [The theme of the 'wounded deer' in Palaeolithic parietal art from the Cantabrian region. Iconographic evaluation]. *Veleia* 24–25, 305–27.

Helskog, K., 2012. Bears and meanings among hunter-fisher-gatherers in northern Fennoscandia 9000–2500 BC. *Cambridge Archaeological Journal* 22(2), 209–36.

Helskog, K., 2014. *Communicating with the World of Beings: The World Heritage rock art sites in Alta, Arctic Norway*. Oxford: Oxbow.

Hesjedal, A., 1992. Veideristninger i Nord-Norge; datering og tolkningsproblematikk [Road carvings in northern Norway; dating and interpretation problems]. *Viking* 55, 27–54.

Jordá, F., 1975. La sociedad en el arte rupestre levantino [Society in Levantine rock art]. *Papeles del Laboratorio de Arqueología de Valencia* 11, 159–84.

Langlais, M., A. Sécher, S. Caux, V. Delvigne, L. Gourc, C. Normand & M.S. de La Torre, 2016. Lithic tool kits: a metronome of the evolution of the Magdalenian in southwest France (19,000–14,000 cal BP). *Quaternary International* 414, 92–107.

Lefebvre, A., A. Marín-Arroyo, E. Álvarez-Fernández, *et al.*, 2021. Interconnected Magdalenian societies as revealed by the circulation of whale bone artefacts in the Pyreneo-Cantabrian region. *Quaternary Science Reviews* 25, 106692.

Lejeune, M., 2000. La chasse dans l'art préhistorique [Hunting in prehistoric art]. *Anthropologie et Préhistoire* 111, 410–15.

Leroi-Gourhan, A., [1965] 1971. *Préhistoire de l´Art Occidental* [Prehistory of western Art]. Paris: Éditions d'art Lucien Mazenod.

Leroi-Gourhan, Arl. & J. Allain, 1979. *Lascaux Inconnu* [Unknown Lascaux]. Paris: Centre National de la Recherche Scientifique.

Lewis-Williams, D.J., 2002. *A Cosmos in Stone: Interpreting religion and society through rock art*. Walnut Creek (CA): AltaMira.

López-Montalvo, E., 2018. Hunting scenes in Spanish Levantine rock art: an unequivocal chrono-cultural marker of Epipalaeolithic and Mesolithic Iberian societies? *Quaternary International* 472, 205–20.

Lorblanchet, M., 1995. *Les grottes ornées de la préhistoire. Nouveaux regards* [Decorated caves in prehistory. New perspectives]. Paris: Errance.

Lorblanchet, M., 2001. *La grotte ornée de Pergouset (Saint Géry, Lot): un sanctuaire secret paléolithique* [The decorated cave of Pergouset (Saint Géry, Lot): a secret Palaeolithic sanctuary]. Paris: Maison des Sciences de l'Homme.

Lorblanchet, M., 2010. *Art pariétal. Grottes ornées du Quercy* [Cave art. Ornate caves of Quercy]. Rodez: Rouergue.

Magnus, B. & B. Myhre, 1986. *Forhistorien. Fra jegergrupper til høvdingesamfunn* [Prehistory. From hunter groups to chieftain communities]. (Norges historie 1.) Oslo: Cappelen.

Mikkelsen, E., 1977. Østnorske veideristninger—kronologi og økokulturelt miljø [East Norwegian road carvings – chronology and ecocultural environment]. *Viking* 41, 147–201.

Moure, A., 1990. Fauna y medio ambiente en el arte rupestre paleolítico [Fauna and environment in Palaeolithic rock art]. *Boletín del Seminario de Estudios de Arte y Arqueología* 56, 38–52.

Quiles, A., H. Valladas, H. Bocherens, *et al.*, 2016. A high-precision chronological model for the decorated Upper Paleolithic cave of Chauvet-Pont d'Arc, Ardèche, France. *PNAS* 113(17), 4670–75.

Ranta, M., P. Skoglund, T. Persson & J.M. Gjerde, 2020. Hunting stories in Scandinavian rock art: aspects of 'tellability' in the north versus the south. *Oxford Journal of Archaeology* 39(3), 228–46.

Reinach, S., 1903. L'art et la magie á propos des peintures et des gravures de l´âge du renne [Art and magic: paintings and engravings from the Reindeer Age]. *L´Anthropologie* 14, 257–66.

Rivero, O., 2010. La movilidad de los grupos humanos del Magdaleniense Medio de la Región Cantábrica y los Pirineos: una visión a través del arte [The mobility of Middle Magdalenian human groups in the Cantabrian region and the Pyrenees: a view through art]. PhD dissertation, Universidad de Salamanca.

Rivero, O., 2020. El arte prehistórico [Prehistoric art], in *Prehistoria de la península ibérica* [Prehistory of the Iberian peninsula], eds E. Álvarez-Fernández, A. Blanco & O. Rivero. Salamanca: Universidad de Salamanca, 211–323.

Ruiz López, J.F., 2009. Cazadores y presas: simbolismo e interpretación social de las actividades cinegéticas en el arte levantino [Hunters and prey: symbolism and social interpretation of hunting activities in Levantine art]. *Archaeobios* 3, 104–26.

Sauvet, G., 2019. The hierarchy of animals in the Paleolithic iconography. *Journal of Archaeological Science: Reports* 28, 102025.

Sauvet, G., J. Fortea, C. Fritz & G. Tosello, 2008. Echanges culturels entre groupes humains paléolithiques entre

20.000 et 12.000 BP [Cultural exchanges between Palaeolithic human groups between 20,000 and 12,000 BP]. *Préhistoire, Art et Sociétés* 63, 73–92.

Sauvet, G., C. Fritz, J. Fortea & G. Tosello, 2014. Fluctuations des échanges symboliques au Paléolithique supérieur en France et dans le Nord de l'Espagne [Fluctuations in symbolic exchanges during the Upper Palaeolithic in France and northern Spain], in *Transitions, ruptures et continuités en Préhistoire* [Transitions, ruptures and continuities in prehistory], eds J. Jaubert, N. Fourment & P. Depaepe. Paris: Société préhistorique française, 403–15.

Sauvet, G. & A. Wlodarczyk, 2000–2001. L'art pariétal, miroir des sociétés paléolithiques [Cave art, a mirror of Palaeolithic societies]. *Zephyrus* 53–54, 217–40.

Sieveking, A., 1979. Style and regional grouping in Magdalenian cave art. *Bulletin of the Institute of Archaeology* 16, 95–109.

Simonsen, P., 1979. *Veidemenn på Nordkalotten,* vol. 3: *Yngre steinalder og overgang til metall tid* [Roadmen on the North Calotte, vol. 3: Neolithic and transition to metal age]. (Stensilserie B, Historie 17.) Tromsø: Institutt for Samfunnsvitenskap, Universitetet i Tromsø.

Skoglund, P., M. Ranta, T. Persson & A. Rédei, 2022. Narrative aspects of images of spear use in Scandinavian rock carvings. *European Journal of Archaeology* 25(2), 176–95.

Tilley, C., 1991. *Material Culture and Text. The art of ambiguity*. London: Routledge.

Tosello, G., 2003. *Pierres gravées du Périgord magdalénien. Art, symboles, territoires* [Engraved stones from the Magdalenian Périgord. Art, symbols, territories]. Paris: CNRS.

Trombe, F. & G. Dubuc, 1947. *Le centre préhistorique de Ganties-Montespan (Haute-Garonne)* [The Ganties-Montespan prehistoric centre (Haute-Garonne)]. (Archives de l'Institut de Paléontologie Humaine 22.) Paris: Masson.

Utrilla, P. & M. Martínez-Bea, 2005. La captura del ciervo vivo en el arte prehistórico [The capture of live deer in prehistoric art]. *Munibe* 57, 161–78.

Valladas, H., 2003. Direct radiocarbon dating of prehistoric cave paintings by accelerator mass spectrometry. *Measurement Science and Technology* 14, 1487–92.

Vialou, D., 1986. *L'art des grottes en Ariège magdalénienne* [Cave art in Magdalenian Ariège]. Paris: CNRS.

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