Grammatical Complexity in the Sanctuary Engravings at Les Trois-Frères

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Grammatical Complexity in the Sanctuary Engravings at Les Trois-Frères

In examining smaller sample sizes for the identification of the presence of a unifying grammar in cave art

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Abstract

The figurative depictions from the Magdalenian parietal art of Les Trois-Frères cave have been used as a small investigative sample to analyse the presence of grammatical structures that may underpin the 97 animal representations from the four panels studied. A database of measurements was created for the anatomical dimensions of each representation and their respective categories of species, orientation, behaviour, panel and completeness. Very few combinations of co-occurrences that would have constituted a grammatical structure were found through a panel-by-panel analysis of the data. The dominant trends overall were that most were engraved by artists/authors who had a dominant right hand. This included both instances of anthropomorphs (one of which being the famous 'sorcerer') and dangerous or powerful beings depicted throughout the panels (bear and rhinoceros). Because grammar could not be found through statistical analysis, an alternative hypothesis as to what produced variations in the cave's art was put forward, examining the engravings from a more aesthetic perspective. This introduced the idea that the negative space of a 'central animal' was being appropriated and respected by multiple depictions around it, putting forward the case that aesthetic interactions between animals were effecting multiple dimensions of their depictions.

Chapter 1 Introduction

The Upper Palaeolithic artistic cultures began some 45,000 years ago and ended with the arrival of the Holocene 12,000 years ago. These are defined by their realism and their technical and stylistic diversity – behavioural characteristics we still identify as quintessentially 'human' today. Towards the end of the 19th century, caves were uncovered, revealing the artistic expression of little known cultures from deep prehistory, localised in the Franco-Cantabrian region (between France and Spain). Doubts concerning the authenticity of the work undermined the study of 'cave art', which intensified and modernised to a more pragmatic approach from the middle of the last century. Cave environments allow archaeological preservation as they are stable enough to retain the pigments and shallow engraving techniques employed in making parietal art from this period. The majority of the examination of this art is localised to these subterranean galleries and chambers. The Volp caves are a collection of caves joined together by such galleries and passages. They have frequently been the subject of academic attention due to the intriguing relationship between each of its three sister caves, within which is the cave of Les Trois-Frères.

Les Trois-Frères is the focus of this investigation – more specifically, the engravings found in the most abundantly decorated chamber in the cave, known as 'the sanctuary'. This chamber has the highest concentration of parietal engravings from the Magdalenian period (c.17,000 – c.12,000 cal BP) anywhere in Europe, becoming a rich resource for study. Their localised and relatively detailed nature provides a perfect subject for intense analysis into the presence of grammatical structures within Upper Palaeolithic cave art. The depth of study was inhibited by lack of access to the site. Thus this investigation is wholly reliant on literature resources which contain their own biases (discussed further in the literature review). For the engravings included in this investigation, their locality in relation to the wider morphology of the cave and their spatial organisation is described. The engravings from the sanctuary chamber are available for study because of published tracings drawn by Henri Breuil who dedicated many seasons to carefully recording the walls' engravings (Lawson 2012:80). To minimise

any subjective interpretation of these engravings by Breuil, further analysis was undertaken to certify the accuracy of these tracings, comparing them to the art they represent. It concluded that only very minor corrections needed to be made, localised in areas of the cave not covered in this investigation (Bégouën & Clottes 1987:181).

1.1 Order

The investigation in this thesis is based on a systematic and statistical analysis of mural cave art from the Magdalenian. (The details of which and previous parallel studies are explored in the next chapter.) Analysis of this kind is focused on assessing whether order can be extracted from sample data which appears seemingly random. In order to find order, one must have an understanding of what 'order' means in the context of art and, more broadly, visual psychology. Symmetry, as an example of order, has been the subject of archaeological research by Derek Hodgson (2011) who examined the use of symmetry as an aesthetic tool to add beauty to worked material and its origins as part of the hominin cognitive repertoire. However, less evident examples of order can be defined in behavioural terms as actions that are set on a predictable trajectory, and only with perceived obstacles that impede its advance does that ordered predictability terminate and reset. An example from the natural world illustrates this point further: the aim of a prey animal knowing that it is being pursued will navigate across its environment in the most 'dis-orderly' fashion in order not to give its predator any pattern through which it may predict the prey's behaviour and trajectory (Gombrich 1979:2,3).

The characteristics that define orderly behaviour are the same when referring to 'order' in visual culture. But what is apparent is that throughout different artistic cultures, both extinct and extant, the level of order and pattern is subject to drastic variation. The extinct visual culture that will be studied in this thesis is parietal art from the Magdalenian period. How it relates to order is complicated by the multi-faceted nature of such art: in broad subject matter it is predictable (dominated by large herbivores), as it is in artistic style, but when studied on a more analytical level less order can be discerned.

For this investigation I will follow my own definition of order to appropriately align oneself with the research material: order is the repetition of convention in the themes depicted, and particularly in the manner in which they are depicted, e.g. size, orientation, stylistic characteristics, and little or no deviation from a definable norm.

This thesis examines how far we can understand Magdalenian art as orderly by studying engraved panels from one chamber of a particular decorated cave which is uniform in style, date, artistic technique and cultural affinity. This will allow for a manageable amount of parietal cave art to be studied as a way of assessing the presence of 'order' in cave art as a whole. The importance of studying the art produced by one small body of people from a particular culture is that variability in depiction can be examined as pertaining to one culture's point of reference for grammar, structure and order. If the art was produced by multiple cultures then the art would contain an indeterminable amount of grammatical variations, making the search for a unifying structure unachievable.

In his book about the sense of order and patterns in visual culture (ibid.), Gombrich suggests that the way an observer understands the visual world is firstly through means of 'groping before grasping or seeking before seeing'. But the means by which one can comprehend visual data is similar to making what is unknown and random something known and predictable: it is guided by an 'inbuilt sense of order' (ibid.:5). Although this sense of order refers to the comprehension of the visual world, it informs us about its explicit influence on schematic renderings of the visual world found in visual cultures. In this vein, one can examine how a culture projects the order in the natural world through their art. I am examining the art to seek order derived from the artist themselves – in this case grammatical

structure. The artist expresses order from the world in their work and so too am I producing work that requires the search for order in theirs. Furthermore, the Magdalenian artist processes the random input of their natural world to produce order. I mirror this endeavour by way of mediating their seemingly random depiction of animals to a more comprehensible sense of order and structure. This leads to a structuralist interpretation of the nature of parietal cave art.

Deciphering order from artistry is mostly intuitive in its nature and does not appear to be analytical in its approach. Therefore, one needs structure to the analysis of Les Trois-Frères' engraved panels. I am trying to be as objective as possible when analysing the data. Therefore, in order to avoid influencing it with preconceived ideas concerning the art, a data-analysing software has been used for primary analysis (see Chapter 6 Methodology (page 38)).

This investigation shall artificially run the otherwise cognitive process of discerning the level of order and organisation from an arbitrary visual input. The visual data (Magdalenian parietal cave art) will be translated into a dataset appropriate for analysis by computer algorithms and correlation formulas.

Prehistoric cave art and its accompanying themes and styles have been found across a vast time frame and pan-European scale. On one level, this may encroach on the potential to uncover a fixed or unifying structure within this small sample. On another level, the expanse and chronology of cave art can be viewed favourably, with these characteristics supporting an idea that it was created and viewed for spiritual or religious reasons. This has been poetically put by Leroi-Gourhan, likening the iconography of cave art as that of more recent religious institutions: 'in the life of a society models of weapons change very often, models of tools less often and social institutions very seldom, while religious institutions continue unchanged for millennia' (Leroi-Gourhan 1968:48; Sieveking 1979:20). And, just like in religious institutions, the members are well-versed in the iconographic significance of its images. However, the difference between the iconography of a religious sects and cave art lies not only in the lack of an explicit and repeated semiotic motif (i.e. Christianity's affiliation with the image of a cross) but in the complex and often haphazard manner in which the art may relate to an overall cosmological idea. The scope of this thesis cannot accommodate discussion on a sense of order in relation to cave art as a whole, but it is worthy of a brief inclusion in order to contextualise the dataset.

1.2 Looking at the art

People who look at cave paintings today see them as the most significant parietal art form found in the prehistoric archaeological record. Its visual dominance and artistic style chimes with modern-day aesthetics. Due to the preference for painted art, engraved art, like that found at Les Trois-Frères which is equally as rich a source of realistic imagery, is overlooked. Reasons for this perhaps relate to the visual discretion of figures engraved into parietal clay layers as opposed to the application of pigment to decorate them. The level to which an artistic medium 'stands out' is often seen as an indicator to the level of its importance.

However, art's significance can also be amplified by its size or scale. This is because size corresponds to visual dominance. However, this works only with artistic mediums wherein size can be easily understood and appreciated. In caves like Les Trois-Frères, where representations of animals and anthropomorphs have been engraved into the cave walls, it is difficult to see the art even in well-lit circumstances, existing more as an art form that one seeks rather than immediately admires. Therefore, engraved art does not accommodate the observer to the same extent, becoming a visually restricted rather than dominant artistic form. Interestingly, however, there is significant variation as to the scale these animals have been engraved on, suggesting determining factors of scale are being considered that do not pertain to visual dominance. These shall be studied by measuring the anatomical features of individual animals engraved on the walls of Les Trois-Frères and recording them

in a spreadsheet for analysis. How the aforementioned visual discretion of these engravings affect the observer and how their size shall be measured is discussed in Chapter 5 *Methodology* (page 38). Alternative factors as to the variation of individual animal sizes are hypothesised in the discussion.

Once an appropriate amount of statistical analysis has been performed on the dataset, it is then necessary to discuss the findings, focusing on any signs of grammatical structures that can be found through the combinability of one variable with another. An alternative hypothesis will also be examined that follows a more visual – rather than statistical – analysis of the source data. This information will culminate in the conclusion to determine the extent to which grammatical structuring is evident in the sample data through statistical analysis, and crucially whether it can be determined through other methods of examination.

1.3 Summary

The art at Les Trois-Frères cave is going to be examined in conjunction with my definition of order: repetition of convention in the themes depicted, and particularly in the manner in which they are depicted. The aim of doing so is not to 'decode' the 'linguistics' of cave art, but to address the question of whether variations in cave art depictions, examined on a localised scale, can exhibit a form of recurring principles that indicates they were made with a sense of order. In this sample, the art is visually discrete which may affect such notions of unifying grammar throughout different panels, but the following chapters will cover any panel-dependent variable.

Chapter 2 Literature review

2.1 Introduction

Upper Palaeolithic cave art, which in this essay is defined by any painting, drawing or engraving that modifies a cave's interior wall (otherwise known as 'parietal' art), was a practise that intensified in production at the start of the Upper Palaeolithic some 40,000 years ago in Western Europe.
With over 350 (Pettitt & Pike 2007:28) Upper Palaeolithic decorated cave sites discovered in Europe to date, cave art '[…] forms the most robust set of visual culture for exploring the early evolution of human visual systems' (Sakamoto *et al* 2020). Moreover, because of its abundance as well as supposed fidelity to the social (Conkey *et al* 1997) as well as cognitive (Helvenstone & Hodgson 2010) components of Palaeolithic life, it has been used to vicariously examine the character of the human past. Although cave art research has been assigned the task of answering archaeological questions pertaining to the evolution of culture, symbolism (Garate *et al* 2020), aesthetics (Leroi-Gourhan 1993) and religion (Lawson 2012:217-8), some anthropological as well as visual-psychological approaches have been called upon to analyse the complex nature of cave art. There are many ways one can examine cave art – either in relation to components within the art itself or to the wider archaeology of the cave/culture – which requires a subdivision of the material for analysis. This investigation has isolated a collection of engravings from one particular cave – Les Trois-Frères – as a sample for using analytical software to try to uncover the 'thematic grammar' that may underlie and structure the specific character of those animal representations.

However, the amount of decorated caves and the abundance of its studies and related theories have been heavily explored multiple times in encyclopaedic publications on the subject (Bahn 1998; Clottes 2013; Lawson 2012; Ucko & Rosenfeld 1967; Wymer 1987 (to name but a few)). Stylistic analysis attempting to create a chronological sequence of cave art and historic development of its theories are equally reiterated throughout these publications. These have been discussed both for defining the art's character as well as in relation to other behaviours. The literature studied in this investigation are those relating exclusively to cave art, although its discussion is complimented by a small amount of further reading.

2.2 Cave art: chronology and evolution

To understand the data used in this investigation, it is important to contextualise where it fits into cave art's expansive timeline which stretches back to even before the arrival of modern humans into Europe some 50,000 years ago (see below). However, the comprehension of this timeline (although not its general trajectory and evolution) is, when examined closely, dependent on a string of biased selection and controversial dating methods. Direct dating, although gaining anchorage on an exact time period for non-chronometric, relative dating methods (through style for example), is extremely selective. Moreover, the reliability of direct dates can be misleading. By 2007, 'only some 61 images from some 19 caves out of over 350 known decorated caves can be said to be at all reliably dated' (Pettitt & Pike 2007:28).

The progression of cave art through Upper Palaeolithic cultures exists in academia and beyond as a well-accepted rule-of-thumb, with the earliest examples appearing as sporadic non-figurative art forms from which developed, over considerable time (some 30,000 years), into the highly realistic representational cave art of the later phases. However, measuring the age of cave art through stylistic and scientific methods alike prove to be pot-holed by issues and the timeline is deceptively unstable. For example, the stylistic dates obtained from art engraved into a layer of parietal clay deposit (known as petroglyphs) is very difficult to anchor to scientific dates. This is because, although U-series dating (see below) can be applied to the build-up of calcite over the engravings, no such dates have been

produced for this artistic medium due to the lack of organic materials in pigments or engravings that would be amenable to radiocarbon measurement (Pettitt pers comm 2021). On the other hand, carbon found in paint pigments can be analysed, which makes pictographs (painted cave art) a more reliable source for direct dating techniques. The study of pictographs has also enabled archaeologists to discover other aspects of Palaeolithic artistry, such as the recipe sophistication and distribution of pigments (studied in Lorblanchet 1990). However, dating petroglyphs does not have any such material to analyse, being the removal – not addition – of material. Furthermore, if one bypasses this issue by obtaining scientific dates for artefacts taken from stylistically contemporary archaeological layers under or in the vicinity of engraved art (known as indirect associative dating (Pettitt & Pike 2007:29), the comparison relies on style seriation and thus no direct dates can be obtained. This is true also when non-chronometric (indirect) dates rely on comparing a cave's art style to another's who, in turn based their dates on non-chronometric style seriation. This inevitably produces a 'family tree' of multiple caves dated on a theoretical chronology (Von Petzinger & Nowell 2011). When the cave in question – Les Trois-Frères – yields no datable archaeology in relative proximity to its art, indirect dating methods cannot be used (for more information on Les Trois-Frères, see archaeological context). Although the apparent lack of archaeology would demonstrate restricted activity in that area, the sanctuary chamber has little evidence to compliment the human endeavour evident on its walls. This is discussed further in later chapters (see section 3.4 *Archaeological context* on page 31).

Although stylistic analysis accomplishes only a relative date for art that can be compared across decorated cave sites, it is the only way to date material that is otherwise undatable. Even then, it is used to demonstrate the shortcomings of certain dating techniques, most evident in the case of Chauvet's cave art (Jouve, Pettitt & Bahn 2020). Leroi-Gourhan developed a typology of cave art based on a chronological development in style. This was initially practised by Henri Breuil but the former academic's work gained more merit. Leroi-Gourhan's stylistic timeline has been used as the yardstick in stylistic dating, although the sequence has been adjusted in light of more recent direct dates (figure 4). Of course, one fundamental issue with this method of dating is that 'using stylistic seriation assumes that change in style is a function of time […]' (Hyder 1989:4; Rainey 2001:84). The timeline Leroi-Gourhan developed allocated the first figurative representations, appearing as abstract heads and lines of animals, to the first style: 'style I' in the Gravettian. Different styles of the proceeding periods were numbered accordingly all the way to the last phases of cave art in the Magdalenian (ending some 12,000 years ago) (style IV), which consist of complete schematic depictions of highly realistic animals in sometimes twisted perspective. The engraved animal depictions found deep in Les Trois-Frères cave have been dated stylistically to Leroi-Gourhan's final phase (style IV). Artistic style has been verified with scientific dating methods to belong to a certain chronology where the more realistic and complete depictions appear out of the development of earlier, less 'sophisticated' styles. Because conflicting age estimates occur when dating cave art through a scientific (chronometric) or intuitive (non-chronometric/stylistic) approach, an appropriately sturdy timeline of cave art does not exist. However, as proposed by Von Petzinger and Nowell (2011), having a stylistic seriation grounded in the observations of cave art style whose age is known through chronometric dating would be the most pragmatic means of reaching a meaningful chronology.

Between stylistic dating and chronometric dating, the latter is heavily dependent on the material that it dates: Uranium-Thorium dates are acquired from analysing the minerals overlaying art, whereas AMS carbon (C14) is a dating method built for terminating the age of organic binding agents and pigments in paint. The development of this new, direct approach to dating cave art – which began with C14 in the late 1980s (Ilger *et al* 1995; Valladas *et al* 2006) – was seen as hailing in a new 'post-stylistic era' (Lorblanchet 1990), relieving archaeologists from the considerable potholes of relative, non-chronometric dating methods. However, stylistic dating is identified as an adequate dating method to this day (see above), that is, until certain assumptions are proved wrong by scientific dates

(Pettitt & Pike 2007:30). But these direct dates did play a vital role in reorganising the established timeline of Europe's early parietal art.

Of the two major dating methods, Uranium-Thorium (otherwise known as 'U-series') has been seen as an improvement on the C14 method, the latter exhibiting a number of different complications (see Pettitt & Pike 2007). The former does not. It requires analysis of the more chronologically-verifiable calcite formations that grew before and then overlay anything on the cave walls. Because one can date the material both underneath and overlying the art, it improves accuracy when establishing an age, allowing archaeologists to anchor art within a specific timeframe between the minimal and maximum date. Furthermore, because this dating technique could date inorganic material, it opened the means to date extremely early ochre cave art – an inorganic material that has been noted for its use in early symbolic behaviour.

2.2.1 *Pre-Aurignacian artistry*

The use of ochre oversaw the transition between hand stencils (that were created through engagement with the body, known as 'body-extension art' (Sakamoto *et al* 2020)) and the beginnings of abstract schematic symbols (suggesting increased interaction with mental concepts). The most notable application of U-series dating was in a series of Spanish caves decorated with many ochre signs, the most famous of which being La Pasiega that demonstrated the occupants were capable of depicting a variety of schematic shapes in ochre from arranged clusters of dots to ladder-shaped structures at a time before anatomically modern humans colonised Europe (Hoffman *et al* 2018). These signs were painted by hand all on a single panel. Art from other sites including Maltravieso and Ardales (ibid.) were dated using the same technique which producing ages that significantly predate the earliest signs of modern humans in Europe by some 20,000 years. What this evidence makes indisputable is that the authorship of the earliest European cave art was other than the assumed Anatomically Modern Humans (AMHs). Although there were previous claims for the Neanderthal authorship of early cave art (Marquet & Lorblanchet 2003; Rodríguez-Vidal *et al* 2014), these discoveries have, as the article concludes, '[brought] closure to this debate', ending the widely held belief cave art is an activity exclusive to the behavioural repertoire of AHMs (Henshilwood & d'Errico 2011). The decorated cave of Chauvet was dated back to 30,000 cal BP (its date is disputed due to the reliance on indirect AMS carbon dating (Pettitt and Bahn 2015)) which has been influential in sparking debate over the stylistic chronology of parietal cave art. With this in mind, the minimum dates obtained from the Spanish caves appear to extend the first tentative symbolic parietal art forms further back to around 51,000 years ago (Hoffman *et al* 2018:914), even before the expansion of AMH into Europe (45-40,000 cal BP (Zilhão & d'Errico 1999; Higham *et al* 2014).

2.2.2 *The Aurignacian*

The first archaeological period that can exhibit the earliest forms of figurative parietal cave art was the Aurignacian. Originally, however, figurative art that came to dominate artistic produce was exclusively found in sculptural form, the earliest being the 'Lion Man' from Stadel cave dating back to 40,000 years ago (Cook 2013:30). The production of figurative statuettes found in cave sites such as Vogelherd and Hohle Fels may predate the early schematic depictions on cave walls but they come to mirror it in subject matter. Animals and the exaggerated sexually dimorphic female forms that were carved as figurative statuettes were being made at the same time as increasing effort was being put into manipulating material for the purposes of personal adornment. Examples include perforated teeth and polished ivory beads (Lawson 2012:124), but artistic endeavours extend to a broader catchment of simple mark-making on bone fragments. These simple linear marks were the first things to be drawn up on a larger scale on cave walls. Often discovered in the same cave as their portable counterparts, these parietal art forms mimicked these abstract designs – as is the case in

Geißenklösterle site in South-West Germany (Lawson 2012:216). How far, therefore, can these designs be termed 'art' when they appear to have closer affinity to 'mark-making' than traditional views of schematic design (Pettitt pers. Comm. 2021)?

Figure 1: An early figurative depiction of a large bovine depicted in profile (after Lawson 2012:121).

This matter aside, however, there is large regional diversity throughout European cave art at this time and in other caves, in France in particular, 'figurative rock art had already developed' (Lawson 2012:126). An example of this is a figurative depiction of a bull in profile with a minimum date of 37,000 cal BP (Lawson 2012:121) (figure 1). This very early depiction of a large bovine animal in profile, exhibiting both its dorsal and upper ventral line, displays the core qualities of cave art that would persist throughout the Upper Palaeolithic, with equestrian animals additionally represented as a majority alongside bovines. The subject matter was to be continually revisited in different styles throughout the next twenty millennia, with animal depictions in cave art almost always in profile. Reasons for this strict profile view have been discussed in relation to the idea of saliency: animal taxon is more easily recognised when the most salient features are presented (Meyering 2021). With the arrival of characteristic cave art and its immense longevity, it is appropriate to mention the idea that a concomitant arrival of an underlying structure (whether grammatical or otherwise) must have been at the core of such an artistic tradition, echoing Leroi-Gourhan's analogous way of connecting cave art and religious institutions above.

As mentioned previously, Chauvet cave has been the focus of dispute over the validity of its scientific dating and therefore, due to its stylistic complementarity to later cave art of the late Magdalenian period, has been allocated (tentatively) alongside them in this chronology. The earliest figurative cave art depictions were 'overwhelmingly dominated by prey animals such as horse, bovids and cervids' (Sakamoto *et al* 2020), reiterating the need to re-examine the date of Chauvet's art which exhibits multiple representations of predatory animals.

2.2.3 *The Gravettian*

Not only was there an expansion in the technique employed in producing cave art by the Gravettian, but there was also a surge in the number of cave sites whose art has been (less contentiously) dated to this period (Lawson 2012:131). The material homogeneity found across Europe in this period has

led some to believe that the Gravettian was the first 'pan-European' culture of the Palaeolithic, overriding the more localised and detached heterogeneity of material cultures in the preceding Aurignacian (Maier 2017).

The art of the Gravettian (between 33-26,000 cal BP) was typified by the amount of Venus figurines, the first of which appear towards the end of the Aurignacian. Evidence of this type of human depiction that is characterised by the exaggeration of female genitalia, breasts and buttocks were found mainly in the portable artefacts on both open air and cave sites. However, at the site of Abri de Laussel in Périgord, France, a boulder was unearthed during excavations (which previously would have been part of the wall) that depicted the same subject but as a large limestone carving. Carving a figure in relief demonstrates that caves were playing host to an increasingly rich repertoire of human artistry. This figure in particular is front on, with her head in profile, raising what appears to be a horn or cornucopia in one hand. Other blocks from this cave as well as others (Delluc and Delluc 1991) show that animals were also the subject of carving into rocks, suggesting this female figure was probably part of a larger frieze that existed across the cave wall. The Gravettian also has the earliest evidence of engravings: the French cave site known as 'Pair-non-Pair' was excavated in the late 19th century and when they reached a layer with Gravettian material, the excavators found 'a mass of images of mammoth, bison, ibex, and horse engraved into the walls' (Lawson 2012:131). It is interesting to note that even in the earliest instance of engraved art the subject matter was much the same as that in Les Trois-Frères which was produced in the Magdalenian (some 15,000 years later). The use of the form of the hand as part of the image-making process has also been dated to the later phases of this period, hand stencils (a technique where paint is either blown over or applied to the hand on a wall, leaving respectively negative or positive paint prints) being found in multiple cave sites throughout France and Spain. It would appear that these art forms are found in caves which have evidence of multiple phases of artistic production, of which hand stencils appear to be the earliest. Peche Merle is the most fascinating example of the use of hand stencils that compliments a stylistic depiction of two horses. In this cave, pareidolia in a natural rock was used to form the silhouette of one of the horse's heads and with its mane and coat pattern painted by a blown paint technique, it creates a multi-media representation (figure 2). The hand stencils themselves are found across the top and lower parts of the panel, clearly arranged with a sense of order and spacing (Bahn 1996b).

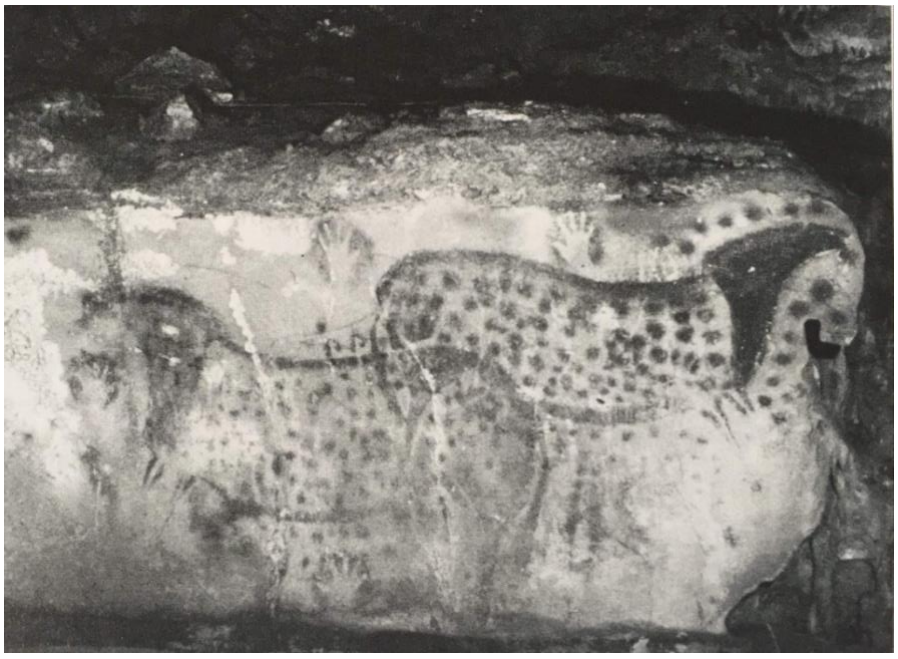


Figure 2: The two horse depictions at Peche Merle cave with the hand stencils spaced orderly around them. The rock's formation can be seen to have outlined the head of the right horse, exhibiting an example of pareidolia (after Lawson 2012:133).

Although the examples mentioned above prove the application of pigments being blown onto the walls as well as the use of carving and engraving techniques, painting was also used to create schematic representations of animals, mostly focusing on single-pigment outline depictions (Lawson 2012:135). However, a more colourful picture of the evolution of schematic depictions in painted and engraved cave art from the Gravettian comes from Gargas cave in the Pyrenees. Here, the repeated overlay of paint and engravings means one can build a chronological picture of the styles employed. The earliest engravings mostly comprised of large herbivores such as ibex, aurochs, bison and reindeer all depictions of which focus on their head and neck, with little inclusion of the lower part of their bodies. This was succeeded by a greater variety of taxa depicted in the second phase – inclusive of horse and birds. There was more attention to realism, the body was drawn as a more complete form and facial features within the outline of the head were incorporated.

The third and final phase, dating probably to the start of the Solutrean, was typified by the enlargement of animal depictions and the introduction of scraping to enhance the colour contrast and the width of the engraved line. Interestingly, the third phase cause there to be a reduction in the animal taxon depicted and there was a slight recapitulation back to incomplete engravings (Garate *et al* 2020). Abstract symbolism have been found on cave walls which dates to before the succeeding Solutrean, evident in finger-fluting, dots, aviform symbols and linear marks (ibid.:22), however dating them is contentious as they may derive from earlier, Aurignacian activity (Lawson 2012:135; Fortea Pérez 2005:93).

2.2.4 *The Solutrean*

The Solutrean industry (starting at c. 27,000 cal BP) pre-dates the peak of the Last Glacial Maximum (LGM), with its later phases overlying it – seen in the archaeological record as the more characteristic period of the Solutrean for its distinctive tool assemblages. In terms of its parietal art, the Solutrean unfortunately have few direct dates to pinpoint its artistic chronology on a scientific basis. However, the French site of Le Roc de Sers is an example of cave art that can be directly dated to the Solutrean, where blocks of a fallen frieze were found buried in an archaeological layer of Solutrean date. These blocks display a sample of the style and subject matter usual to Solutrean cave art. The rocks date to around 19,000 cal BP and show a number of large herbivore species 'all with large bodies and disproportionately short legs' but also what appears to be the figure of at least one man wielding a spear (Lawson 2012:143). These were made by either engraving, carving or painting techniques and are thought to be a part of a composite frieze. The Gravettian tradition of carving into limestone was developed in the Solutrean and it is evident that there was a deeper understanding of the artistic and aesthetic potential of such techniques in the creation of 'bas-reliefs'.

Figure 3: A Solutrean 'bas-relief' engraving of two ibex fighting (fragment O), showing how knowledgeable and attentive these artists were to the behavioural ecology of the animals they depicted (photo credit: Hitchcock 2019).

There also appears to have been more deliberation and foresight in the making of parietal art forms in this period, evident in apparent 'sketches' carried out prior to carving and engraving (Tymula 2002). Art from Le Roc de Sers can also prove that the Solutrean has the earliest evidence of art (if one was to discount Chauvet (Pettitt & Bahn 2015)) wherein animal figures were depicted engaging in highly animate behaviour (see figure 3).

This suggests that although animal imagery was consistently the subject of cave art throughout the Upper Palaeolithic, it was in the Solutrean that the artistic mind moved from not just animal depictions but to animals that exhibited zoomorphically accurate behaviours characteristic of their specific animal taxa. If Chauvet's art is of a later period, it would also suggest that predatory animal species were not introduced into cave art depictions, only to emerge first in later Aurignacian portable art in Germany, and in Gravettian art more widely. Abstract and non-figurative art was also painted in caves at this time, with the continuation of signs from preceding periods as well as the introduction of claviform-shape signs and it is thought that the earliest markings in Lascaux cave date from this period.

2.2.5 *Magdalenian*

The most exuberant examples of cave art date to the Magdalenian period, and the art is of such high quality it has often been seen as the first instances where man has mastery over aesthetics. This starts around 17,000 cal BP, at which time the cold conditions of the LGM had ameliorated, facilitating the expansion of Magdalenian groups out of their southern refugia. The temperatures gradually continue to rise throughout this period and, at around 12,000 cal BP, the dramatic warming of the continent brings forth the beginning of the Mesolithic era. The reason this period can boast such an array and vast amount of cave art is somewhat down to the fact that glacial conditions, which had previously deteriorated the surfaces of exposed rocks and cave entrances on which art was being made, did not return in Europe. This, coupled with a population growth (Lawson 2012:145), allowed cave art in the Magdalenian to both blossom materially and become preserved by favourable conditions archaeologically. This, therefore, gave the appearance that in the Magdalenian, art (and its associated cultural-social assets) flourished to a level not seen before. Cave sites beginning to appear in increasingly northern areas of Europe – recolonising Britain by 14,800 cal BP - is testimony to the population expansion and continental warming of this period.

In the early phases of the Magdalenian, the bas-relief forms continued from the late Solutrean and incorporated the exaggerated female form in some examples which was first applied to miniature sculptures in the Aurignacian but now found emerging as bas-relief sculptures from the fine-grain limestone bed rock at Le Roc-aux-Sorciers in France by the middle Magdalenian. Just as the interaction between artist and cave walls became increasingly sophisticated and dextrous, so too did the use of pigments, evident in polychrome images of bison at Altamira and the interesting coloured 'palettes' found at Lascaux (Lawson 2012:349). It is to be noted, however, that polychrome art is frequently the product of a palimpsest of reapplied pigment; most evident in Altamira's polychrome chamber where scientific dates were obtained (ibid.:149). Further examples of this suggest that within the Magdalenian a tradition of reworking or going over previous art had developed. Some dates can only provide us with a maximum date and so the earlier art underneath later reworking could even have been made by an earlier culture: El Castillo cave in Spain is an example that shows how Magdalenian people repeatedly revisited the cave over long periods (Cabrera *et al* 2001). In the middle Magdalenian the styles incorporated into cave art became more attuned to visual phenomena not previously recognised: twisted perspective and an attention to detail when depicting animals in contorted positions became a recognisable characteristic of art from this period. This was continually revisited in multiple examples of Magdalenian art and, as will be seen in later chapters, Les Trois-Frères cave shows that artists were able to depict large numbers of different animal behaviours and positions. All of which, however, are in profile and this rule is rarely ever broken throughout the Upper Palaeolithic.

Another interesting attribute which will be touched upon in a later chapter is that Magdalenian artists often fit animal bodies within pre-existing spatial structures, most evident in portable art. However, when examining other alternatives at the end of this thesis, there is evidence to suggest this characteristic spread across to more creative and aesthetic examples in parietal art.

It is in the later stylistic phases of the Magdalenian that Chauvet art has been allocated, displaying all the characteristics of art produced in this period including the heavily filled-in outline of the animals, ascribing incredible detail to their depictions. The diversity of abstract signs is most clear in the Magdalenian, with the example of Lascaux showcasing how many different forms had been created and were incorporated into the visual culture of that time.

2.3 History: discovery and approaches

The expansive knowledge, theories and public interest of cave art has been developing since the late 19th century, where the most influential discovery in the discipline was of Altamira cave. Beforehand, cave art was noted upon by different published academics but the art discovered in these cases were often too unimpressive to upheave people's view of the 'primitive' cultures which existed deep in the past. However, biblical doctrine had dictated that the model of the human past was to be closely aligned with the Christian faith by way of studying the world's history exclusively through written texts. Even the concept of 'prehistory' was not an accepted one until the latter part of the nineteenth century, where evidence from geological research started to propose a deeper and more complex timeline for the earth that was originally deciphered through studying ancient scripture. At the same time, flint tools were beginning to be reconsidered as evidence to investigate the age and stages of humans and their cultures. As the notion of geological stratigraphy was being understood, tools exhumed from deep layers could be recognised as much older than originally thought, through theories of superimposition and using geological time frames. When finding a buried object beneath a geological sediment, one may not be able to determine its precise age, but it is indisputably older than the sediment above.

This line of chronology by sediment superimpositions could not, unfortunately, date the art that was found on cave walls, thus their date and even authenticity was questioned. Moreover, at the beginning of the twentieth century it was upheld by academics whose opinions were based on ideas of cultural evolution, that those who made the tools were primitive and uncivilised. It was the general acceptance of this notion that lead many to dismiss and actively renounce 'primitive man's ability to achieve the level of artistic skill apparent on cave walls. This perspective is detailed in the academic disputes caused by the discovery of Altamira cave: when the discoverer – Sautuola – presented his findings to a professor at the University of Central Madrid, he in turn presented these to fellows at the Spanish Society of Natural History. The idea that art of such aesthetic merit was produced so early on in the established timeline of cultural development did not conform to the academically accepted notions at the time and therefore prohibited Altamira's art from being accepted as authentically prehistoric. Eventually, the painted bison on the ceiling of the Polychrome chamber were accepted to be of Palaeolithic date (then known as 'the period of chipped stone' (Lawson 2012:52)) tragically only after the death of Sautuola: the man who discovered the cave's art and constantly advocated for its authenticity died in 1888.

Gradually, archaeologists began to realise in the face of more pressing evidence, that the human past was more colourful than was expected. Cave art was beginning to gather more interest by the turn of the 20th century, which brought in a wave of new academic figures. Henri Breuil, the 'most influential authority on cave art for more than half a century' (Lawson 2012:59), was known to have considerable skill at drawing and therefore was recruited to trace the art of La Mouthe cave just 20 years after the death of Sautuola. Between 1902 and 1950, Breuil recorded huge amounts of cave art from different

cave sites, making the art comprehensible through his drawings (Fritz & Tosello 2007). This allowed the images made by Palaeolithic people to be circulated and published for appreciation and study across the world, elevating interest for cave art, both academic and public, even further. It was with the advent of yet more discoveries of archaeologically datable cave sites, where the evidence to certify the date of cave art became easier to prove (for example, the site of Sergeac found cave art sealed into a stratigraphic layer) that sceptics became aware their accusations were unfounded (Trigger 2015:155). In 1902, one of the academics who had vehemently argued prehistoric peoples were uncivilised and savage, wrote a short article finally accepting the authenticity for the date of Altamira's – as well as other cave's – art, including in the title 'I am guilty of being a sceptic' (Lawson 2012:64; Cartailhac 1902:354). From this point onwards, research into cave art continued without impediment and was even encouraged and funded by royal interest when Breuil met Prince Albert of Monaco which resulted in the Prince not only sponsoring the publication of Altamira's finds but also several other campaigns to record cave art for Breuil. These campaigns were to be 'under the banner of a fledging Institut de Paléontologie Humaine' (Lawson 2012:65) that would be established by Albert in 1910.

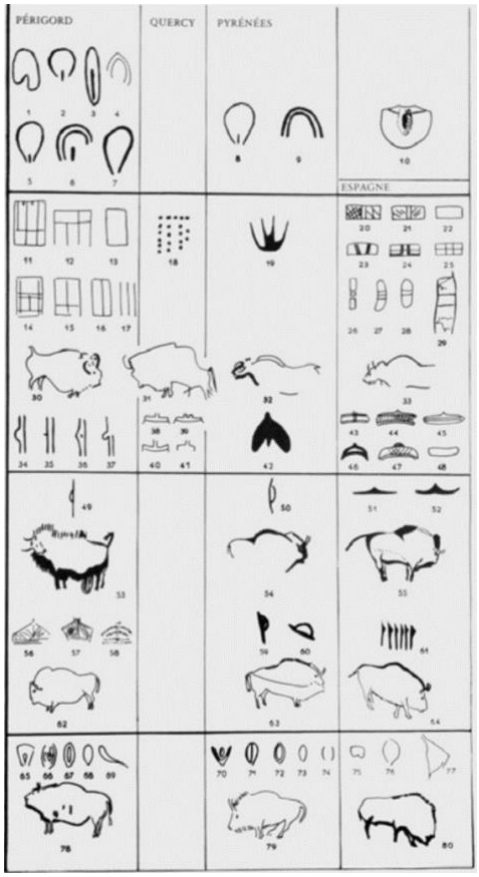


Figure 4: Leroi-Gourhan's chronology of cave art for the Perigord, Quercy, Pyrenees and Spanish regions (left to right) (after Leroi-Gourhan 1971).

Over the following decades, Breuil became the leading authority on cave art, drawing up the initial stylistic chronology of cave art that was then later improved upon by Leroi-Gourhan. By 1950, over a hundred decorated cave sites had been discovered and in 1956 Leroi-Gourhan began to systematically study Palaeolithic cave art (although not initially focusing on parietal examples) to further the understanding of its chronology (Lawson 2012:92), but would later turn to structuralist analysis, for which he would be best known (see analytical approaches to cave art below). Before the rise of structuralism in the 1950s, 'all interpretations were based on hunting magic and consequently the images were thought to have been accumulated at random on the cave walls' (Sauvet & Wlodarczyk 2008). However, the amount of decorated caves discovered by the mid-20th century gave Leroi-Gourhan as well as other prehistorians the material to embark upon extensive and more precise investigations into the nature of cave art as a whole. Leroi-Gourhan had enough material from so many decorated caves that he could create a timeline of stylistic development which has come to influence modern-day opinion of the chronology of cave art. The difference between his proposal and his predecessor's – Breuil – was that Leroi-Gourhan set down characteristics that would typify the art to a particular stylistic age. This was not a vague timeline from faint abstract depictions to realistic schematic scenes. Instead, he observed stylistic change and evolution with a lot of precision region by region, creating a gridded timeline (Leroi-Gourhan 1971) (figure 4) that is still cited in relation to archaeological finds today, rearranged slightly only when new scientific dating, developed in the latter decades of the 20th century, makes apparent the need for adjustment.

2.4 Analytical and theoretical approaches to cave art

After the initial acceptance of the antiquity of parietal cave art, those that studied it were mostly influenced not by observing what was present on cave walls but by rigid constructs of evolution and cultural progression. Cave art was, for many years, fetishised as being an artistic expression showing ancient man's preoccupation with primitive forces and superstition, seen in association with the aboriginal totemism beliefs (Reinach 1903; Ucko & Rosenfeld 1967:123-8 in Trigger 2014:155) – an ethnic group hunted by colonial forces. Therefore the state of cultural and biological superiority that was assumed by European colonialists over the native people in the lands of imperial expanse – an idea that morphed through time – was applied not only to cave art but to the archaeological and (to a lesser extent) anthropological discipline in the form of 'ethnocentrism'. This term describes a culture whose opinion of another's is determined by its own and must have been in part due to Europe's demographic expansion into foreign lands and thus partially replacing the native culture with their own, evidently superior one. As this mind set receded in the first decades of the 20th century with cultural relativism increasingly influencing academic thought (Boas 1887; Stocking 1982), attitudes towards prehistoric societies and 'uncivilised people' were less biased, allowing their interpretation to be based on a more systematic, analytical approach. This influenced both archaeology and anthropology, bringing the ideas and methods of 'hypothesis testing' from the sciences across to these humanity disciplines, no longer relying on colonial sentiments of cultural hierarchy.

Lévi-Strauss and Laming (later to be Laming-Emperaire) were the most influential academics in establishing a new approach in analysing cave art from a logical and scientific standpoint. Lévi-Strauss initially applied structuralism – that is, 'the individual units of any system have meaning only by virtue of their relation to one another' (Conkey 1989) – in an anthropological setting but then transposed the idea to parietal cave art, suggesting that there was an order or code that acted as the framework that wove the networks of symbols that could only be found by objective investigation. Laming's work, which furthered the ideas of Lévi-Strauss, stressed that, in order to find the framework underlying cave art, the art itself had to be studied through detailed inventories (Lawson 2012:211). Only then, she argued, could one studying the inventory see the figures as existing 'in relation to each other, the composition of a group, the deliberate superimposition, the associations of one group of animals with another, or the associations of signs and symbols with animals, etc.[...]' (Laming 1959:170-1). This shows that the aims of her work were aligned closely to the classic definition of structuralism, in which 'the world is made up of relationships, rather than things' (Hawkes 1977:18). Laming's observations about the art of Palaeolithic caves were highly influential, basing interpretations on reason and logic. These attributes lead to an analytical approach (see below) to cave art, which gained scientific accreditation for diverging from the use of cultural analogies to explain archaeological phenomena. She revolutionised the discipline's approach to cave art and 'dismissed the various, too creative theories of its predecessors, and, with them, any residual nineteenth-century prejudice or romance about the "primitive" mind' (Thurman 2008:62). Furthermore, in examining Palaeolithic art exclusively, without examining its social or cultural context, it distanced an objective investigation of cave art from the subjective theories and notions relating to the people of that period.

Laming's application of structuralist theory to cave art was noted by Leroi-Gourhan, an ethnographer like Lévi-Strauss who initially studied cave art to develop a chronology of it based on stylistic topology (figure 4). He supervised Laming's doctoral thesis in 1957 and used the ideas she explored in it to study nearly seventy caves the following year (Lawson 2012:212). He wanted to find out whether there was a predictable structure in the art depicted. Leroi-Gourhan, however, was not reliant purely on analytical investigation to produce clearly evidence-based discussions and conclusions. Instead, he applied his own ideas of biological and cultural evolution to investigate cave art from a framework in which schematic symbolism was part of advancing aesthetic sophistication (Abadía & Palacio-Pérez 2015:660). In pursuing the importance of symbolism, Leroi-Gourhan rejected the idea of realism which

was accepted in cave art studies in the 1950s. In this context, the idea of realism proposed that the meaning of a schematic depiction in cave art, for example a horse, did not extend further than that: a simple depiction of a horse, thus eliminating the idea that the horse may be a symbol that represents something beyond its mere figurative depiction (Leroi-Gourhan 1958:318).

Although Leroi-Gourhan was not the figurehead of the movement, and indeed merely carried out Laming's work, his contribution to structuralism was discussed in a recent paper which examines his standpoint in depth (Abadía & Palacio-Pérez 2015). When referring to how his approach differs to that of his contemporary academic – Lévi-Strauss – two points were made: 'in both cases, there was an 'organisational scheme' either to be proved (Lévi-Strauss) or to be discovered (Leroi-Gourhan)'; and 'Leroi-Gourhan declared that the main problem encountered by scholars of prehistoric art was the lack of a complete inventory of Palaeolithic images (Leroi-Gourhan 1966:110; 1971:78–9). For this reason, he introduced a number of statistical methods to chart the frequency and distribution of Palaeolithic representations (Leroi-Gourhan 1971a:81; 1971b:90–91)' (Abadía & Palacio-Pérez 2015:664). (The second quote is reminiscent of Laming's approach.) These two points collate the summary of Leroi-Gourhan's approach to cave art. He focused on the 'frequency and distribution of Palaeolithic representations' with the mind-set that there was an 'organisational scheme' to discover and the investigation in this thesis shares such aims (but crucially, not methodology). The differences arise in relation to the scale of study. In Leroi-Gourhan's inventory, cave art from several caves spanning great distances were collated. It would appear he documented simply the repetition of depicted figures and his large catchment of sites resulted in data with so many variables that it was not stable enough to make any conclusions as to the presence of a unifying structure convincing. Either way, conclusions were reached which stated that 'certain animals [were] represented together too often to accept that it was a random combination' (Leroi-Gourhan 1971a:80). Structuralism in these instances were led by academic thought that supposed the creation of cave art was an artistic phenomenon that relied on a mechanised, cognitive switch board. In projecting these pre-formed theories onto cave art generates conjecture in their conclusions. Although some aspects of structuralism is adopted in this thesis, such as analysing the art in relation to their spatial placing, it is more productive to approach the art void of pre-conceptions.

These studies take the form of a holistic investigation to either prove or discover the meaning and factors behind cave art, which has been the character of many published works hoping to decode the meaning of parietal art as a whole. They reach conclusions that involve overarching (mostly spiritual) motives that underpin its creation. There is a dichotomy between the approach used to analyse the data and the application of theoretical ideas involved in its conclusions. As we have seen, this type of hybridised analytical investigation was adopted by Leroi-Gourhan, but it bends towards optimistic theoretical ideals of cultural and symbolic evolution which lead to the use of only select sites as appointed examples to fortify claims. This excludes the necessity of studying art whose character is likely to have affinity to its particular cave. However, as we know, it was Leroi-Gourhan's pupil – Laming – that was the driving force behind Leroi-Gourhan's realisation of the structuralist forms apparent in cave art, stating in Scientific American that 'my own work has been motivated [by Laming's studies] by a similar conviction' (Leroi-Gourhan 1968:60). Laming saw that, beyond Leroi-Gourhan's observations of repetition and symbolism (which began to move academia away from ideas of realism (see above)), cave art was more structurally formed around Lévi-Strauss's idea of exchange and balance. This lead her research to take on a more systematic approach that did not have its grounding in looking for categories of symbols – as in Leroi-Gourhan's case – but for trends in the data. Her work discovered, for example, that almost all the subjects of cave art were that of animals – a realisation not made by anyone before her. As has been shown, when analysing the existence of any structure behind cave art, it is best to examine it in a capacity that is as reliant on the evidence base as possible. Leroi-Gourhan's database selected material in favour of a certain theory, and his – as well as Laming's – analysis was disadvantaged in efficiency by the lack of modern data-analysis software. It is, however,

the systematic analysis of cave art undertaken by Laming that should be adopted in this thesis to approach the dataset.

In supporting Laming's work and rejecting the sentiments of (but not methods using in) ethnography that were integrated into Leroi-Gourhan and Lévi-Strauss' interpretations and research, one must be critical of how those patterns in data were perceived. Leroi-Gourhan, for example, examined cave art to support wide-spread assumptions on what 'code' underpinned these patterns: as Lawson rightly pointed out, the act of decoding supposed explicit meanings across cave art is 'perhaps over-optimistic' (Lawson 2012:215). Additionally, Lawson makes clear that 'recognising the existence of a code and deciphering it are […] very different challenges' (ibid.:215). The idea of uncovering a thematic 'code' set out by Leroi-Gourhan seems to acknowledge that differentials found in cave art adhere to an explicit agenda that is implicit from the perspective of modern-day viewers – as appears to be the same for Laming's approach. Although this is a choice word, I feel it is too speculative for use in this investigation – being one where variations in theme is not accounted for because of the presence of a specific code. As a result, I have chosen to replace the idea of 'thematic codes' with a 'thematic grammar', which fits more with the ideas pertaining to a rigorous approach to researching the character of themes in cave art.

Additionally, by narrowing the investigation down to one single chamber of a particular cave has its benefits: the importance of examining art produced by one culture is that it sets a control variable within the data: the potential meanings behind the art based on positioning on the cave wall. This is based on Pierce's semiotic theory which is founded on the principle that the way 'signs' operated was through a 'triadic relation' between three subjects: 'a sign, its object, and its interpretant' (Preucel 2006:47). The uncontrolled variable in this case is the 'interpretant' as what the signs mean in the context they are found is the product of speculation. This thesis is not to be a direct interpreter of the art but create a dataset wherein patterns of order which could *pertain* to an order behind the art are potentially revealed.

The idea of 'thematic grammar' instead of a code has been used in previous research, the most relevant to this investigation being Sauvet and Wlodarczyk (2008), who set out to propose the existence of a formal grammar behind the extensive database of cave art throughout Europe. They compiled huge amounts of data and fed them through analytical software and algorithms to produce graphs and tables based on co-occurrences of animal species.

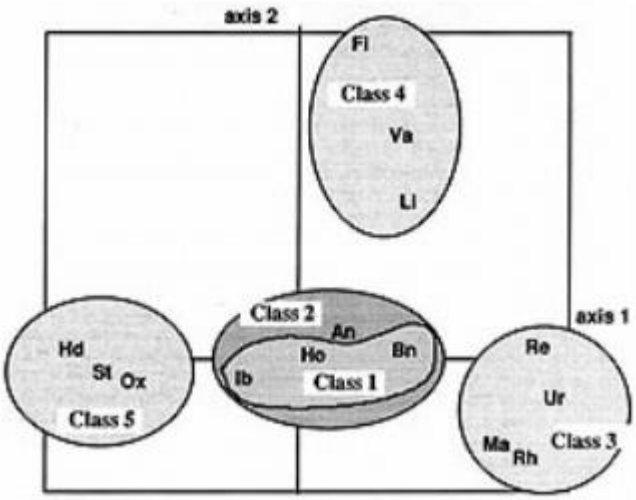


Figure 5: An example graph representing the co-occurrences of 'semiotic units' using factor analysis (after Sauvet & Wlodarczyk 2008:170).

As impressive as it looks, their paper categorises grammatical units by animal species alone and neglects a higher resolution of potential determining factors for, just like Leroi-Gourhan did forty years earlier, the probability that grammatical structures are, to some degree, dependent on the cave and cultural context in which they were made. Therefore, by incorporating such diversity into one dataset for a uniform analysis, one is inviting anomalies in the general formatting that are, when isolated, actually a grammatical format in itself that pertains to a smaller sample of decorated caves. However, Sauvet and Wlodarczyk's work did find those general rules and, although inevitably loose, they achieved results that indicated a dependence of animal taxa for dominant and marginal representation and the relationships between them. Therefore, although it can be shown that there is a form of 'grammar' in cave art that is homogeneous across multiple cave sites, the accuracy to which this can be attested and characterised requires an analysis of art from individual cave sites. Inspecting caves one by one is perhaps the more sensible method of investigation (see below), but many structuralists are not sensitive to the likelihood that grammatical formatting is a semiotic system that is applied differently in different contexts (in this instance decorated caves), being a tempting proposition to unify cave sites under the banner of a single theory, overriding intra-cave perspectives (Lewis-Williams 2002). However, this is not to discount Laming's, Leroi-Gourhan's or Sauvet and Wlodarczyk's approach completely. It was Laming who first proposed the idea of binary opposites, which made way for spatial patterning in cave art being seen as 'a vehicle and not a content' (the word vehicle having been translated subjectively, other interpretations are formula or expression) (Sieveking 1979 (their emphasis)). On the other hand, their research adopts spatial patterns in relation specifically to animal taxon, but in this investigation it is searching for more implicit variations in animal representations, i.e. behaviour, orientation and size. The 2008 study acknowledged that there was some shortcomings in relation to how they acquired and processed data, writing:

> 'In this work, we wished only to answer an important and disputed question concerning the existence of a common structure in Palaeolithic cave art. To address this problem, we developed a methodology which led us to use much reduced data (*themes instead of individual figures*)' [author's italics].

Another shortcoming is the software through which this data must be processed and presented, showing their fidelity to analytical approaches, the authors state in their concluding paragraphs that '[…] new methods able to integrate the new information must be developed' (Sauvet & Wlodarczyk 2008). In truth, this is also a shortcoming of any such analysis even today, with the complexity and information-rich source material needing a huge amount of analytical power to process. In the present thesis, I use Excel to analyse only a sample of European Upper Palaeolithic cave art, which may seem rudimentary to some (see methodology).

Conkey followed Laming's well-received structuralist approach to cave art analysis and preceded to bring the artists of the caves themselves to the forefront of the discussion. Although Laming had focused on how Lévi-Strauss's observations of underlying structures in human social organisation could influence cave art studies, Conkey saw cave art as an extension of more explicit social organisations represented by cave art. This uses art and its associated archaeological context as a medium through which one can examine not just the function of art within Palaeolithic societies (predominantly from the Magdalenian period), but also the nature of those societies themselves. This has been revisited in more recent papers (see Pettitt 2020).

By the end of the 20th century, cave art studies had attracted a range of theories, research approaches and even disciplines integrated into its study so that, by then, cave art was subject to novel perspectives, for example 'paleospeleology' (Rouzaud 1996; 1997 in Pastoors & Weniger 2011). Visual psychology was one such example where a foreign discipline was used to interlace the archaeological study of cave art with the pragmatism of exact scientific investigation. Today, this continues to be a

valued quality in this discipline's research, approaching a rigidly analytical background to modern-day studies, using digital software developments to increase its accuracy. One such example of statistical software being employed to find variations in cave art is discussed below.

Sauvet and Wlodarczyk's article titled 'Towards a Formal Grammar of the European Palaeolithic Cave Art' (2008) utilises statistics in a similar way and to accomplish the same goals as in the investigation enclosed in this thesis, making it highly relevant for comparison. It shall be a considerable help for this thesis to examine their methods of analysis and theory as, when coming to discuss my findings, previous work can be revisited and referenced. Although both their work and mine are investigating cave art for similar reasons, there is a notable difference between the methods used: the 2008 article uses dramatically different source data and intentionally groups together multiple individuals into 'units' for collective analysis. They also use a scope of data collection far greater than what has been employed in this thesis, encompassing 416 polythematic panels (from 84 caves) which range across geographical, chronological and stylistic boundaries. This range of data collection is in stark contrast with that employed in this study which only analyses four panels from a single chamber of a cave. However, even with the massive scope employed by them, their findings suggest that 'inter-thematic associations were governed by semantic choices which remained relatively stable during the Upper Palaeolithic in Western Europe' (ibid.:165). In order to combine the thousands of animal and human images from each cave, they use 'formal and computational linguistics' (ibid.). The product of their analytical endeavours were to decidedly identify what '[…] rules would constitute a formal grammar of Palaeolithic cave art or, more exactly, a model of such a grammar.' Comparing this paper to the current thesis is evidently very valuable and therefore has been revisited throughout different chapters and sections. From *Methodology* to *Discussion*, it guides the investigation when needed and reinforcing how collating data of drastically different sizes influences one's conclusions and interpretations.

What has already been noted as a distinguishing feature between this thesis and the 2008 paper by Sauvet & Wlodarczyk is the way the data was processed. The theories behind their analysis was based on the idea that, 'as it is well known in Communication Theory, the most simple [aspect of a 'language'] is the most frequent (Mandelbrot 1954)' (2008:168). Therefore, frequency of a certain 'semiotic unit' in association with another was the focus of their research. This is applicable to the research aims for this thesis too, examining the dataset for similar inter-variable associations. However, they seem to have limited attempts to put forward a grammar in cave art purely based on analysing the frequency as which certain species are represented. This may have been due to the scope of art used, encompassing such high saturation of data subsequently decreases its resolution and thus compromises analysis. The analysis undertaken in this thesis is done on a dataset with much lower saturation, which increases its resolution, in turn allowing it to accommodate a larger array of variables from which potential co-dependence can be sought. It is not just focused on species but incorporates the orientation, size, behaviour and proportion ratios of each individual animal.

The method by which Sauvet & Wlodarczyk interrogate the data is solely dependent on feeding it into computational formula. Using species representation alone as the factor of any variation 'in order to discover the basic rules of the system' (ibid.:167) required few numerical tools that were available to me in this thesis (those that were being standard deviation), and instead factor and cluster analysis was employed (see figure 5). Although these are more advanced than the analytical tools used here, they are simply short-hand for a method of deconstructing what is represented on these panels. Indeed, the amount of data that needed to be processed in their article had to rely on a few analytical tools to heavily compress the findings in visual mapping. This, it could be argued, may have been detrimental in over-refining an organic and sometimes haphazard dataset when searching for consistency. However, this refinement occurred during the collection of the data and therefore the simplicity of the data's processing was a subsequent symptom of the over-refinement in the previous

step: they reduced the input of data by replacing an individual's species with group-determined species in 'message units'. Sauvet & Wlodarczyk acknowledge the crude simplicity of their work by firstly expressing it as an attempt to discover the basics of the grammar system but also in the closing pages of their article where they write:

'At this stage, the individual figures should be reintroduced with their morphological attributes such as size, orientation, degree of completeness, attitudes and technique, and their spatial distribution and associations with signs should also be taken into account.' (ibid.:175)

The current study, therefore, is an extension of their research played out on a miniature scale, using a cave site which possesses the optimum conditions for studying the most culturally and grammatically unified production of cave art (unified by locality, style and technique). In other words, where Sauvet & Wlodarczyk seek to 'discover the basics of the system', this thesis seeks to discover the presence of a system amongst the most basic example of cave art. This, admittedly, does not embody the grandeur of Sauvet and Wlodarczyk's work, where one aims to analyse and subsequently discover one unifying grammatical 'language' hidden throughout cave art from across Western Europe, but it is a showcase of what we can do when the conditions are optimal. Therefore, this thesis aims to analyse this sample cave art to discover the 'language' of grammatical order that may be found to be underpinning some aspects or all of it.

To be clear, this thesis' analysis of Les Trois-Freres' art in later chapters is fundamentally dictated by what was found. However, its analysis is carried out in a statistical fashion lead by the appropriate methods adopted from recent research mentioned above.

2.5 Cave art as archaeological excavation

Although regarded as an archaeological 'artefact', cave art cannot be approached in the same capacity as an archaeological excavation, though both have been continually integrating modern software – analytical or otherwise – since their development. On an excavation, these new technologies analyse the distribution of certain artefacts that can, for example, lead to systematic investigations into spatial behaviour. It should be noted that the level of spatial analysis would not have been accomplished without such digital systems. To record the huge amounts of data from each stratigraphic layer of an excavation, archaeologists use a wide variety of geophysical, photogrammetric and illustrative tools. However, cave art is a comparatively simple 'artefact' to catalogue, existing on one plane and comprised of a set of consistently reoccurring depictions, whereas artefacts from an excavation are plotted across three-dimensions in which exists complicated recording of artefact type, event horizons and the relation between both. Another apparent difference which positively benefits those studying cave art over excavations is that all of cave art exists in situ: the placement, orientation and behaviour of every figure that constitutes a cave's decoration is the product of explicitly deliberate efforts. Therefore, one is studying an aspect of material culture that was directly as a consequence of an individual's deliberate acts, existing at the interface between individual artistic choices and wider cultural memes or references. However, the examination of excavated material culture from contemporary habitation zones, either in open air or cave sites, are reliant on the fact that the threshold of self-awareness in those arbitrary behaviours was not crossed. This leads to the assumption that spatial organisation in such a context is a behavioural act made material through subconscious habit rather than conscious deliberation.

2.6 Les Trois-Frères

There are plenty of encyclopaedic resources on Palaeolithic cave art, heavily documented since discovery and, moreover, an insatiable appetite for academic research which is still prevalent today. For those that analyse cave art, many investigative techniques have been used aiming to decipher and ultimately understand what factors underpinned the artistic output of Palaeolithic peoples. Additionally, cave art has been studied on many levels of specificity, with some operating on a broader scale, incorporating the art of many decorated cave sites – Les Trois-Frères included – to promote a wider discussion and produce more over-arching conclusions (see above). Unfortunately, the cave of Les Trois-Frères is limited to brief inclusions in these texts: documentation of the art at Les Trois-Frères is not adequately detailed to generate an inventory appropriate for the aims of this investigation. This in part is due to its connection to two other caves of archaeological interest (referred to as the Volp caves (see geographical context). The literature exclusively examining Les Trois-Frères result in less diverse resources than those broader literature bases, with the number of academic publications delimited to the specificity of the subject matter.

However, the published research that focuses its attention on the archaeology and art of Les Trois-Frères (or the Volp caves in general) is a great resource for this investigation and shall be relied upon heavily in this thesis. Early rigorous documentation of Les Trois-Frères' engraved panels by Breuil did create an astonishing inventory that mapped out – in illustrative detail – every element of a panel's engravings (Bégouën & Breuil 1958). Unlike parietal art made by using pigments, engravings are unclear and difficult to comprehend as they have only a slight colour contrast to the surrounding wall and are shallow. This requires a low, well-positioned light to make them out. Thousands of years of erosion and calcite formation over engravings have resulted in states of deteriorating preservation, making the engravings a difficult technique to comprehend. For this reason, a medium other than photography must be employed in recording engravings, as the dimensions of the engraved art cannot be adequately detailed by camera work. This required Breuil to take a lot of care undertaking its detailed recording by hand, tracing the engravings at Les Trois-Frères over many seasons of work

spanning almost two decades (Rodriguez & Damion 2006:48). Although not as precise as a written inventory, it still remains the best representation of the engravings to this day, evident in its use as a citation in many published works (see Bégouën & Clottes 1987; Sieveking & Sieveking 1962).

However, this does not mean that these illustrations are as reliable a source of visually examining the engravings as the engravings themselves. Laming rightly noted that the irregularities of the wall surface (which can create large concave cavities over which art is made) cannot be appreciated in illustrated representations of parietal cave art, flattening the arrangement of art from the three-dimensional wall to the two-dimensional paper makes everything 'stretched, twisted, distorted in every sense' (Laming-Emperaire 1962). These issues are covered in more detail in a later chapter (Chapter 8 *Issues with the data* (page 45)). Besides this, Breuil's tracings of the engraved panels opened cave art up as a subject that was now comprehensible for future analysis. Therefore, one can vicariously inspect the engravings through the tracings and detail the characteristics of particular animals irrespective of whether the minutiae of the cave's morphology determines the placement of certain figures. This is not to say that the wall morphology of the cave does not affect the demarcation or wider composition of a panel or indeed the chamber's layout, as this shall be taken into account in further discussions (see analysis from an artificially holistic viewpoint), but it becomes irrelevant when studying a cluster of engravings as all of the constituent figures often appear on the same undulation. When this is the case, the art seems to have been produced irrespective of the cave's morphology.

As useful illustrations are when compiling the art into an inventory for this thesis, unfortunately its full, published form is unavailable to me. Thankfully, however, a few excerpts of Breuil's illustrations appear – admittedly infrequently – when Les Trois-Frères is mentioned in other published works. Analysing these illustrations when they appear in archaeological publications is the only available way to study and then re-appropriate them for the purposes of this thesis.
Although the illustrations are dispersed throughout different books, the one with the most accessible, concentrated and diverse illustrations are in a work whose recent publication was to conflate all the information available about Les Trois-Frères and includes all the most recent research: Les Cavernes des Les Trois-Frères. This was published in 2014 and covers all the areas of the cave, its context, history of discovery and research as well as popular interpretations of the findings. As specified above, excerpts of Breuil's illustrations are required to carry out this investigation and the list of applicable panels presented is listed in the results. Additionally, what is an essential but perhaps underestimated aspect of the chamber that needs to be comprehensively understood is the geological form of the chamber's walls. Understanding how the people who decorated the walls must have navigated the chamber and spatially delegated it into separate panels may lead to understanding certain thematic or stylistic variation within the art itself.

A description of the layout of the chamber has been provided in this publication accompanied by an annotated diagram that incorporates the location of particular engravings. However, this publication presents the complicated dimensions of the sanctuary chamber at Les Trois-Frères differently compared to other works such as those from Sieveking & Sieveking (1963). Therefore discrepancies occur. The reasons for this, in my opinion, is the difficulty of displaying in two-dimensions what is a complicated three-dimensional situation – many overhangs are not visible when viewing the floor plan but the overhangs would obscure and complicate its representation if they were included. It is therefore down to the respective authors to illustrate the same complex layout as best they can, placing emphasis on what they find to be most appropriate. Sieveking & Sieveking's representation is the most useful for this thesis as it provides annotations to accommodate the chamber's panels (not just individual engravings) and narrates navigation through the chamber's confusing layout in comprehensive detail. For further details on the navigation through the sanctuary and its panels, see the sanctuary below.

As above, although the main source for collecting information and data for this investigation is Les Cavernes des Les Trois-Frères (Bégouën *et al* 2014), other resources are needed to fully understand and contextualise the art, the most notable being Lawson's Painted Caves (2012). This additional literature is required in this thesis in order to generate an adequately informed discussion on the factors behind certain 'grammatical structures' potentially underpinning the artistry at Les Trois-Frères.

In the last pages of Les Cavernes des Les Trois-Frères, when the sanctuary's art is discussed in concluding remarks, a point is made that is highly relevant to this investigation. What is noted by Bégouën and others is that there is a vertical progression in scale, where those animals depicted on a higher point are predictably larger in size (2014:242). They describe a three-tiered system which divides the sanctuary's engravings into higher, middle and lower lines that correspond to the scale at which an animal is depicted. In an investigation which seeks to find what present factors in cave art (if any) determine variables in size, orientation or behaviour, to name a few, this holds invaluable insight and is discussed in relation to the findings in section 10.1.3 (page 69).

What is also briefly mentioned in this remark is that such 'graphic groupings [are] very tightly linked with the topography and multiple shapes of the wall'. Although being able to comprehend the dimensions of the individual rock faces which delimits the dimensions and size of each panel, comprehension of the topography and shapes of the cave wall is heavily restricted by the lack of detailed photographs. This makes me reliant on tracings and illustrations as the source data for this investigation, not the engravings themselves. Therefore, searching for factors within the engravings that pertain to topographic makeup is severely restricted. Evidence that the natural contours and morphology of the engraved sandstone slabs in Enlène cave influenced the scale and orientation of the animal depicted (Bégouën & Clottes 1991:72) emphasises such a line of enquiry. Although this indicates the topographic determiners of artistic output from a separate (but nevertheless adjoining) cave to Les Trois-Frères, there is enough evidence to assume they were both highly contemporary and complementary in style and theme (ibid:66).

Nevertheless, such evidence in Les Trois-Frères' sanctuary, where art's size correlates relatively to its height, suggests that the art's author(s) were sensitive to the overall thematic grammar of the chamber's art. This is a valuable foothold on justifying further investigation into the grammatical phenomenon evidently present throughout the engraved panels in this chamber. Now we know there is a factor implicit in determining scale across different panels, factors that determine size variables within individual panels, for example, will hopefully extend our knowledge of other such grammatical laws that may govern the artistry in such a cave as this.

Above, I have compared the art of Enlène and Les Trois-Frères cave, but with the focus on the engravings from the sanctuary chamber, the data analysed from Les Trois-Frères is chronologically and spatially – and therefore conceptually – tight. What is mean by this is that, when investigating the presence of co-occurrences, conceptually synchronised data is advantageous as it can hold with stronger conviction that 'inter-thematic associations' within the art is coordinated to fit within a deliberate semiotic system. This cannot be said for every example of cave art throughout the European Palaeolithic, and in fact the panels chosen for study in this thesis were done so because of their merit in this respect. Therefore, the character of any grammatical rules found u the art in Les Trois-Frères is particular to that semiotic landscape, and therefore is not reproducible beyond it. Most importantly, the methodology of investigating the presence of underlying grammar in cave art employed in this thesis can be transposed to other sample studies. (The level to which this is an effective or appropriate method will be dependent on the data set chosen for study.)

2.7 Summary

To summarise the literature review, in this study parietal art is examined to understand whether, in the multi-faceted representations of animals, there are some facets that exist dependent on – or coupled with – another facet. Therefore, this thesis does not continue the trend of analysing cave art for any theories, including those mentioned above. Instead, what I hope to do is start from the ground up, focusing on the evidence as it stands and any discussion that may further its interpretation constantly in reference to the evidence base. With that said, this investigation will still bare semblance to the research methods adopted from those who analysed the same subject matter before: generating a detailed inventory to understand the thematic character present in sample cave art and determine the presence of certain grammatical rules-of-thumb that underpin it. In adopting aspects of past research into my work, I aim to base this investigation on established academic foundations.

As we have seen from examining Leroi-Gourhan's approach of creating a systematic dataset of cave art, he accumulated a large amount of material which was surface-level in observation, a consequence of over-saturation. The same approach was adopted in more recent years using a higher degree of technicality in its data analysis but the same shortcomings seem to persist. The investigation in this thesis, however, aims to create an inventory of art which should produce the reverse effect – more observations of individual figures will allow for a higher resolution of data than in Leroi-Gourhan's work: only one decorated cave will be examined but as a consequence more detail of particular depictions will be retained, adding to the inventory. It focus this investigation's attention – and thus database – on grammatical rules in art that are self-contained by cave and chamber. In this approach, I aim to avoid contaminating one dataset with art that may have been created by artists who were foreign to the understanding of semiotic formatting and its application set out by the initial authors. This is one of the greatest in-built issues of cave art studies, wherein a cave wall can be host to multiple layers of artistry (Bahn 2016; Conkey 1989:136).

I also aim to withhold any theoretical discussions until after the analysis of the data. This goes against Leroi-Gourhan's opinion, which was that you cannot separate the style of an artwork from its underlying religious meaning (Abadía & Palacio-Pérez 2015:662). Being of this opinion, he thereby constrained his analytical potential by applying his results to the understanding of broader cosmology that may tie the art together over multiple sites. This led him to expand his dataset over and beyond its capacity and could no longer maintain a high resolution of each cave's particular layout.

Because there have been huge advancements in software analysis, the models of structuralism that fuelled Laming and Leroi-Gourhan's investigations of cave art has been the basis of modern research (Fritz & Tosello 2007; Groenen & Groenen 2017; Gonzalez-Garcia 1987; Sakamoto *et al* 2020; Sauvet & Wlodarczyk 2008), introducing a systematic method of analysis. I will use these technological developments to construct a digital inventory of the source material, akin to Sauvet and Wlodarczyk's research.

Chapter 3 Background

Now the literature has been reviewed, it shall be studied to compile a coherent background of Les Trois-Frères cave itself:

3.1 Geographical context

The data analysed for this investigation comes from the cave site of Les Trois Frères, which exists in a wider cave system situated in the valley of the Volp river (see below for further context) which today flows through some of the deeper passages of these caves. As a whole this cave system conveniently divides into three: Enlène, Les Trois-Frères and Tuc d'Audoubert. Enlène cave is the eastern-most cave and it is from here that the only present-day above ground access point to the cave system is found (Bégouën & Clottes 1991:65). Les Trois-Frères cave, situated between Enlène and Tuc d'Audoubert is connected to Enlène by a long narrow passageway which is hard to traverse, and to the western cave, Tuc d'Aboubert through its lower galleries which is only accessible today by boat (Bégouën & Clottes 1991:65) (see figure 6).

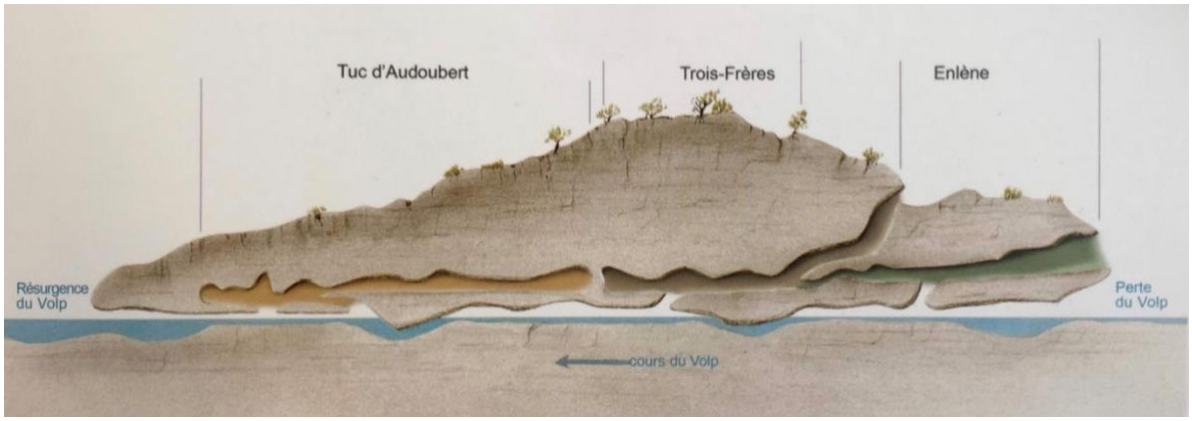


Figure 6: Cross section of the topography of the Volp cave system showing the river Volp flowing through the lower galleries. From right to left is the cave of Enlène, Les Trois-Frères and Tuc d'Audoubert (after Bégouën *et al* 2014:51).

The Volp river, whose tributary flows through the lower galleries of these caves, passes through the foothills north of the Pyrenees mountain range. It is within these hills approximately 65 km from France's modern-day border with Spain that this cave system is located (Bégouën *et al* 2014:50). Here, the limestone bed rock is fast to erode, meaning geological action has created multiple natural sinkholes and underground passages, and in neighbouring foothills many other decorated cave sites have been discovered, most notably Le Portel and Niaux (Lawson 2012:159). All decorated caves in the Pyrenees, without exception, have been engraved 'whether on the mud floor or the limestone walls' (Sieveking 1979:146). It is, however, arguably only at Les Trois-Frères where this has been done so prolifically and to the exclusion of almost all other artistic techniques.

Twenty kilometres away, in the same area of foothills, is a decorated cave site which holds great affinity to the three Volp caves (Bégouën *et al* 2014:245). The cave – Le Mas d'Azil – had also been explored by Magdalenian people, and their artistry has been found on the walls of this cave's 'sanctuary' respectively, employing engraving techniques just like Les Trois-Frères (see below) but also applying pigments. Other than the complementarity of art in these caves (despite the distance between them), the tool assemblage found at Le Mas d'Azil is so similar to the character of items found during excavations in Enlène cave that it is supposed they were visited by the same people – if

not, there certainly was a high level of interaction and connectivity between them. Categorising cultural affinity of two groups by examining their tool assemblage is, admittedly, a problematic method of investigation which has more conjectural than factual basis when distinguishing different peoples. However, in this case two tool assemblages are being compared which exhibit close technological affinity – not difference – to one another. The significance of Le Mas d'Azil in relation to this investigation is discussed in section 13.1 (page 88).

3.2 Historical context

This section outlines the discovery and academic attention Les Trois-Frères and its sister caves has generated since its discovery: The Volp caves were brought to archaeological attention in 1912, although Les Trois-Frères cave remained undiscovered for a subsequent two years (Bégouën *et al* 2014:15). The landowner of the site, who discovered its archaeological potential was Count Bégouën. The cave was previously known but no archaeology was apparently noted (Lawson 2012:80-81). The Count and his three sons had a fascination with human antiquity and his naming of Les Trois-Frères – meaning 'the three brothers' in English – was dedicated to them. The initial discovery of the entrance passageway to Enlène cave in 1912 was the result of multiple excursions to possible cave sites organised by the Bégouën family who were deliberately seeking out further evidence of the deep human past. Since the rich seam of parietal art from Les Trois-Frères was discovered, it has been subject to extensive documentation and research and has subsequently expanded the scope of cave art studies. In 1958, Abbé Breuil exhaustively documented the finds in the sanctuary chamber (see section 2.3 (page 16)) after he had included the site as one of the 'six giants of prehistoric Palaeolithic art' (Bégouën *et al* 2014:12; Breuil 1952). Because the sanctuary chamber itself presented no significant archaeological context to accompany its extensive art, the flurry of archaeological investigation into Les Trois-Frères cave between 1985 and 1990 was focused on excavating a wider sample of the cave's chambers. However, more art was discovered during these light excavations which resulted in further insight into the engraving techniques used in the parietal art, using plaster casts of the walls to examine the more delicate techniques that had remained undiscovered.

3.3 Artist context

Through these recent discoveries, the evidence of artistic output within the Volp cave system is expanded, but it was already apparent that this art spanned across different natural chambers, existing in a dispersed manner, but mainly concentrated in one chamber called 'the sanctuary'. This chamber contains an unprecedented amount of Late Upper Palaeolithic engravings and will be the focus for this investigation. In date, the engraved art has been consigned to the Magdalenian period and, more precisely, Leroi-Gourhan fitted them stylistically to an art period between 16,000 and 11,000 cal BP (style IV) and no earlier (Leroi-Gourhan 1968; Bahn 1996a; Sieveking 1979:141). However other chambers from this cave have been thought to be Solutrean in date (Sieveking 1979:141). The art includes the famous 'sorcerer' – a painted as well as engraved anthropomorphic being, which gave the cave world renown (Bégouën & Clottes 1987). However, what prevails throughout the sanctuary walls are not mythic beings but fauna typically found on the Pleistocene Mammoth steppe (Guthrie 2005). These are just as unrivalled in the art of Les Trois-Frères as they are in all decorated caves of this time period (Lawson 2012:234; Sauvet & Wlodarczyk 2008). The animals engraved into the sanctuary chamber walls mostly comprise of bison and horse, followed by reindeer and ibex; bear and rhinoceros are also present. (Although there are two examples of 'anthropomorphic beings', I will henceforth use the umbrella term 'animals' when describing the depictions in their entirety for ease of reference.)

It would appear that the authors of the art at Les Trois-Frères mainly portrayed animals who were just as prevalent in the natural world outside the cave, taking precedence over the less abundant

depictions of mythic origin. It is obviously the art of hunters who are familiar with their prey animals, but to query whether these animals are strictly 'local' to the cave is still only answered as half conjecture. This is because aggregation points existed for large numbers of people who probably came from multiple dispersed kin groups, bringing with them knowledge of fauna from neighbouring ecologies (Igarashi & Floss 2018:200). Archaeological evidence of this is present in the open air site of Gönnersdorf, where the animals depicted by multiple groups included a variety of animals which the artists must have encountered (Lawson 2012:234). Lawson extends this to cave sites, writing 'archaeological evidence for the mobility of human groups over considerable distances means that a single group of people could have explored neighbouring topographical zones with contrasting faunal. Having encountered different animals in these areas, the explorers returned to their traditional venues to depict the diverse fauna' (ibid.:234).

The geological and ecological distance at which individual groups operated can be indicated by the aforementioned cases, but using cave art as an indicator to group behaviour can open up further interpretations. The styles and themes that appear throughout multiple cave sites in the Pyrenees seems to suggest that the choices made by Magdalenian artists were synchronous with the wider 'community' of cave artists all the way across the mountain chain of the Pyrenees (Bégouën *et al* 2014:244).

The existence of a singular stylistic format is evident across decorated cave sites. Almost all are depicted in 'strict' profile (showing two legs and one horn). Recent studies have used visual psychology to elucidate the ubiquity of profile depictions in cave art (Meyerings *et al* 2021:1,2), with these profile depictions transcending reasonable limits of cultural influence, extending as far as China (Taçon *et al* 2010). The saliency of an animal's profile outline has been considered in the aforementioned paper as a fundamental determiner of taxon. However, considering the matrix of lines that naturally occur on a cave's surface (known as fissures), the ubiquity of profile depictions (and animals in general) in parietal art may be partially due to the orientation and character of fissures as much as the innate priming of the artists' visual processes. These factors were fused together by Hodgson in his persuasive hypothesis which transposes 'hyperimagery' – the theory of projecting primed mental images onto an ambiguous stimulus – to cave art studies from neuropsychology (Hodgson 2011). Although style, theme and technique vary throughout figurative cave art's 25,000 years of production, '[specific dimensions of animal depictions] are the essentials of European Upper Palaeolithic figurative visual culture' (Meyering 2021; Bahn 2016).

The evidence of such wide-spread homogeneity in subject matter and style supports the proposition that multiple caves were decorated and/or visited by the same people, if not the same culturally identifiable group. However, tight, repetitive artistic 'memes' or similarities of this kind are prolific across the Pyrenees (see below), suggesting that knowledge must have pervaded intergroup boundaries to organise the thematic 'grammar' that seems to have been adhered to here. (Archaeological evidence from later prehistory shows pan-Pyrenees knowledge and material exchange networks were well-established and intensely used (Bahn 1983).) Evidence that such a network existed can be observed using cave art as an indicator: the well-established precedence of bison and horse recorded throughout the Franco-Cantabrian region. A more specific geographical dataset, however, indicates that the Pyrenees and its associated foothills exhibit an artistic theme exclusive to its decorated caves – there are many more depictions of humans or anthropomorphs, which suggests a more attentive attitude towards their significance (Lawson 2012:163). Throughout prehistory, the Pyrenees was a centre for knowledge distribution and exchange, supporting the argument that cave art itself can be indicative evidence of such networks, studied closely for its grammatical rules.

To focus on the engravings studied here, however, they exist within a complex cave system, and their placement within it must be noted. As Leroi-Gourhan did in his structuralist work of the 1950s

onwards, one must examine the choice of the sanctuary chamber as a deliberate focal point within the cave's layout. He divided up the caves into 'entrance zones, in-between areas, central and side areas, passages and end zones' (Pastoors & Weniger 2011:379). For Les Trois-Frères cave, its entrance zone is a passage leading from Enlène cave, therefore it does not conform to the common idea of an entrance zone for most caves with connotations to a liminal boundary between above and below ground. The sanctuary itself resides in the central area of the cave system, but appears to be in a small side passage diverging from the main passage that runs a little further west before opening into its largest chambers – *Galerie des Chouettes* and *Salle du Foyer* – at the back of the cave (figure 7). The sanctuary appears to be the place of the most intense artistic output. Situated in the deepest area of the cave, it is remote from natural light, a theme that was explored in Pastoors and Weniger's 2011 study (ibid.) of the spatial organisation of caves for the use of art. The relationship between the art found in the connecting caves of Enlène and Les Trois-Frères is a fine example of this organisational behaviour (discussed below).

3.4 Archaeological context

Additionally, in order to appreciate the unique significance of this cave in relation to the art produced within it, one must understand its archaeological context in relation to its sister caves. The comparative study between these caves is only possible because of the efforts made to preserve the archaeology in Les Trois-Frères. Although this cave system was discovered at the start of the 20th century and has since been extensively investigated by Breuil and others (Bégouën & Clottes, 1987:184), the archaeological context throughout remains relatively intact. Those that have visited the cave on more recent expeditions were careful to use the same path to avoid destroying fragile potential archaeology beneath clay deposits.

With the care taken to preserve the materials in the cave, what was found on subsequent excavations in sample areas of the cave, was relatively little – mostly just 'traces of fire and a few bones' (Chapelle de la Lionne) (Bégouën & Clottes, 1987:184) and 'undisturbed hearth-stones, charcoal and scattered bones, [and] traces of ochre' [in the 'Salle du Foyer' chamber] (Bégouën & Clottes, 1987:185). In the sanctuary chamber 'there is not the least archaeological trace of any Magdalenian passage [through it]' (Bégouën *et al* 2014:242). Reasons for such an unusual lack of archaeological material in a space evidently used for concentrated artistic production is unknown. Some interpretations have been discussed, the most reasonable proposes that this was a 'voluntary act, any tools brought in being taken away after use' (Bégouën *et al* 2014:242). In Tuc d'Audoubert there is also very little archaeology. This is a behaviour applicable to other caves, but there appears to be no distinguishable pattern (Pettitt pers. Comm. 2021).

The above interpretation should be considered in the context of the broader archaeological evidence from other parts of the cave system. In order to emphasise why the incorporation of the adjoining cave of Enlène is necessary when considering the relation between Les Trois-Frères and its sister caves, Bégouën and Clottes point out that 'although the problem of possible entrances to Les Trois Frères has often been debated and many more or less unlikely hypotheses have been put forward, we have one certainty: in Magdalenian times, one entrance at least was through the cave of Enlène which is joined to Les Trois-Frères by a narrow passage 60 meters long' (Bégouën & Clottes 1987:186). (For the case for the existence of an entrance into Les Trois-Frères close to the sanctuary chamber, see Sieveking (1979:146).) Taking this into account, it is probable that Les Trois-Frères was accessed by passage through Enlène cave. That in turn means that examining the archaeology of both caves together is a useful approach – especially if the main occupation phases of these two parts of the cave are of the same broad date (see below). For further evidence to support the contemporaneity and complementarity of Les Trois-Frères and Enlène, see Bégouën *et al* (2014:243).

Excavations in Enlène cave have unearthed a huge amount of 'extremely varied and rich' portable art as well as a large amount of artefacts characteristic of habitation phases (Bégouën & Clottes 1987:186). The importance of these two adjoining caves and their respective archaeology is emphasised further by the fact that, stylistically, the art found on the plaquettes in Enlène is contemporary to the engravings on the walls of the sanctuary chamber in Les Trois-Frères (Bégouën *et al* 2014:244). This, along with the fact that Enlène's walls have close to no artistic output, forms an intriguing dichotomy in the different ways the two connected caves respect each other's activities but lack material contamination between them even when being used in tandem. One – Enlène – seems to be exclusively a habitation site (or base camp due to its tool assemblage (Bégouën *et al* 2014:243)) with additional artistic output in a portable medium; and the other – Les Trois-Frères – being exclusively a site for the production of parietal art. Therefore, it is worthy of note that the parietal art in Les Trois-Frères has been deliberately segregated from the domestic environs of Enlène and thus proves that certain groups held the production of parietal art as an act separate to more portable, individual art forms. The archaeological milieu of this cave site is emphasised by Bégouën and Clottes: 'a physical link therefore existed during the Magdalenian between these two caves, and so here we have the unique case of a first-rate wall-art sanctuary [Les Trois-Frères] intimately associated with one of the largest sets of portable art in Europe [Enlène]' (1991:65-66). The art presented in this thesis from Les Trois-Frères was created some distance from, and in exclusion of, the simultaneous domestic activities of Enlène cave. Although the artistic relations between these two connected cave sites is unique, it must be acknowledged that there are multiple other instances where 'the close link between Les Trois-Frères and Enlène recalls a very probable similar link between Niaux and the cave-habitat of La Vache' (Bégouën *et al* 2014:244).

A note of interest must be included here to reiterate a point developed further in chapter 11 that the way pre-determined spatial structure used to direct the attributes of engravings in portable art (in Enlene) is reminiscent of some examples of parietal engravings found in Les Trois-Freres.

3.5 The Sanctuary

Although not as ostentatious as, say, the famous painted walls of Lascaux cave, Les Trois-Frères cave hosts the densest accumulation of art. The art was engraved, using the contrasting tones of the fresh stone underneath the dark, weathered surface. The sanctuary chamber (annotated number 6 on figure 7 below) hosts the most intense production of art – containing thousands of superimposed engravings.

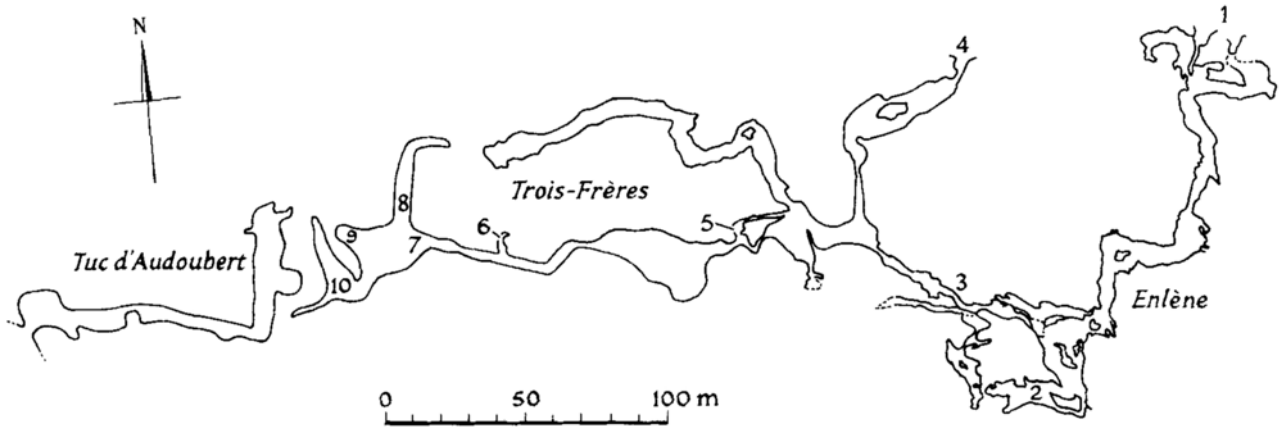


Figure 7: Aerial plan of the Volp cave with the passage between Enlène and Les Trois-Frères [3] and the sanctuary chamber [6] (after Bégouën & Clottes 1987).

It is of crucial importance to understand the complex geological morphology of this chamber in order to comprehend where the panels are positioned in relation to each other to elucidate any qualitative associations between them, which might constitute as a grammatical format. Their proximity to, say, the presumed focal point of the chamber's art – the 'sorcerer' – could be an example. This is covered below.

The sanctuary's entrance appears on the opposite end of the chamber to the heavily engraved walls above which is the sorcerer. However, the chamber's walls are of such drastic morphology that only some panels are visible when approaching the art from the entrance. The others are only visible once some level of manoeuvring around certain geological features and overhangs is achieved. Because of this, there are no panels that face the visitor directly. The panels first encountered from the sanctuary's entrance way appear on the left wall, consisting of small units of engravings and isolated animals: a mammoth (figure 12a); large ibex; collection of eight bison; and one or possibly two 'grotesque' human faces (Sieveking & Sieveking 1963:201, 202). Especially relevant to this investigation is the fact that although almost all the animals in these panels are depicted in 'strict' profile (as noted prior in section 3.1), almost all human or anthropomorphic representations are depicted facing the viewer. The depictions of two owls from La Galerie des Chouettes in this cave are also depicted face-on. This is a recurring theme in decorated cave sites in Western Europe as a whole (Meyering *et al* 2021) and seems to be adhere to the same loose grammatical convention of other artistry evident in cave art as previously discussed.

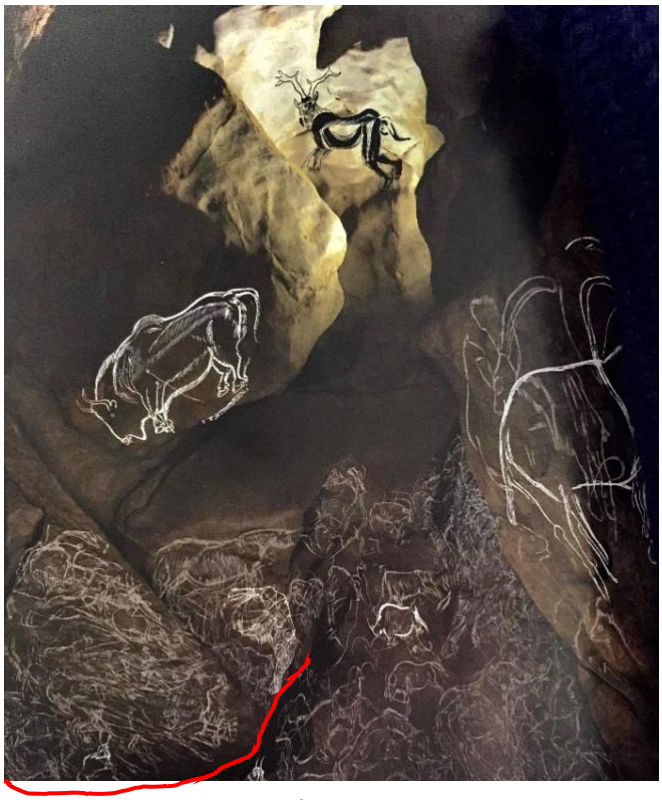


Figure 8a: A photograph of the most heavily-engraved area of the sanctuary chamber in Les Trois-Frères. To the right is the end of the panels on the right-hand wall. The sorcerer can be seen towards the top of the photograph, as if looking down onto the chamber. The panel at the bottom left is engraved onto the overhang (indicated by the red line) which obscures the left and *right panel* (the *right panel* includes the highlighted rhinoceros and anthropomorph (bottom-middle and bottom-left respectively) (after Bégouën *et al* 2014:132).

Figure 8b: A photograph of Professor Beltan and Spanish colleagues (1948) at the entrance to the Tunnel of the Rhinoceros examining the *right panel*, showing the positioning of the left panel on the underside of the overhang on the left (after Bégouën *et al* 2014:118).

Deeper into the chamber is where the greatest number of engravings are present, dispersed across the panels below the sorcerer, and it is from these that we derive the majority of the investigation's dataset. Because the surface of almost all the available wall space in this part of the chamber has been engraved to some degree, contextualising the panels is the same as describing the morphology of the chamber walls, which includes the multi-faceted overhangs and niches (highlighted from figure 8a). This makes it difficult to lay the plan of the engravings onto a two-dimensional plane. For example, the *right panel*'s left side is obscured by an overhang (engraved just as abundantly as the *right panel*). The underside of this overhang, facing the obscured left part of the *right panel*, is also densely engraved upon, forming the *left panel* (see figure 8b).

The *left* and *right panel* are the only two that have been included in this investigation from the main chamber of the sanctuary – the other two are taken from engraved panels found on the walls of passages that exist behind the initial back wall of the sanctuary. These passages can be accessed from the main sanctuary chamber by crawling through a small natural gap where the *right panel* ends to its left (bottom left of figure 8a). These passages, although not in plain sight to a visitor, have been engraved to the same extent as the main chamber of the sanctuary itself. Out of the four passages that branch out from the sanctuary, one enters the *chamber of the small reindeer* where the third panel to be studied in this thesis is found. The other panel comes from a passage that 'circles round the outside of the sanctuary, climbing until it reaches a 'window' overlooking the sanctuary on the right wall, 12 feet from the floor of the [chamber]. There is a fine series of engraved panels within this small corridor and, just inside this window, is [the sorcerer][…]' (Sieveking & Sieveking 1962:199).

It is from the walls of this passage, on the climb up to the sorcerer, that the final panel studied for this investigation is found. For the purposes of this investigation, the sorcerer himself is included into this final panel. However, when discussing this panel and any panel-specific variants, its elevated status shall be recognised. Together, the above panels encompass all of Les Trois-Frères' engravings studied in this thesis, consisting of the *right panel* (figure 13a (page 48)) and *left panel* (figure 14a (page 52)), the *chamber of the small reindeer* (figure 15a (page 54)) and the *climb to the sorcerer* (figure 16a (page 56)). At times, these will be referred to as panel 1, 2, 3 and 4 respectively for ease of reference.

Chapter 4 Aims and objectives

The aim of this investigation is to firstly create a high-resolution inventory for each individual engraving using the various illustrations and tracing of the panels available from La Caverne Des Les Trois-Frères (see *Appendix* (page 91). This inventory conflates multiple features of the engravings: for example the orientation and species of the animal (for the full list of variables, see *Methodology* (page 38)). These can enter into the inventory as absolute, categorical data, but other features, such as size, require a more relative and less absolute method of recording (see *Methodology*). In completing this, I aim to construct an adequately detailed inventory containing a high resolution of the variable qualities from the available engravings found at Les Trois-Frères.

Generating such an inventory is a necessary stage, organising the data in order to undertake its analysis: the second aim, which is the purpose of this investigation, is to cross-examine the character of certain differentials in the dataset to establish whether there are any differentials (e.g. depicted behaviour) that correlate with, or are dependent on another (e.g. species). We know already that there is a link between the size of any given depiction and its height from ground level (lowest=smallest, highest=biggest) (Bégouën *et al* 2014:242). This provides a footing from which further, more rigorous analysis can be accomplished to uncover the extent of such variable correlation, i.e. is it just height that governs the size of an engraving? Can we see variable correlation self-contained within individual panels? Bégouën's work has discovered that height is a determining factor of the size of the art in Les Trois-Frères' sanctuary chamber, but this thesis aims to take it further: using limited resources, how far can we transpose this idea of an underpinning grammar (or grammars) onto the extensive artistry engraved in Les Trois-Frères and beyond? As mentioned above, I aim to answer this by cross-examining variables for co-occurrences, which will be examined in Microsoft Excel. Some examples are: orientation of the engraved animal (facing left or right); whether their engravings are complete or incomplete; and whether they have been depicted in a static or animated state (incorporating behaviour). Presented in this manner, one increases the efficiency of analysing the strength of correlation between different variables. From these selected engravings I aim to shed light onto the nature of the thematic 'grammar' that might have been employed, if not the level to which it exists. This in turn may be contextualised further, providing insight into the model by which one can determine the underpinning rules that create, to some extent, the homogenous nature of Magdalenian parietal art.

As discussed above in section 3.5 (page 32), the reason this chamber's art does not appear as one seamless 'picture' is because the cave's topography (i.e. the morphology of the cave wall) does not allow the art to be visualised in one conceptual sweep of the eye, the walls having severe undulations, further obscured by overhangs. This results in art becoming compressed into conceptually 'bite-sized' areas of the cave wall, known more broadly as panels. Each panel may be separate from one another in locality but, as continuity is constant in many ways across the art (be it technique, style or theme), they seem to appear conceptually uniform. This investigation relies on such consistency (see summary under literature review (section 2.7)), but for the most part, in order to not over-saturate data analysed, I study panels individually. The particular panels for this investigation and its order have been laid out above (section 4.5) and its study has been outlined below.

In relation to analysing the findings of this thesis, undertaken in the discussion section, the aims and objectives are to be partially open as to tailor it to the results collected and also guiding to direct analysis towards a statistically-grounded interrogation. To expand this point, analysis of a category's significance is somewhat dependent on their representation within the dataset (e.g. the representation of Ibex are few and sporadic in appearance across few panels, making statistical analysis of them unwarranted. This is opposed to reindeer (see section 10.4)). However, I aim to apply

statistical analysis on proportion ratios and standard deviation to extract potential patterns of animal representations that can be further investigated in relation to species/behavioural dependency.

The dataset shall be created by assembling a control variable which has absolute units of measurements (e.g. species) and then superimpose relational variables such as size/scale onto it. This will be done by studying such variants and converting them into statistics recorded in excel. This will enable them to be presented in graphs displaying the outcome of cross-analysis and combinability of variants and from there analysed in alignment with the aims of this thesis.

As to tackle the saturation of data collated in this thesis, combinability between variables of appropriate types (dependent on whether they appear across panels) will be localised to where they appear most frequent. Thus questions of visual grammar will be analysed with greater focus by centring them within their panel's setting where appropriate. However, any variable that appears adequately stable across the entire dataset will be analysed on that level of saturation.

Variable combinability is the backbone of this investigation, as is the best use of a statistically-centred dataset. Thus all derivative investigations necessary to answer the questions posed in the section below are in reference to variable combinability, or at least how uniform a certain variable appears in relation to others throughout the dataset or panel setting. The objective is to deliberate on these findings to explore their limitations and this naturally results in coming to a conclusion as to the extent of grammar within the cave's art.

Chapter 5 Questions for the data

The previous chapters introduced the data set studied in this thesis and the contextual background of the art and methods by which it is studied. The following chapters demonstrate how the data will be collected and processed. In order to make sense of the data and give direction to my analysis (co-occurrences and inter-thematic associations), I constructed a set of three questions derived from the core aims of this investigation, which are as follows:

- Are the features of an animal depiction influenced by its scale?
- How standardised are the anatomical proportions of different depicted species and does this vary dependent on their panel?
- To what degree do inter-thematic associations within the dataset demonstrate the existence of a deliberate form of grammar?

Chapter 6 **These questions structure the direction of the discussion set out in Chapter 10 (page 65). Each question is answered throughout the analysis in the sections within this chapter; the first being addressed in section 10.1.2; the second in section 10.1.3; and the third is repeatedly addressed throughout the whole discussion and further chapters, existing as a question most pertinent to this investigation.**

Methodology

Analysing and compiling a dataset of all the engravings from the illustrative representations available in La Caverne Des Les Trois-Frères (2014) requires a novel and consistent method of recording and quantification. This has been elaborated upon in this chapter. Although exact measurements are the primary form of recording and collecting data in this investigation, some analysis and cataloguing does not require additional methodological technique beyond common sense, such as an animal's species and orientation. These are examples of characteristics that are easily identifiable and therefore can be recorded categorically. The size on an individual engraving, however, cannot be transferred to the dataset in the same manner, requiring the design of a standardised system whereby a collection of measurements can be applicable for use on any species or animal – complete or incomplete (see figure 9 below). Synchronising the data is a necessary aspect of a statistical analysis, as Sauvet and Wlodarczyk (2008) make clear '[…] statistics can only operate on regularised data. In other words, data should be processed so as to give them a regular form allowing comparisons.' Additionally, this acts as a fundamental aspect for calculating the average size of an animal.

The anatomical references used to measure most depictions for entry into the dataset are as follows:

A) Muzzle terminal to nuchal crest (in centimetres);

B) Muzzle terminal to coccyx (in centimetres);

C) Width of body from dorsal to ventricle line (measured perpendicular to B line) (in centimetres);

D) Total length of dorsal line from muzzle to coccyx (in centimetres);

E) Hoof to hind on the dorsal line (in centimetres).

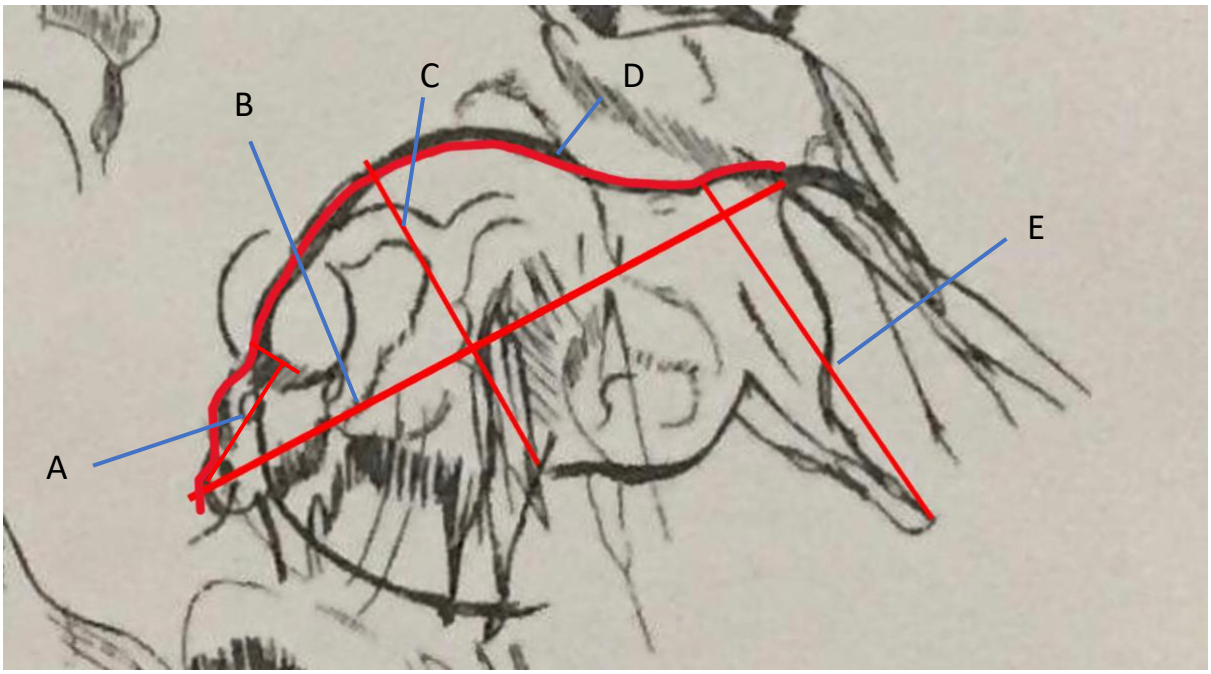


Figure 9: An example (taken from the *right panel*) with annotations showing the anatomical references points used in measuring the dimensions of an engraved animal.

As shown in the above figure, measurements are mostly taken in relation to the tip of the animal's muzzle, with the initial measurement taken from here to the nuchal crest (line A). This anatomical feature relates to the zoomorphic positioning of the ridge where the skull is connected to the anterior spine. These skeletal reference points are not visible in the cave art studied, but they remain relevant due to their positioning in relation to the depictions of fur covered animals where other anatomical landmarks are harder to discern. The nuchal crest is positioned just beyond the horns and ears on the dorsal line of the cranium. If the precise location of this anatomical reference is obscured, for example by the animal's head craning upwards in a bellowing stance, pushing the nuchal crest down below the neck line (figure 10), then the positions of the horns and ears are used to create an estimate.

The second measurement (line B) is a straight line from the muzzle to where the spine meets the tail. This measurement is the most informative indication to the animal's size as scale variants will be more apparent when measuring the length of an animal's body against another. Moreover, human error in measuring length is minimised as longer, straight measurements from one feature of anatomy to the other results in more accurate readings. Human error is an issue discussed under issues with the data below.

Line C is measured at a perpendicular angle from line B, thus standardising the features used in measuring the width of the body. This records the breadth of the body depicted, between the tip of the fur at the shoulders of the animal (in the above example, a bison) and the corresponding ventricle line at the ribs or stomach. Animals such as horse are consistently depicted without accentuating their shoulders, therefore measurements are taken at the lowest point of the back on the dorsal line and where it meets the corresponding ventricle. Species-specific size variables will therefore be apparent due to the difference in species size distribution: horses being a more slender animal, their 'abdominal width' measurement (line C) will be predictably shorter than a depiction of a stockier animal such as a bison. As such, this should not be seen as a defective record of an animal's size, but as a measurement that pertains to the different anatomical dimensions between species and will translate into their comparative overall body size.

The line annotated 'D' is a measurement taken from the muzzle to the coccyx via the contours of the animal's dorsal line. This measurement is of the most salient line of the animal (Meyering *et al* 2021; Hodgson 2008) and should be considered as a measurement that can approximately tell the size of an

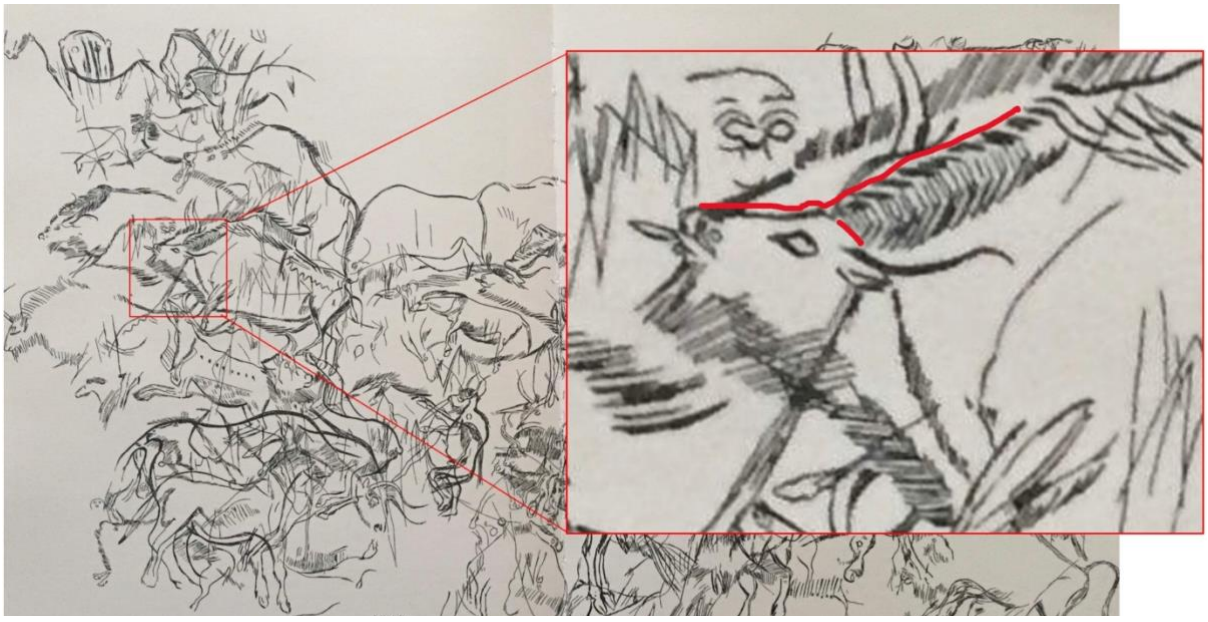


Figure 10: An example of a bison from the *right panel*, enlarged to illustrate how its stance effects its dorsal outline, bringing the nuchal crest down to below its neck (after Bégouën *et al* 2014:99-100).

animal no matter how contorted the body. This is because a hunched, high-shouldered stance that some depicted bison assume would give a shorter 'B' line reading than those whose length is elongated by a mid-running position, even if they both had the same dorsal length. Therefore, measuring the dorsal line's undulations calibrates the measurements of animals with different body lengths. As the dorsal line on all the engraved figures is depicted to be one of organic undulations, the measurement is the sum of multiple straight lines that can be measured by a ruler (measurement by string is too weak to hold the form of the undulations for accurate recording). Usually, this line is slightly longer than line B (see section 10.3 (page 74)).

Unfortunately, some animals have only the most minimal of features depicted/documented (for example, hind legs). Therefore, measuring the height of the hind legs as an additional precaution would mean that, for an engraved figure whose anterior is either lacking or obscured, a measurement from its posterior can still be taken. Standardised deviation can then be calculated and those animals lacking in anterior features are more easily incorporated into the wider inventory. Additionally, some engravings are comprised of one or more undulating or ambiguous lines and therefore cannot be included into this database, being immeasurable both for taxon identification and size (needing two identifiable features for there to be a measurement made between them).

Size is one variable that can be easily studied for its variations but without putting this variable *against* another to generate potential correlations, which leads to producing evidence of underpinning culture-specific grammatical structures, it is useless for the aims of this thesis. Therefore, one must compile a dataset that collects detailed but categorical data (so as to be put into statistics) from each animal depiction. In this respect, another aspect of the engravings that might relate to the formatting of the visual grammar is the animals' depicted behaviour. It has been the subject of structuralist research in cave art (Conkey 1989) and is simplified here into binary values for ease of cataloguing: static versus animate (standing vs in motion) positions being the most visually clear – and thus objectively measurable – dichotomy of activity.

In order to distinguish between an animal that is static or animate in these selected engravings, I described their particular characteristics – those that were not clearly engraved/represented were noted as 'N/A' for this category. The animals that were static have the following attributes and resemble those describing an animal in homeostasis: all four limbs are straight, from the body downwards; hooves/paws/feet are as one would imagine if the animal was not moving (perpendicular to the limbs and flat on the imagined 'plane' on which the art's author(s) depicted them); the figure is depicted in profile with the head pointing forward, the neck holding the head in a relaxed but upright fashion. An engraved figure must fit into all these categories for it to be listed as 'static', whereas it only has to possess one of the following characteristics of a body in motion to be listed as 'animate': one or more limbs are bent up to the body (possibly also extended limbs to stretch for the ground if running); a feature depicted multiple times to create a 'flip book' effect (Azèma 2009) on the animal; the head of the figure is either facing the viewer (not in profile) or is engaging in behaviour that does not conform to a homeostatic posture – this could be a craned neck or lowered but extended head and tongue indicating perhaps rutting behaviour (figure 10).

As mentioned above, the imagined ground or plane on which all the figures stand and it should be noted that in all cave art from this period the contextualising plane or even the environment of the animals is not depicted. Therefore, one must determine whether an animal is leaning at an abnormal orientation from the rest of the panel's depictions but still stationary in their limbs (all four limbs on the 'ground') or leaping up or down, and thus in motion. Usually, this can be determined by examining the positioning of the limbs in relation to the plane; if they extend in a diagonal fashion outward from the body then it is seen as a characteristic of a moving/jumping animal. If the limbs extend vertically from the body then the animal is stationary (if no other features of the body appear animate). The

orientation of the animal is, in itself, a subject of interest to be included in this thesis's inventory: animals either on a left or right bodily orientation (OL/OR) are distinguished from the orientation of the animals' head, i.e. which way they face (noted FL/FR). If the animal's body is depicted vertically (or at an acute vertical angle) then the animal is categorised as having an 'abnormal orientation' (AO).

Superimposed animals are not given their own category in this investigation as they appear in too varied a fashion, like incomplete depictions – with a range between minor or major overlap. However, unlike that of the incomplete engravings, which are of sufficient number to be statistically useful in this investigation (unlike those that are overlapping), the superimposed animals can be engraved across multiple animals. All this amounts to superimposition as a variable being unsuitable for the range of the statistics used here, which requires unpicking at a scale not fitting for the scope of the statistics applied to the wider dataset.
In relation to this, animals that display high levels of detail or additional signs (FD) are a minor category within the wider dataset, but are more relevant to include as variables ascribing to these graphics are more indicative of grammatical structure than superimposed engravings (see below).

An issue that should be noted before discussing the recording of the finds further is that between the *left panel* and *right panel* some animals are positioned directly above the viewer under the overhang. At that point, the rules of a collective imagined plane are eroded, with the viewer and artist/author alike having to disorientate themselves to see that part of the wall. The question is, does that leave the observations of an animal's orientation redundant as the wall morphology seems to be the primary factor that dictates the orientation, not human agency being applied at will? This will be answered in analysis from an artificially holistic viewpoint (section 8.4 (page 47)) in chapter 8: *Issues with the data.*

To continue, individual engravings have attributes that must be documented in order to collect the maximum amount of data possible to query the existence of potential variants concomitant to grammar such as orientation, levels of completion, etc. These attributes are separated into categories in order to make them more distinct as factors to analyse co-occurrences in the data. This means that one single engraving can occur in multiple categories if it possesses multiple attributes. Presented below are some examples of the categories used to departmentalise particular attributes of individual engravings into category format: in/complete (I)/(C); only head present (H); static/animate (S)/(A); facing right/left (FR)/(FL); orientated right/left (OR)/(OL). The last two may seem an unnecessary division between which way an engraving 'faces' and which way it is 'orientated', but this points out a dichotomy between observations of an animal's head and their body. For example, with the engravings that only have the animal's head present, one cannot know the orientation of the animal's body but know which way it is 'facing'. In retrospect, I found that throughout the dataset there was no instance of an animal's orientation conflicting with the direction of its head. Therefore, even though the bodily orientation may not be known for an animal that is only represented by its head, it is certain that instances of opposition between these variables are not represented in a substantial manner throughout parietal art to give it weight in argument. Thus, I have attributed any unknown orientation of a body to the direction of its head and vice versa (i.e. where an incomplete animal depiction is attributed to the category titled 'facing left', it means one of two things: the head is facing left but the body is absent; the body is facing left but the head is absent).

To further justify this simplification of the data, it can be argued that, when examining the art as a linguistically charged material, it would be counteractive for the author to introduce an explicit meaningful variable (in this case, an animal's body opposing the direction of its head) that the observer cannot determine. It is much simpler to overcome this false dichotomy between head and body orientation by ignoring it in the results and analysis, focusing more on the variables attributed to incomplete or 'head only' categories.

It needs to be recognised in this thesis that a semiotic system – communicative or otherwise – must not occur randomly and therefore is deliberate. In accepting this it puts into question how deliberately engravings were left incomplete (discussed below: incomplete depictions). Analysing this in the data on a par with, say, the choice of species in a certain panel, is to say that this information is just as important. Therefore this attribute should be regarded as a determiner of grammar as much as the other factors. The intentionality of incomplete depictions shall be addressed further after analysis of the results has been carried out.

An additional category has been generated for the inclusion of animals which exhibit Further Detail (FD). Engravings in this category have a larger visual impact on the viewer attributed by additional markings made by the artists. This could be by enhancing anatomical detail around the head (e.g. adding bone structure), or the inclusion of abstract signs within the animal's outline (e.g. zig-zag or arrow-shaped signs). This is an important category to include in this thesis as one imagines the technique of adding further detail visually elevates an animal above their surrounding depictions, thus ascribing importance to a small demographic – a visual 'exclamation mark', as it were - that might elude to an underlying grammatical rule within the art. Further discussion on this in relation to the results is discussed in the discussion. The same reason is why the inverse - ambiguous depictions - has also been included in the compiled statistics.

Documenting the various characteristics of the engravings in detail brings what are initially an illustrative representations from *La Cavernes Des Les Trois-Frères* into a qualitative dataset that can be observed and analysed from a pragmatic standpoint. In doing so, it enables the investigation to have a greater hold over the potential to extrapolate possible inter-thematic associations between the schematic engravings. For example, documenting the reindeer from *the chamber of small reindeer* without observing their behavioural differences would not have yielded the same level of insight into the importance of an animal's depicted behaviour in relation to their scale. However, not everything from these walls can be easily calibrated into a quantifiable spreadsheet when you have raw data as haphazard and organically-composed as, for example, the *right panel*.

The only attribute of the animals collected from Les Trois-Frères cave walls that cannot be displayed in a graph or compressed into a category are those animals that interact with each other (for example, face each other in close proximity or share elements of the same engraved line). Therefore, any findings shall be included in the *Results* and elaborated further in the discussion, developing into an alternative hypothesis of how the grammar is structured within these panels (see section 11.1).

Chapter 7 Methods by which the data is presented

There are lots of dimensions to each engraving studied in this investigation, so categories have to be made that are applicable to as many of these as possible in order to maximise the comparisons between them for statistical analysis. In doing so, grammatical characteristics could be rendered highly visible. This was seen as an important step in regularising the data to be primed for analysis by Sauvet and Wlodarczyk in 2008. They commented that 'data should be processed so as to give them [cave art] a regular form allowing comparisons' (2008:166). Because their dataset was a collation of an extensive amount of cave art, categories were essential to aligning specific depictions to one another, mostly taking into account species grouping. However, information saturation from Les Trois-Frères is lower and therefore categories can filter the depictions at a higher level, producing a higher resolution of results, which are as follows:

The recording of the engravings involved assigning each animal to its respective species and then working from left to right, documenting each animal according to such subdivisions. Because of the irregular matrix of the chamber's wall (see section 3.5 (page 32)), the panels themselves will be studied individually to create a category concomitant to spatial determiners. These will be presented in order of appearance from the source text, *La Caverne Des Les Trois-Frères*. Individual engravings that exist on their own panel, such as the 'sorcerer', are unable to contribute to this dataset which relies on relative categories within panels/species. However, they are known to exist as potential factors of size in themselves.

Examined in this thesis, there are 97 engravings overall, each with its own combination of particular variables (see *Appendix*, page 91). This could become overwhelming when presented as a graph and therefore a level of data isolation had to be applied, appropriating one variable as a base to see correlation with others. This approach to analysing the dataset puts the data into larger but still separate analysis for particular variants, and thus is unsuitable for digesting a dataset which may contain interconnecting variables. Therefore a medium must be negotiated that works for both isolating and collaborating variables with their potential dependence on their relative scale.

7.1 Box and whisker plot graphs

The closest I have found to this medium is a box and whisker plot graph which puts variables against their scale range, thus enabling potential scale dependence variables to be detected easily (see Chapter 9 Results (page 50)). Box and whisker graphs are designed to display ranges within data, using mean lines, quartile calculations and incorporating 'outlier' points. The range is thus divided into its constituent parts and can be analysed more thoroughly, eliminating occurrences of range data with one outlier point to be incorporated into homogenous ranges. For example, a data range might comprise of 5, 6, 7, 8, 9, and 50. Without acknowledgment of 50 as an abnormal value in comparison to the rest of the range, one would not be able to see this outlier as a divergent value. This therefore would not reflect the data as accurately as it needs to in order to maximally exploit analysis.

Complimenting this with a corresponding bar chart that collates the variables with their representation in the panel means more information can be represented on a compacted display. This is done on a panel-by-panel basis and works well when analysing variables by their particular aspects. To illustrate this point, I have used bison as an example: using this method of data collation, the range in size of the bison is presented (box and whisker graph) as well as how many bison there are (bar chart), thus complimenting the size of the range with the amount of bison present on that particular panel. This is important because some animal taxa appear as little as once on some panels and therefore documenting the size of multiple examples to create a 'range' is no longer possible. To counter this, the amount of Individual Specimens Present (ISP) in a range is displayed beneath the box

and whisker graph, thus illustrating the reasons for potential range sizes. As stated, these graphs may account for each other – for example, a variable that has nineteen values has higher potential for a larger range to be obtained than that of a variable that has three. Because of this, it is important to maintain constant reference between these two graphs when analysing the data in graph form. This is useful when understanding both how many taxa are depicted in particular ranges as well as calculating the percentage of certain taxon in the panel as a whole.

7.2 Pivot tables & t-tests

To take full advantage of Microsoft Excel as a data analysis software, other techniques have been employed, namely pivot tables and t-tests. Pivot tables present data more numerically and less visually than graphs but they are particularly useful for determining trends in categorical data, generating the sum of data rows and calculating relative percentages. Although size averages are often analysed in this investigation as number sets, so cannot be quantified into percentages; for example, the amount of reindeer that are animated compared to other species in a panel or as a complete dataset can be seen as a percentage.

Like pivot tables, t-tests are employed as a means of discovering trends and/or correlations in the dataset. This is more attentive to size and exploits the 'standard deviation' imposed upon the incomplete data entries. Using the null hypothesis, the average sizes of one variable is compared against those of a compatible other (that is, a variable that will generate a meaningful correlation). Sauvet and Wlodarczyk term the grouping of variables like this as 'combinability' (ibid.:172). For example, the size averages from complete and incomplete bison is a comparable trend that pertains to how levels of completion influence size in an animal depiction or vice versa (although a consideration of the factors of incomplete depictions' size must be made).

7.3 Standard deviation

In this study, standard deviation has been employed to determine whether individual species' anatomical proportions have been engraved to a high level of standardisation (i.e. are the necks of all the horses depicted to be shorter than their hind leg measurement, and if so, how strict is this correlation). These measurements shall be examined both on a panel-specific and cross-panel basis in order to open up discussion about the level at which the variation fluctuates. I predict that the standard variation of proportion sizes of different species will increase when collating data across multiple panels as larger amounts of data implies an exponential increase in variation.

Bison, being of numerical dominance, is a good species to select to examine panel-specific proportion standardisation in higher resolution. In seeing how standardised proportions are, and how strictly animals' features conscribe to a standard ratio, one can investigate the selective nature of potential grammatical structures through a statistic-lead lens.

7.4 Summary

To summarise this chapter, I have laid down systems by which the data can be analysed to uncover trends between variables (if they exist). That requires use of particular cataloguing to order the data in an accessible manner, as well as certain formulas to 'standardise' the data for use in comparative data analysis. The way the data was organised for analysis can be seen in the Appendix: Data derived from the sanctuary engravings as illustrated by Breuil. Although dealing with a certain reduction in the accessible materials, the engravings in this cave are homogenous enough to be studied without much dependence upon where they appear on the chamber's walls, making the inventory a manageable size for digestion.

Chapter 8 Issues with the data

8.1 Incomplete depictions

An animal depiction in the panel that is incomplete is problematic for two reasons: one cannot fully measure the animal's size; and neither can one be sure of its status as a deliberate – and thus justifiable – variable in the dataset, to be measured as part of a semiotic system. This variable and its issues are discussed at length as there are thirty individual examples of incomplete depictions throughout the dataset studied (with an additional thirteen represented by their head alone), which suggests it should be examined further than a typical anomaly.

As stated in the methodology above, all engravings documented in this investigation were measured five times (when available) at different points. For the purposes of this investigation, plotting the data series into graphs is essential, but data series with multiple values for each figure are not easily modelled into graph format. Therefore, the five measurements must be condensed into one average value. In all panels studied, there are examples of engravings that are incomplete, ranging between immeasurably minimal representations of animals (consisting of one faint dorsal line) to practically complete (for example, a depiction which represents the whole body bar their hind legs). In order to measure body size, different anatomical features must be present. Absence of such features create gaps in the dataset, consequently producing too few size values crucial in the calculation of an animal's overall body size. Because of the recurring nature of incomplete depictions throughout the sanctuary's panels, it can detrimentally effect the reliability of the size averages and corresponding interpretation of size variability. This is caused by a misrepresentation of an animal's overall size through immeasurable anatomy, resulting in body averages lower than they would be if its entire anatomy was present. Although the presence of incomplete specimens can be used to investigate what role it may play in relation to other variables, it is evident that its incorporation into the wider set of data creates a bias of size which might generate inaccurate conclusions if not righted. To combat this, predicted measurements have been calculated in place of the data potholes, making the dataset more functional for analysis without losing sight of which animals are incomplete. This is accomplished by using 'standard deviation', a formula that predicts certain values in a dataset by calculating size ratios between measurements in complete specimens and transposing them onto incomplete specimens, thus filling the gaps with a reasonable prediction. This means we can look at the dataset without excluding incomplete specimens on the grounds of bias averages, and thus widen the breadth of data analysis over larger and more compatible value ranges.

The second issue pertains to the wider discussion of the use of data to question deliberate semiotic systems that reside within the visual representations in this cave. To view this collection of art as an overt visual communication system, it needs to be seen as expressing a grammatical model or format. To simplify matters, words, as individual communicative units, will be used as an analogy for incomplete visual depictions in this cave's art. There are therefore two interpretations for incompletion: either they are seen as an abbreviation of a 'word' – meaning the need for completing the depiction is secondary in getting the semiotic message across; or as an unfinished word, which renders that unit as 'unreadable'.

Additionally, natural processes must be considered as a factor for an engraving's incompleteness: shallow engravings can be partially destroyed by the erosion of cave walls. This takes away from the human agency implicit in the dataset studied in this thesis. The only way to determine whether an incomplete depiction derives from deliberate agency or natural processes is by documenting the cave wall using high resolution imagery, thus one can look for indicators that distinguish erosion from incompleteness (CITE). This is not possible under the limitations of the literature review, and thus, for

ease of interpretation, one reverts back to examining the two interpretations of incompleteness as communicative units:

Each of the interpretations influence the way in which one views the dataset as a whole. If one takes the former interpretation to be the case – that the meaning is condensed into an abbreviated version of the original – then incomplete depictions may act as a tool to decipher the salient features of the grammatical rules: it points out which parts of a depicted animal are primarily needed, without which, the formatting of the grammar cannot be recognised. For example, if all depictions that are incomplete are of merely the bust of an animal (something that is not the case), then it suggests that whatever the grammatical format is, it pertains to – or is primarily attentive towards – the positioning, orientation and even behaviour of an animal's head. Secondary formatting is therefore, hypothetically, found in any of the further anatomical detail shown.

The latter interpretation – one which sees the engraving of incomplete depictions acted out with little interest in upholding any underlying grammatical infrastructure – puts the incorporation of incomplete depictions into the dataset, and the presence of a formal grammatical model within the art itself, into question. If incompletion does indeed mean there is a percentage of artistic output within these panels that adheres to a model of grammatical formatting which requires an entire animal to be depicted in order for it to be 'readable', then the question is this: how loose – or how present – are the grammatical rules if they are only selectively applied?

Both points are important and both lead to the same conclusion: one must examine this variable using statistical analysis in order to find where it fits into inter-thematic associations in the wider dataset. If no correlation occurs then it is important to re-examine this query in the discussion (see section 10.1.1 (page 66)). The same applies if correlation does occur.

8.2 Superimposition

Superimposition is a frequent and almost unavoidable aspect of cave art and causes an obvious obstacle to its statistical analysis when recording each depiction as an independent unit, statistically isolated from others around it. Equally, superimposition puts into question the notion of dealing with a temporaneous dataset, and further implying that the art studied was the product of multiple cultures, rather than the one. This leaves us with two issues that shall be resolved respectively below:

In this study, the overlap of depictions are a common occurrence and several appear to represent faint initial 'sketches' of salient features of animals. In this thesis, thematic associations between variables in the dataset – which is the main element underpinning this thesis – is analysed by the combinability between absolute and relational measurements (see methodology). Therefore, as an immeasurable quality to an engraving, a superimposition (which could involve more than the supposed overlap of two animal) cannot be easily reproduced alongside other variables in the dataset to produce meaningful findings overall.

However, these immeasurable qualities of cave art are explored independent to statistical analysis in chapter 10, where aesthetic explanations for variables in behaviour, orientation, species, etc. are explored as an alternative to the idea of grammatical determiners.

The issue of temporaneity is less direct and requires deducing from the literature reviewed: in style, the art within the sanctuary chamber at Les Trois-Freres belong to the same phase (cite), but that is not to suppose the art was created simultaneously, as it seems, evident in superimposition, that the art is composed of multiple phases. The time between two overlapping engravings is unknowable, due to the fact that chronological dating produces a margin of error and stylistic dating can only attribute it to a broad time span of an artistic phase. Therefore it is only practical to assume that the *use* of the

cave's walls were continuous between this indefinite period of the two animals being engraved as, whether overlapping or not, all engravings are executed using a specific repertoire that is applied across the panels: the engravers are exercising within set limitations of choice species, perspective, technique and other aesthetic rules that indicate a core cultural unity to the art.

To surmise, superimposition within the dataset probably does not elude to the art being the product of multiple cultures using the cave across a large time frame, but perhaps an indication of which areas were used more frequently. Then again, it was a trait of the Magdalenian cultures to use superimposition in their art intentionally (cite).

8.3 Uncontrollable variables

In line with this investigation, there are two variants in the data collection that cannot be controlled: one is a documentation bias in which the selection of illustrations studied for this investigation are wholly dependent upon the resources available; the other is in effect a result of the former: analysis of the cave wall morphology as a determining factor in the art's production. Because these aspects of the raw data cannot be studied personally, and are infrequently incorporated into the art's discussion in publications, this raises issues of resource limitation as particular variables may be (and have been shown to be by Bégouën (2014:242)) responsive to unseen factors (e.g. cave wall morphology). Both issues arise from the same point: data collection is not the result of direct observations of these engravings but instead collected by analysing selected illustrations by Henri Breuil and further photographs of the cave in La Caverne Des Les Trois-Frères (Bégouën *et al* 2014). Not only have these crucial illustrations been through a selection procedure before being included in the publications studied, but some are further restricted in their representation by the limits of the page border. This results in illustrated engravings on the periphery of a panel being inadvertently cut off (figure 11 below). Such issues create documentation bias for this investigation which has an effect on the dataset and will inevitably influence the conclusions. Therefore, one must acknowledge that conclusions from an incomplete dataset do not fully represent all that is present on the walls of Les Trois-Frères' sanctuary. The range of the inventory is further limited by the lack of scale reference in some illustrations and images, making what would appear to be a useful asset immeasurable and thus inapplicable to this investigation.

Figure 11: An extract from Breuil's tracing of the *right panel*: the dorsal line of the horse (top left) has been cut off by the page border (1958 in Bégouën *et al* 2014:99).

8.4 Analysis from an artificially holistic viewpoint

This section criticises the use of statistical analysis on cave art as an academic practice, from which I hope to convey that this investigation is one in which data is gathered and analysed whilst taking into account the bridled nature of human agency in artistic output. The cave 'artists' were constrained by the perceptual and physical limitations of cave walls and indeed the environment of a cave and this will have inevitably influenced and sometimes limited their work. This admittedly creates

discrepancies between the holistic approach of the data in this investigation and the real restrictions of artistic output.

In recent years, the morphology of decorated cave walls has been taken into consideration as an active component in how one should view art. Although it has been acknowledged in discussion of the subject throughout the 20th century (e.g. Alcalde del Río *et al* 1911; Breuil 1952; Lemozi 1929; Leroi-Gourhan 1992), it is only with the development of high-powered digital software that cave art can be analysed to an adequate degree especially in cases where one's perception of the art is dictated or guided by the wall's morphology (Sakamoto *et al* 2020). It has been realised that the undulations and irregularities in the cave wall have been deliberately used to accentuate the form or muscularity of particular figures painted over them, and thus determine the placing and dimensions of the cave's art. (Leroi-Gourhan (1971a) created the term *la caverne participante* to describe this phenomenon (Pastoors & Weniger 2011:3)). The most pronounced example of this is found in the polychrome chamber in Altamira (Perez-Seoane *et al* 1998:31). It is, however, hard to appreciate the extent to which cave wall morphology has been used in the engravings of Les Trois-Frères' sanctuary chamber, as it has not been discussed as a determiner of the art's formation within the literature studied. A large (53 cm long) depiction of a mammoth, for example, on the right wall of the sanctuary was engraved over a noticeably deep but narrow vertically-orientated undulation in the cave wall which was incorporated, one presumes, to indicate where the set of front and back legs separated (Bégouën *et al* 2014:136) (figures 12a and 12b).

Figure 12a: Engraving of a mammoth on the right wall of the sanctuary chamber, Les Trois-Frères.

Figure 12b: Figure 12a's illustration after Breuil (1958 (in Bégouën *et al* 2014:136)).

So perhaps, with the lack of substantial research on this matter, one would assume that where a depiction is incomplete, it is possible that the absence of engraved lines to depict certain body parts is instead indicated by features of the cave wall which resemble them. This can also be said for complete depictions which use undulations to accentuate form. The morphology of a cave's wall is formed by specific geological action and there is a limited scale to the size of the undulations. The scale at which these irregularities form therefore corresponds with the size of the art that appropriates the undulations, for example, a constituent part of the anatomy of an animal.

In Les Trois-Frères, it appears that the cave wall's morphology on the panels studied in this thesis does not exhibit irregularities small enough to be incorporated into the depiction of any individual figure. Having said this, the placing of 'the sorcerer' within the wider layout of the sanctuary chamber seems to be deliberate: it is engraved and overlaid with pigment residing in a cavity high up in the chamber overlooking the sanctuary. It is not conclusive from available publications or my own examination of the figure that the depiction of the sorcerer incorporated direct, deliberate use of the cave wall

morphology, yet its placing suggests that naturally occurring features of the chamber were exploited to endow the anthropomorph with importance, elevated above the rest (figure 8a).

Another feature of human agency not considered in the data is the access to light. As stated in Sieveking (1979), a restricted light source can light up a larger area without the light diffusing when put into an enclosed area of the cave wall. In Les Trois-Frères, we have potential evidence of rudimentary candles (ibid.:70) which would confirm the use of localised low light sources in the process of exploring – if not decorating – the cave system. Alongside this, the *right panel*, which exists partially under the curve of an overhang, is the most intensely engraved panel from the chamber and is one of many highly decorated panels in this chamber that exists close to floor level (see three tiered system (figure 8a)). Taking Sieveking's (1979) statements on light sources on board, this may explain the unbalanced distribution of depictions evident in the sanctuary chamber, alongside assumptions on how climbing up to reach higher areas in the chamber may restrict one's capacity to use fine motor skills, impacting artistic output. These factors are necessary for analysis but irrelevant when analysing the cave wall in a strictly statistical fashion. This produces a dataset of individual figures which are assumed to be a product of identical forces. These could be grammatical in nature, but the reality is a lot more complex.

Because of this, the analysis carried out here does not address the full extent of how the cave's environment dictates the placement and depiction of the engraved animals in the sanctuary chamber. It appears that the preferred panels were those that could be easily lit and accessed, leading to higher numbers of artistic depictions in concentrated areas. Because panels closer to the ground are more heavily populated with engraved figures, it may have affected the scale of individual depictions, and this will be developed further in the discussion (section 10.1.3 (page 69)).

Chapter 9 Chapter 8 **Results**

Mirroring the documentation of the animals for this investigation from left to right, the panels are presented in the same order, starting with the *right panel*, ending with the *climb to the sorcerer* and concluding with an analysis of the variables across all the panels.

Accompanied at the end of each panel's variable analysis is presented a figure illustrating the distribution of average sizes of each variable described.

9.1 Right panel findings:

50 engravings in total:
Bison = (n=30) 60%; Horse = (n=12) 24%; Reindeer = (n=3) 6%; Rhinoceros = (n=1) 2%;
Anthropomorph = (n=1) 2%
Static = (n=15) 30%; Animated = (n=24) 48%; N/A = (n=11) 22%

Incomplete and Head only:
Incomplete engravings range from 5.3 cm to 31.4 cm; 'Head only' range from 7.6 cm to 15.1 cm. The correlation present between degrees of incompleteness and average scale is predictable based on dependence on smaller length measurements where larger measurements were not available. Thus the overall average of an incomplete specimen is made using the smaller lengths between distinguishable anatomic features, narrowing the range of numerical values which constitutes an average. There is only a slight majority of incomplete and 'Head only' measurements for the first panel in bison (53%) (in the case of 'head only' values – all). All other incomplete values were horse and ibex, with no other Head only values. When identified, there are more incomplete examples that are animated than static, but there is an equal dispersal of animated examples throughout, as well as for those that are unidentified as either.

Complete:
These engravings range from 9.6 cm to 55.4 cm, with 23 examples (47% of all engravings present). Incorporated into complete engravings are all animal species present to some degree, but with bison as majority (which mirrors the overall representation ratio of different taxa). There is an equal distribution in the bison as either complete or incomplete. The only species which has only complete depictions is the rhinoceros, with reindeer only having one instance of incomplete depictions. There is correlation between complete engravings and depicted animation.

Facing right:
'Facing right' engravings range from 5.9 cm to 55.4 cm and as a variable constitute 30% (n=15) of all engravings from the *right panel*. There is no correlation between this category and static/animated dichotomies as well as varying degrees of completeness. Only bison, horse and ibex have examples where the depictions face right, with bison holding the majority (see above).

Facing left:
Engravings that face left range from 5.3 cm to 35.7 cm, with 35 examples (70% of all depictions). It is predictable that, when a variable constitutes a majority of the overall engravings, a similar trend is exhibited by the panel as a whole. Therefore, it is not surprising that most examples are complete and slightly more are animated. This variable encompasses all the examples of reindeer, and the one example of a rhinoceros and anthropomorph.

Figure 13a: The *right panel* as traced by Breuil (1958 (Bégouën *et al* 2014:99-100)).

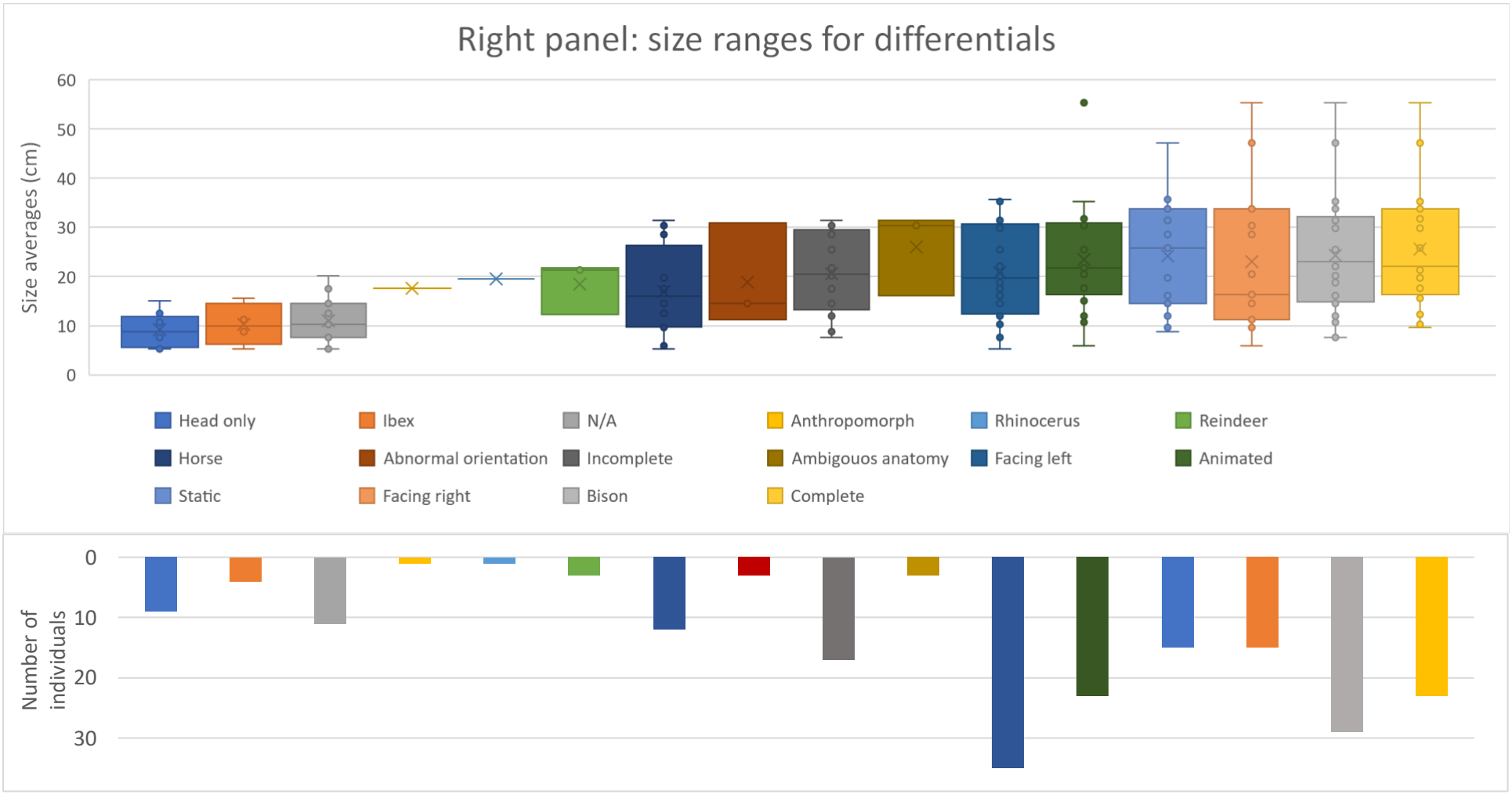


Figure 13b: Box and whisker graph showing the range of sizes for different categorical values for the *right panel*. They have been arranged in ascending order to emphasise differences between each category's size ranges. Below it is an accompanying bar chart which shows the amount of individual depictions in each category.

Abnormal orientation:
The engravings that are at an 'abnormal orientation' range in size from 11.2 cm to 30.9 cm. All examples are incomplete, with two bison and an ibex. There are only three instances of this in the first panel (accounting for 6% of all engravings), and both bison have their head facing vertically. The largest of the three – a bison – is animated (the others' behaviour cannot be identified).

Ambiguous anatomy:
This category was put in as a variable distinguished from engravings that are definitely incomplete from those that might have faded detail or obscurity in their features but where there is evidence that the original intention was to be depicted in complete form. Therefore, with only three examples, there was no expectation of a strong correlation in the data between this variant and any other - which was the case. One animated horse specimen (31.4 cm) had ambiguous anatomy because it was cropped by the border of the page in a published copy of La Cavernes Des Les Trois-Frères (Bégouën *et al* 2014) (see section 7.1 (page 45)). Both of the other examples are of bison (16.1 cm and 30.4 cm), one of which has been listed in this category as well as an 'incomplete' specimen. Therefore, one specimen can show signs of ambiguous documentation and erosion (Ambiguous anatomy) as well as a deliberate attempt to leave it incomplete.

Obscured:
The engravings in Les Trois-Frères are frequently superimposed on top of one another. When examining the *right panel*, for example, there are no individual animals that are engraved without superimposed lines intruding into their outline from either simple linear or curved lines branching through them (either 'parasite lines' (termed by Bégouën & Clottes (1991)) or by other animals crossing through them completely). However, these superimpositions do not obscure the engravings they overlap, and therefore this category has been made to incorporate those whose features are completely obscured by the superimpositions, thus narrowing the field for applicable engravings. There are three examples of this occurring throughout the four panels that can be sufficiently examined. For this panel, the example is a reindeer.

Further detail:
This category is of particular interest for this investigation as it seeks to find animals that have an elaboration of detail beyond the normal standard of depiction found in other animals. This panel has an example where a complete, left-facing bison (which has an average 31.8 cm) has a pattern running along its flank which is unlike any other animal depiction from this or any other panel. It is interesting to note that close to this bison is a reindeer which also has a pattern running along its flank, but when examining other examples of this species from other panels it becomes clear that this is a commonly found detail. The pattern along the bison appears in a zigzag formation. No other animal from this panel fits this criteria.

Static:
Engravings that are presented as inanimate or static range from 8.8 cm to 47.2 cm. Only bison, horse and one example of an ibex are represented in this panel by static examples. There is no correlation between this variable and the animals' orientation, but there was a moderate correlation between this variable and species, with bison making up 60% of the animals from this criteria (coincidently the same percentage as the bison overall for this panel).

Animated:
Engravings that have been depicted as characteristically animate range in size from 5.9 cm to 55.4 cm. This includes an obscured, abnormally orientated, detailed bison, and an animal that has ambiguous anatomy, encompassing the array of non-binary variables. It appears that more animated animals are depicted as facing left, but a level distribution in the other variables. There are more bison that are

animate than those identified as static/unknown, with 16 examples from an overall of 29. With horse, there is a moderate negative correlation with this criteria: 3 out of 12. With reindeer, however, a clearer correlation can be made: all three examples are animated.

Unknown:
All engravings that are indistinguishable between static and animated (11 examples equating to 22% of overall engravings) are bison, horse and ibex, ranging from 5.3 cm to 20.2 cm. The low range is perhaps due to the high correlation between this and depictions that are incomplete and those where only their heads are present (Head only). Within this, only two are facing right.

9.2 Left Panel:

12 engravings overall:
Bison = (n=9) 75%; Horse = (n=2) 17%; Ass = (n=1) 8%
Static = (n=10) 83%; Animated = (n=2) 17%

Incomplete:
There are four engraving in the *left panel* that are incomplete, including three bison and a horse, all of which are static (ranging from 9.4 cm to 37.4 cm). However, static examples dominate this panel and therefore it is not a significant correlation between incomplete and static engravings. Two of the bison are orientated left and there are no examples of engravings with only the head present.

Complete:
There is a majority of complete engravings in this panel which consequently encompass all taxa present (ranging from 11.4 cm to 64.7 cm). Many of these engravings face left, but the examples that face right include the largest and smallest depiction. This category also encompasses the two examples of engravings that are depicted as 'animate'. Because the majority of the depictions are complete, they also encompass other variables not apparent in the static category.

Facing right:
Three of the engravings that are depicted as 'facing right' are complete, but there is no dependence of species category. They range from 9.4 cm to 64.7 cm and encompass examples of all the species in this panel. This category is largely comprised of animals that are static, complimenting the overall trend.

Facing left:
All five examples of depictions that face left are of bison (ranging from 20.9 cm to 44.6 cm). This category encompasses the only animated depiction of a bison in this panel. Additionally, this incorporates the only incomplete example, both examples of animals lacking in detail, and the only example of an animal with abnormal orientation.

Abnormal orientation:
There is only one example of an engraving from the *left panel* that has been depicted at an 'abnormal orientation'; one static bison (measuring 41.3 cm) which is complete with its muzzle pointing left.

Lacking detail:
There are only two examples of engravings which lack detail and those are both static, left-facing bison, measuring 20.9 cm and 31.5 cm respectively.

Figure 14a: The *left panel* as traced by Breuil (1958 (in Bégouën *et al* 2014:124)).

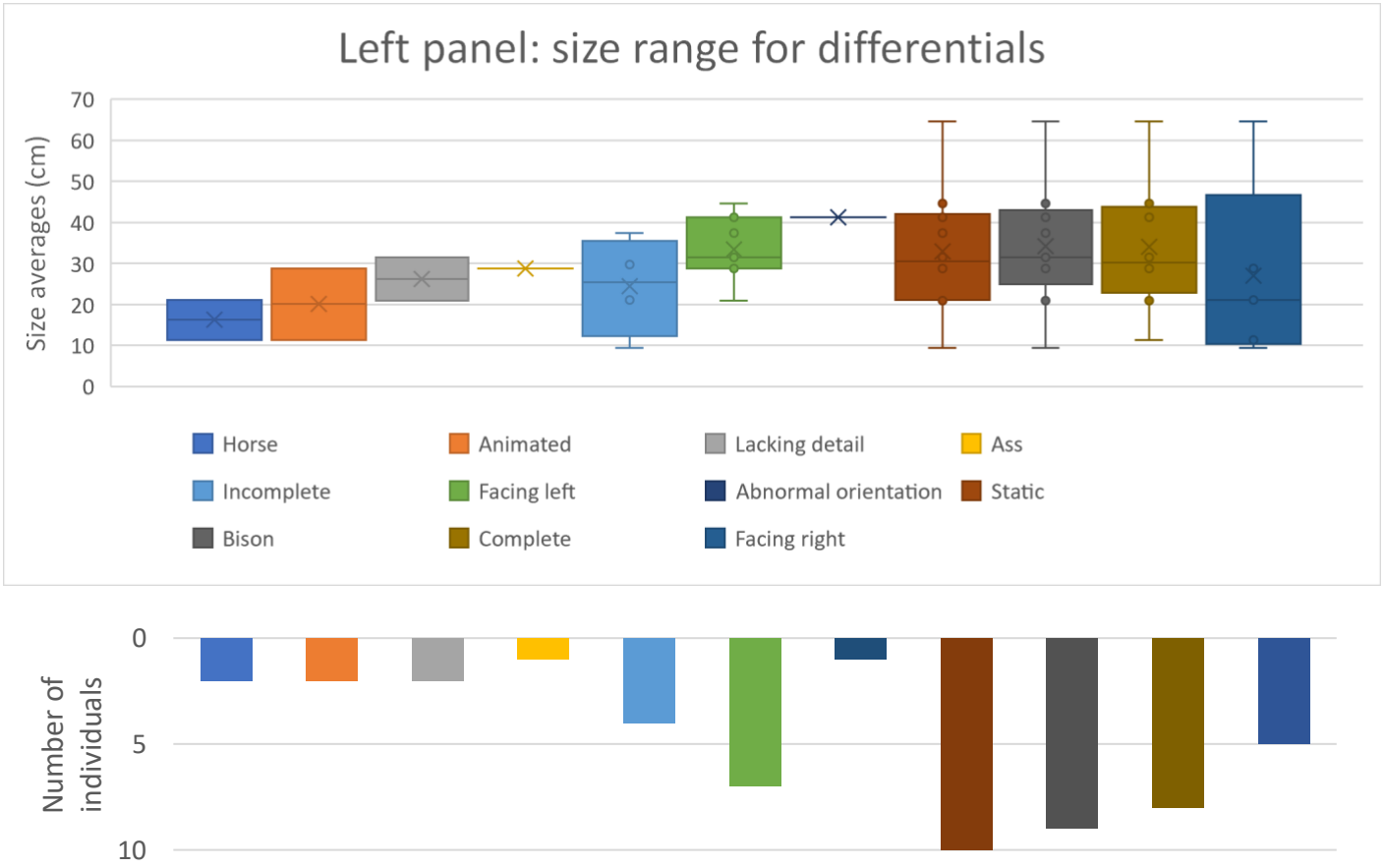


Figure 14b: Box and whisker graph showing the range of sizes for different categorical values from the *left panel*. They have been arranged in ascending order to emphasise differences between each category's size ranges. Below it is an accompanying bar chart which shows the amount of individual depictions in each category.

Static:
Engravings on the left panel that are static form a majority of the overall depictions, encompassing all species within this category.

Animated:
Of the animated depictions (one horse and one bison), both are complete but face different ways. They measure 11.4 cm to 28.8 cm respectively.

Unknown:
All engravings are identified as either Static or Animated.

9.3 Chamber of the small reindeer:

19 engravings overall:
Bison = (n=3) 16%; Horse (n=2) 11%; Reindeer (n=13) 68%; Ibex (n=1) 5%
Static = 42%; Animated = 48%; N/A = (n=2) 10%

Incomplete and Head only:
Animals that have been engraved without completion are made up wholly of reindeer depictions (representing 6 out of the 13 reindeer present in the panel), with half of these only represented by their head (Head only). These range from 6.9 cm to 19.3 cm, all of which face left, and two have unidentifiable behaviour (N/A) which makes distribution within this category hard to interpret.

Complete:
In contrast to this, complete depictions (12 out of 19 overall) encompass all taxa present, but are still dominated by reindeer depictions (58%). Complete depictions range from 11.1 cm to 29.8 cm. There are more animated examples than static or unknown but only by a small majority.

Facing right:
Engravings that face right range from 12.9 cm to 29.8 cm, representing a small minority (n=5) of the panel overall. This category encompasses all species to some degree, but there seems to be no correlation when observing static to animated ratio (where slightly more static than animated examples are present). There is, however, an absolute correlation between taxa that face right and complete depictions (although not all complete examples face right).

Facing left:
Depictions that face left range from 6.9 cm to 25.7 cm and make up 74% (n=14) of the overall engravings from this panel, encompassing the majority of examples that are depicted at an abnormal orientation and the only one that lacks detail. There is no correlation between this and the Static/Animated dichotomy.

Abnormal orientation:
Engravings that have been depicted at an abnormal orientation range in size from 7.5 cm to 26.9 cm (26% of all engravings). Within this category, which is composed of five individual engravings, there is one that is incomplete, two that are only represented by their head (Head only) and two that are complete. Of these, all but one face left. Most are reindeer, some are bison.

Further detail:
There are four instances where an animal from this panel has additional detail drawn into their depiction. All are reindeer, but the detail is not directed at enhancing or even exaggerating their anatomy, instead additional non-figurative designs have been engraved either leading into their

Figure 15a: The *chamber of the small reindeer* as traced by Breuil (1958 (in Bégouën *et al* 2014:127)).

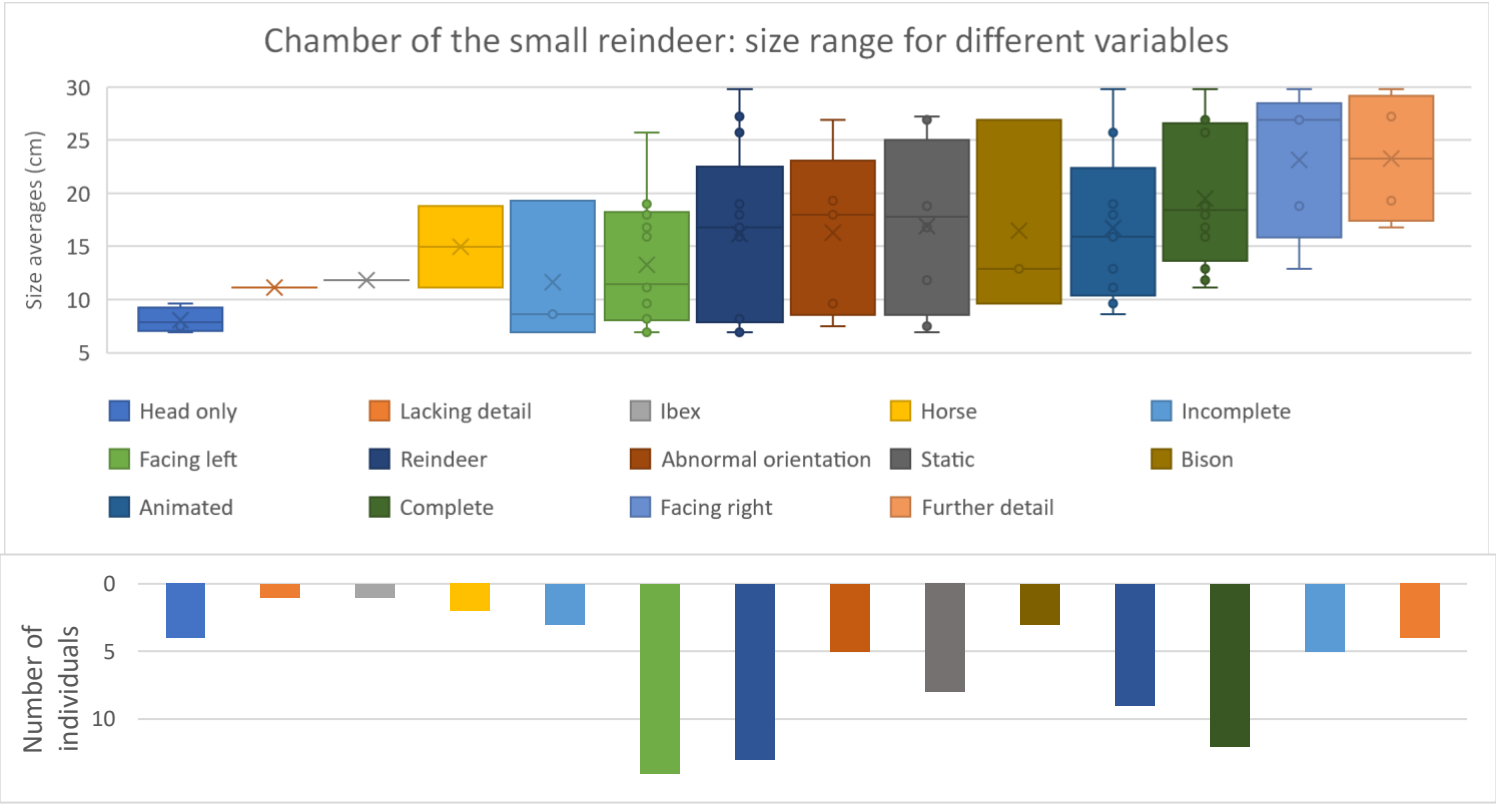


Figure 14b: Box and whisker graph displaying the range of sizes for different categorical values for the *chamber of the small reindeer*. The categories have been arranged in ascending order to emphasise differences between each category's size ranges. Below it is an accompanying bar chart which shows the amount of individual depictions in each category.

flank or within their outline. These resemble arrow-like symbols, which vary in number, trajectory, tail-length and visibility. The tail of these arrow designs intersect the belly of three of these reindeer, whereas the tails of the two arrows seen within the outline of the last reindeer are no longer than their pair of diverging 'wings'.
This last reindeer appears to either be lying down or awkwardly leaping, depicted in a foetal position – either interpretation leads to very different conclusions as to the meaning of these signs. What is also noted is that there is no co-dependence with any other variable, with different orientation, size and behaviour. As seen in the graph above (figure 14b), the average sizes of these animals have come to form the largest category of this panel. This has not been found to correlate with the size range for reindeer overall, y*et al*l animals that have further detail are reindeer. This suggests that the 'arrows' found on the reindeer depictions were applied to only to largest, most visual dominant animals.

Lacking detail:
The only example from this panel that lacks detail is a complete depiction of an animated horse that measures 11.1 cm.

Static:
Engravings that are presented as inanimate or static range from 6.9 cm to 26.9 cm, and mainly depict reindeer. In this variable, examples from all species are present. Most face left and are complete.

Animated:
Examples are mainly reindeer and range from 8.6 cm to 29.8 cm. There appears to be a stronger correlation (from those that are static) between this category and those that are facing left and complete.

N/A:
All examples that are indistinguishable from static or animated are incomplete, face left and reindeer.

9.4 Climb to the sorcerer:

17 engravings overall:
Bison = (n=1) 6%; Horse = (n=13) 76%; Bear = (n=2) 12%; Anthropomorph = (n=1) 6%
Static = 48% (n=8); Animated = 41% (n=7); N/A = 12% (n=2)

Incomplete:
Incomplete depictions range in size from 7.7 cm to 37.5 cm and account for 35% of the panel. All examples but one (the exception being a Bison which is too ambiguous to decipher its behaviour) are static. The same ratio applies to their orientation – all but one are orientated left (but not all left-orientated examples are incomplete). The majority (again, only one exception – one bison) of incomplete depictions are of horses with one obscured depiction. There are no examples of a taxon that fit into the 'Head only' category from this panel. This category encompasses all the animals that fall into the Unknown Facing group. There are four instances of this from within this panel encompassing all examples of incomplete horse excluding one.

Complete:
Complete depictions range from 11.2 cm to 32.5 cm and encompass the only example that lacks detail, with the majority of complete animals facing left but also incorporating all but one (out of the four) examples of right-facing animals. All animated examples reside within this category but also encompass static and unknown examples. This category accounts for 65% of the panel.

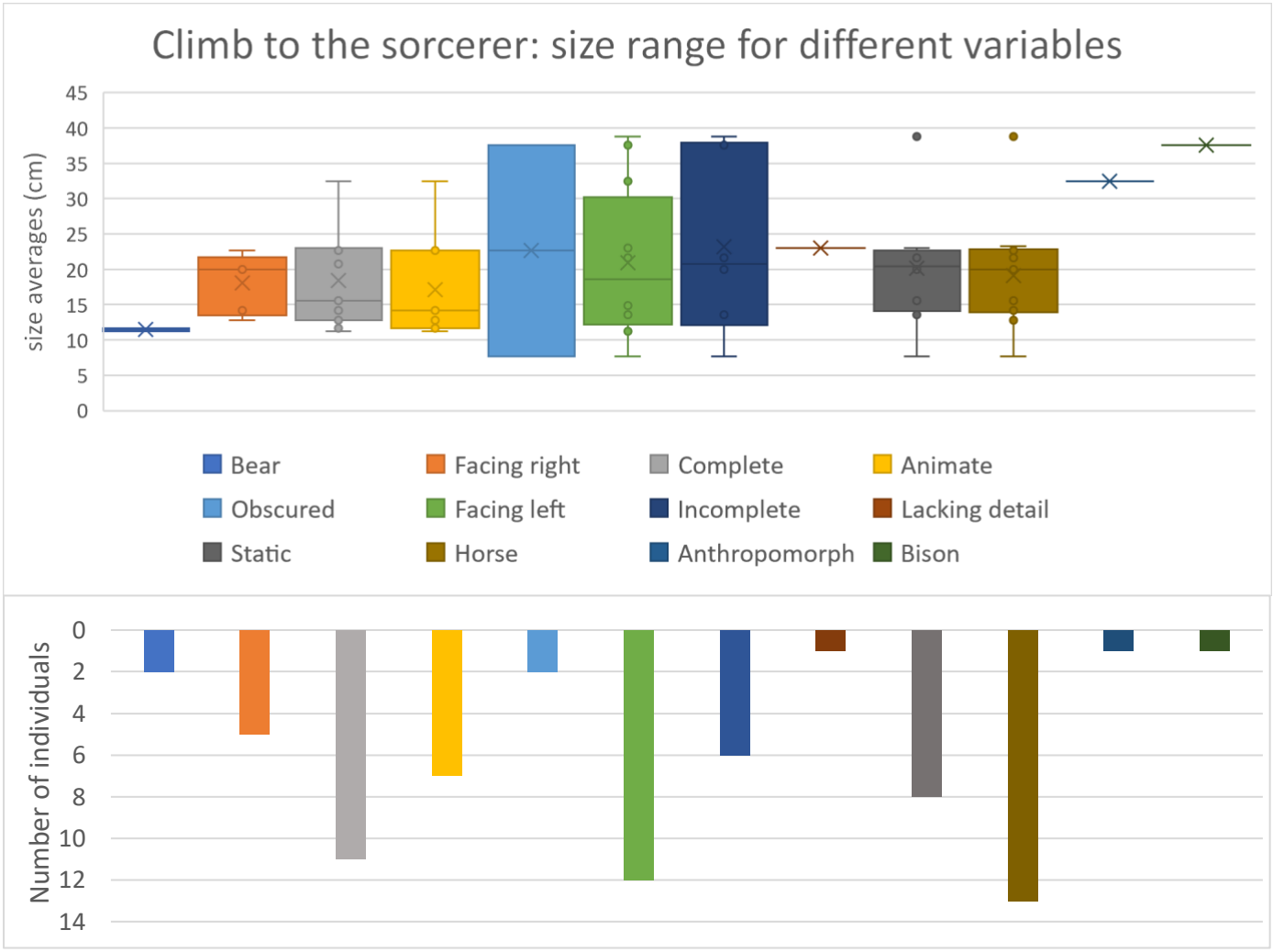


Figure 16a (top): The *climb to the sorcerer* as traced by Breuil (1958 (in Bégouën *et al* 2014:129).
Figure 16b (bottom): Box and whisker graph displaying the range of sizes for different categorical values from *the climb to the sorcerer* panel. The categories have been arranged in ascending order to emphasise differences between each category's size ranges. Below it is an accompanying bar chart which shows the amount of individual depictions in each category.

Facing right:
Engravings that are depicted as facing right range from 12.8 cm to 22.7 cm, representing a small minority (five examples) of the panel overall. All taxa that face right are horse but the large majority of the panel being made up of horse makes it unsurprising. All but one are complete.

Facing left:
Depictions that face left range from 11.2 cm to 38.8 cm and make up 53% of the overall engravings from this panel, with the most complete examples incorporated into that category. There seems to be a balance between static and animated distribution of examples in this category and it encompasses all taxa (being bear, bison, anthropomorph as well as horse). It should be noted that this panel is to the right of the sorcerer, and being called the '*climb to the sorcerer*', it would appear that this panel is a visual pointer or elevation towards the apex of the chamber. Therefore, an animal's bodily orientation may have been considered as an early use of 'leading lines' that point leftward towards the anthropomorph. This is discussed further in the next chapter.

Obscured:
All obscured examples are orientated left and incomplete, ranging from 7.7 cm to 37.6 cm, but apart from that both are allocated to alternative categories throughout.

Further detail:
Closer to the *right panel* than the chamber of small reindeer in the frequency of this variant, there is only one instance wherein a horse's belly, coincidentally depicted within a bigger bison's outline, is swollen with pregnancy and the cave's wall was heavily engraved and scraped along its ventricle line to exaggerate its contours. This is the only instance wherein detail has been used throughout these panels to exaggerate the anatomy of any animal.

Static:
There are eight engravings from this panel that have been depicted as static, with the range of 7.7 cm to 32.5 cm, all of these being horse. The majority of them face left and all are equally dispersed between in- and complete examples.

Animated:
Animated examples incorporate all taxa apart from the one example of bison, ranging from 11.2 cm to 32.5 cm. The one example of an anthropomorph – 'the sorcerer' – was incorporated into this panel (as, on the cave walls, the anthropomorph exists on a panel by itself). They are animated, measuring 32.5 cm, and the engraving technique was an addition to the predominant black pigment it was painted with. All animated examples are complete, wherein three (half) face left.

Unknown:
All engravings that cannot be identified as either static or animated consist of one incomplete bison and a complete horse, both of whom face left.

9.5 Overall

97 engravings overall:
Bison = (n=42) 43%; Horse (n=29) 30%; Ibex = (n=5) 5%; Reindeer = (n=16) 17%; Bear = (n=2) 2%; Anthropomorph = (n=2) 2%
Static = (n=41) 42%; Animated = (n=42) 44%; Unknown = (n=15) 14%

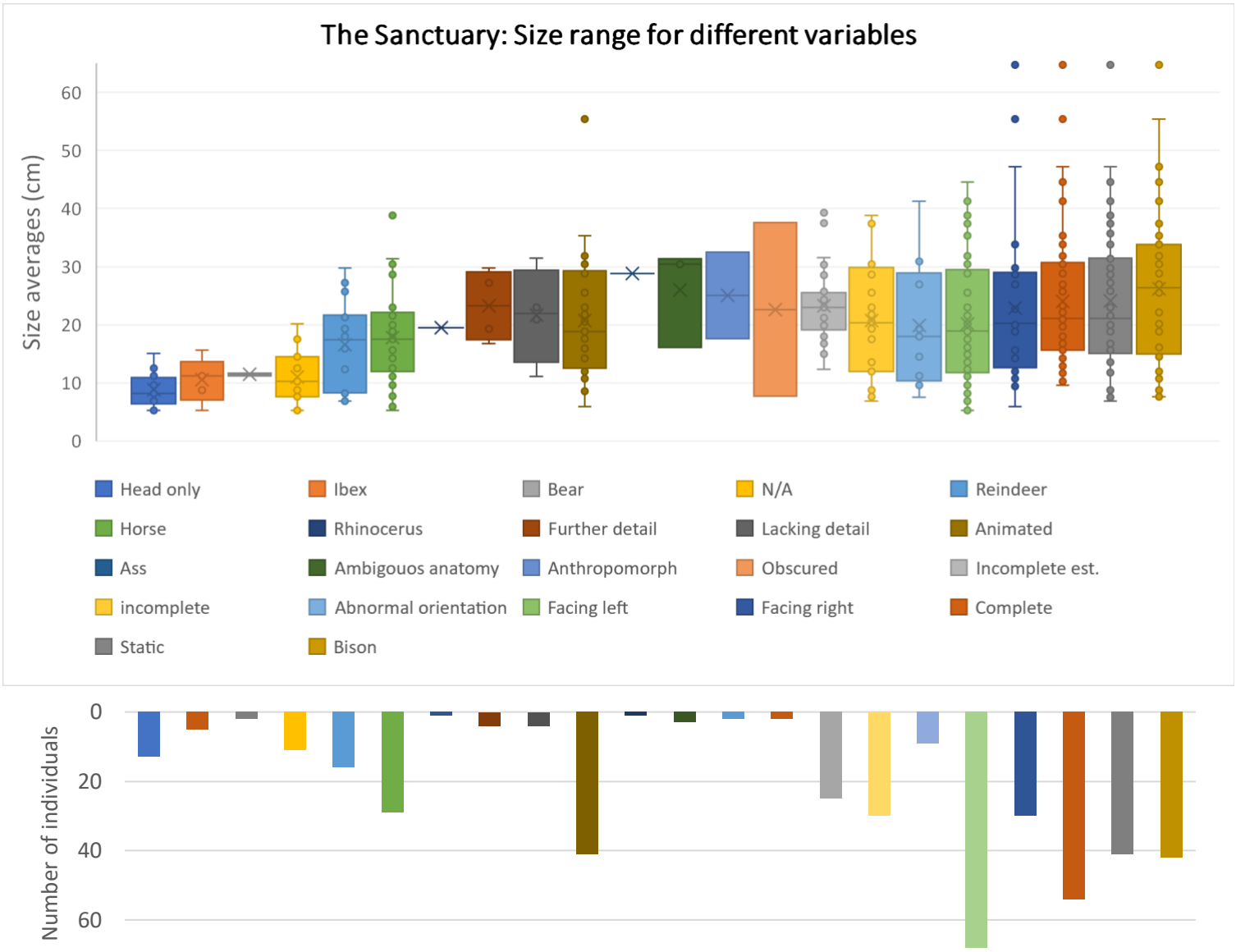


Figure 16: Box and whisker graph displaying the range of sizes for different categorical values irrespective of their panel. The categories have been arranged in ascending order to emphasise each category's size range. An accompanying bar chart shows the amount of individual depictions in each category. Below it is an accompanying bar chart which shows the amount of individual depictions in each category.

Incomplete (n=30):

The majority (73%) of incomplete depictions face left, with bison (n=16) as the species depicted as most frequently incomplete throughout. The *right panel* has the highest representation of incomplete examples (equating to 57%) and, overall, this category has the highest number of depictions wherein behaviour cannot be determined (Unknown). However, in the instances where behaviour can be determined, static examples have the slight majority over animated. 'Incomplete est.' displayed to the left of this category on the graph represents the size range for the *estimated* averages of incomplete depictions. As stated in section 7.1 (page 45), standard deviation was used to create an estimation for these values, hoping that by reintroducing incomplete size ranges as if they were complete, there would not be a bias pertaining to unmeasureable features that led to smaller average sizes. The new callobrated size range has elevated the lowest examples of the original 'incomplete' category, but the

two categories have the same range, with the new estimated incomplete category showing a slightly higher median and a narrower 'interquartile range' (represented by the 'box').

Head only (n=13):
All examples where only the head of an animal has been depicted occur on the *right panel* only with bison. There seems to be a strong correlation between this variable and animals that face left, with only three of the thirteen across all panels facing right. There is a level dispersal of the H variable across the three main species present, as well as ibex (all having three examples within their taxa representation except bison which have four). All instances of this variable exist within either the *right panel* or the *chamber of the small reindeer*.

Complete (n=54):
Complete depictions are the most frequent variable in all panels. There is a strong majority (33 out of 54) that face left. This is unsurprising considering the animals that face left have a strong overall majority over those that face right (54 over 30). Additionally, there is a very small majority of animated as opposed to static animals represented in this variable, which goes against the overall ratio of static to animated engravings throughout the dataset but only slightly. In terms of the taxa represented in this variable, bison are the most frequent – which equally corresponds with the overall representation of species. In the examples of reindeer, a majority reside in this category (10 out of 16), and all examples of abnormal detail are complete.

Facing right (n=30):
The large majority of animals that face right are complete, with those that do not being bison and horse. All other animals represented in their complete form reside in this category apart from the bears and anthropomorphs. Additionally, there are slightly more static than animated animals identified in this category.

Facing left (n=54):
The category in which animals face left seems to have exposed a dependence on animals that are abnormal in their form (lacking or elaborate in detail, abnormal orientation, ambiguous anatomy and obscured). Apart from four examples of abnormal orientation (4/9), all other examples previously listed are from animals that face left. There is a large dependence on complete examples in this variable, but it adds up to very little overall for complete specimens. There is a majority of complete specimens over incomplete for this category and bear, anthropomorphs and the majority of reindeer face left. However, there is no difference in whether an animal is depicted as either static or animated as they are equally dispersed. All but one of the animals with unknown behaviour face left (this category being mostly comprised of incomplete or otherwise ambiguous engravings).

Abnormal orientation (n=9):
The slight majority of animals at an abnormal orientation are complete and face left. However, contrary to the frequency of horse overall, there are no examples of this species that appear either diagonally or vertically on any panel – the majority being bison. The majority (6/9) are either incomplete or only represented by their head alone. However, there is no correlation between this category and an animal's behaviour (either static or animated). The panel with the highest frequency of this variable is the *chamber of the small reindeer* (but only equates to 26% of animals from this panel).

Ambiguous anatomy (n=3):
Those with ambiguous anatomy all come from the *right panel* and are orientated left. This is composed of two bison and a horse. See the *right panel* above for further annotations (page 50).

Obscured (n=3):
Examples where depictions are obscured do not have dependence on certain species (one bison, horse and reindeer) and appear once on the *right panel* and twice on the *climb to the sorcerer*. All are orientated left, but there is no further correlation.

Further detail (n=6):
There are only six examples of animals which have been engraved with additional detail. In the *right panel*, a bison is depicted with a linear decoration on its flank which mirrors the undulation of the animal's anatomy. In the *climb to the sorcerer*, one horse has been allocated this criteria as its ventricle line resembles that of a pregnant horse. However, the majority (four) of this category originates from the *chamber of the small reindeer*, and the additional markings are very different in design to that of the same criteria from other panels, having non-figurative additional designs overlaid onto the depictions of reindeer depictions. All animals from this criteria are complete (except one reindeer, whose hind hooves are missing), most face left and, when known, there is a slight majority of static individuals.

Lacking detail (n=4):
All animals that lack detail are both complete and face left. There is an equal distribution in this category between the static/animated dichotomy, however there is a loose dependence on species, as bison and horse are the only ones that possess examples that fulfil this criteria. These appear in all panels except for the *right panel*, with two in the left. They are all static apart from an animated horse from the *chamber of the small reindeer*.

Static (n=41):
Animals that are identifiably static appear to have a slight tendency to face left (which goes against the strong majority of this category overall) but there is a stronger correlation when examining the levels of completeness in which slightly more appear complete than incomplete. When observing the difference in number between static and animated categories, there is only a slight majority of animals that are static. There is no dependence on animal species or panel (with the panel distribution more equally dispersed). What is also worthy of note is the equal division between bison and horse in whether the animal is static, which goes against the majority of bison overall.

Animated (n=42):
The majority of animated animals depicted also face left, but the correlation is less strong. However, its correlation with bison is stronger. It incorporates both examples of anthropomorphs.

Unknown (n=15):
Examples that cannot be identified as either static or animated have an even dispersal of species, with a large majority facing left as well as complete.

Bison (n=42):
Bison are equally dispersed throughout the static/animated dichotomy, but there is more of a dependence on left-facing and complete examples. Bison have the most frequent examples of abnormal orientation than any other species represented.

Horse (n=29):
There are only slightly more representations of horse that face left rather than right, which is unusual as it goes against the overall ratio of representation. There is a more even distribution within the static/animated examples. There are infrequent (comparative to other taxa analysis) abnormalities in the depiction of horse throughout the panels (although they represent half of the examples that lack detail). Additionally there is a slight correlation between horse and completeness.

Reindeer (n=16):
There are less static than animated depictions of reindeer throughout the panels studied, with all but two facing left. This species seems to exhibit the most dependence on certain variables. There are some examples where reindeer are incomplete but the majority is complete. There are three of the nine examples of reindeer with abnormal orientation and this includes one of the highly interesting examples of further detail.

Ibex (n=5):
Of the five examples of ibex, three are represented by their head alone. This is the only example where the 'Head only' variable makes up a majority of a species' representation. Also, only one example of this species exists outside the *right panel*, which implies a spatial dependence not found as exclusively in any of the larger animals (bison, horse and reindeer). As a whole, it would appear, in line with the findings from the reindeer above, this species has a high level of variable dependence.

Rhinoceros (n=1) One example (see *right panel*)

Ass (n=1): One example (see *left panel*)

Bear (n=2):
The only two examples of bear depicted throughout are presented next to each other on the same panel, both facing left, complete, and animate. However, they appear to have a large deviation in size and proportion ratio (see below).

Anthropomorph (n=2):
Both anthropomorphs are complete, animate and face left (like the bear). The largest looks head-on to the viewer.

	I	C	FR	FL	ABO	AMAN	O	FD	LD	static	animated	N/A
Bison	31%	69%	31%	69%	12%	5%	2	0	5	48%	40%	12%
Horse	31%	69%	41%	59%	0%	0%	3	0	7	52%	31%	17%
Reindeer	37%	63%	12%	88%	19%	0%	6	6	0	31%	56%	13%
Other	20%	80%	30%	70%	10%	0%				30%	50%	20%

Figure 17: A table of animal type from across the panels with their variables in percentage. Here you can see the percentage of bison that face left and how many reindeer are animate.

Chapter 10 Discussion

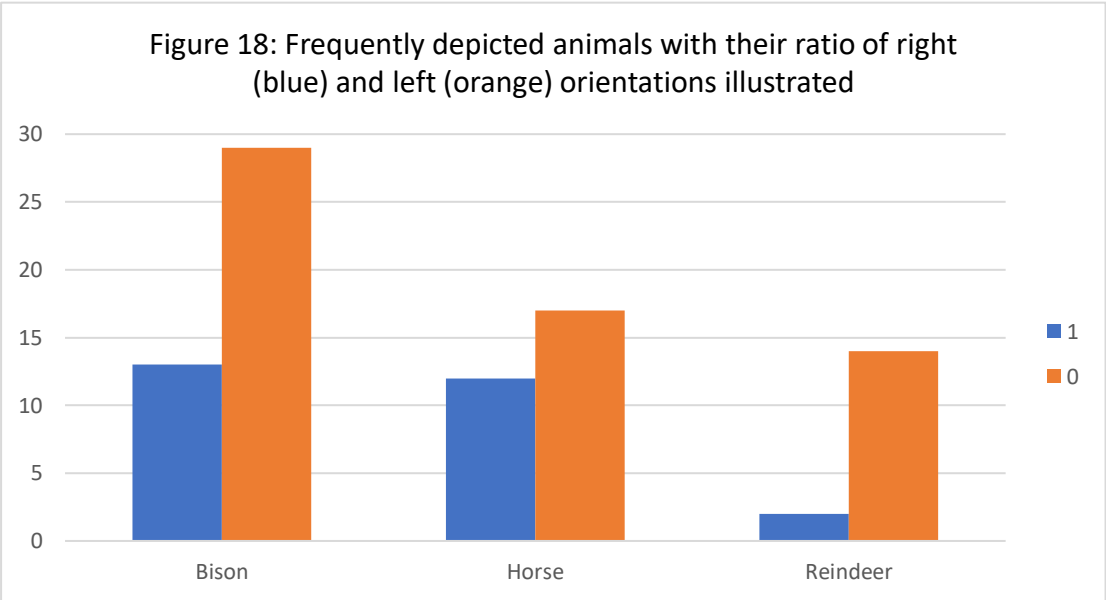
This chapter aims to contextualise the findings presented above with previous statistical analysis, aesthetic theory in cave art, and a wider discussion on what can be concluded from the results. The main work that is looked at as a comparison to the overall trends is Sauvet and Wlodarczyk's 2008 article which aimed to discover the basic levels of a visual language system within Western European cave art by using communication theory. The results above and their associated findings used different analytical techniques to the 2008 paper and therefore uncovers different elements of the inter-relations between variables. This has generated high-resolution results and is something which requires much analysis as it highlights the complexity of Palaeolithic visual art. Sections on examining animals with further detail, proportion ratios and species-dependent scale differentials are examples of additional analysis undertaken in this chapter below.

10.1 Overview and trends

Viewing the dataset as a whole, there are two variables that are most frequently represented, those being bison and engravings that face left. Like the dominance of left-facing individual engravings, the category of bison are only dominant in number, not individual size. Therefore, this observation might not be a direct link to what visually dominates on the cave wall (as seen in Pettitt 2020:212). Thus, co-dependence among variants in the dataset must be investigated to discover whether scale variants go with or against such 'norms'. The high frequency of bison is initially more worthy of note than the preference to depict animals facing left because the bison is a preference that dominates a wider choice of animal species also present such as horse, reindeer, ibex, etc. Horse was the second largest in number, and this preference resonates widely throughout comparative Palaeolithic cave art: in accumulating cave art from France and Spain, Sauvet and Wlodarczyk found that horse and bison were the most frequent species among the panels examined, constituting over 50% of all animals present throughout the 84 cave sites studied (2008:167). Again, the numerical component of their representation is emphasised here, leaving any discrepancies between this (i.e. number) and their *visual* dominance (size) unchallenged.

As for the second 'preference' in the dataset, the direction in which any of the (horizontally-orientated) animals face is better understood as a binary (either/or) choice, choosing between either left- or right-facing.

Figure 18: Frequently depicted animals with their ratio of right (blue) and left (orange) orientations illustrated



The fact that the data displays some dependence on one of the two choices is not surprising, given that even with a random input of data, a lean towards either of the two (no matter how slight) is an outcome that is almost impossible to avoid. However, with research that collates the orientation of particular depicted animals in Magdalenian art and the 'handedness' of an individual, this outcome in the data series may be less arbitrary than what first meets the eye and could even uncover potential species (or other variable) dependencies on right- or left-handed individuals: In a 1999 (Fritz), microscopic analysis of the engraved lines that composed Magdalenian animal imagery on portable artefacts, a wide-spread consistency pertaining to anatomical sequence in the engraving process was discovered. It concluded that the animal depiction started at the head and worked along the anterior dorsal length, then ventricle and posterior outlines before filling in the outline with additional anatomical details. If one was to start with the head and use that as a continual reference for scale and proportion for the rest of the body, then they would not want to obscure it with the hand they are engraving it with. Therefore, when studying handedness in animal depictions from a modern day sample, as Pettitt (pers. comm. 2021) did, their conclusions were in line with what rationally would be the case: 'right handers tended overwhelmingly to draw left-facing animals' (Pettitt pers. comm. 2021). Although this is obviously of importance to the current study as it can indicate directly how many individuals took part in the orchestration of the engravings at Les Trois-Frères' sanctuary and whether certain demographics corresponded to certain species, not just orientation, these studies were not undertaken on the material used in this investigation. It must be acknowledged that engraving a wall must be concomitant to different 'bodily obscuring mechanisms' (Meyering pers. comm. 2021) than engraving on bone or drawing on paper. However, if one was to take these disadvantages into account and proceed to analyse the attribute dependences in the dataset, then this is what they would discover.

The first thing to be noted is that the data reflects the ratio of left-to-right handedness in the current population: left-handed people making up a minority of the world's population. However, right-facing depictions make up around 35% overall. This is perhaps a reflection of only regional differences of the ratio, still pertaining to the fact that left-handed people were the minority in each case.
Secondly, comparing the two binary values exposes a subtle difference between the two, in that the depictions that face left encompass 23 incomplete animal depictions, whereas incomplete depictions that face right only amount to 7. There are also a lot more 'unusual' depictions from the former category – many of the representations that are either under- or over-illustrated than the norm reside in this category. Other than these findings suggesting a certain degree of completion and standardisation according to the artist's handedness, little else can be said. Even looking at it from species-dependence, most animals are not reliant on a certain hand to draw them.

Having said this, however, the only depictions of 'predatory animals' – bear and anthropomorph – (which amount to four individual depictions) are drawn by a person/s with a right hand (i.e. they all face left). Perhaps there is a line of enquiry to exploit in this finding, but it proves very little beyond a tentative suggestion that 'rare' or important depictions (this being assumed by their apparent scarcity) were left to the same demographic as those that were less regulated in their depictions elsewhere. Reindeer, too, were mostly drawn by right-handed individuals and therefore, being a well-represented taxon within the 'further detail' category (discussed further below in section 10.2 (page 72)), this demographic of artists may have been of a higher 'spiritual' status than the other left-handed artists as more 'notable' depictions were engraved under their hand.

10.1.1 *Incomplete depictions*

The other majority in the dataset of an 'either' over an 'or' (binary) variable is the number of depictions that are complete over incomplete. As stated in section 7.1 (page 5), one must identify the significance of incomplete depictions in relation to this investigation in order to ascertain whether they represent

grammatical abbreviations, invalidate their significance or hold no relevance at all, undulating with the variables as if complete. Numerically, those that are complete form a strong majority over those that are not, with 54 complete depictions over 43 incomplete or represented only by their head ('busts'). Animals with only their heads depicted were given their own category as the distinction between 'busts' and other depictions that lack anatomical features is notable. 'Busts' comprise 13 out of the 43 incomplete specimens.

It should be reiterated that the individual depictions that form the incomplete category are from all levels of incompleteness – from almost complete depictions with only minor features lacking, to the presence of animals that have only been represented by a few engraved lines. The fact that such a large variety of depictions were incorporated into one category that subsequently held the minority overall adds more weight to the finding that the more exclusive category of complete animals were still dominant. Due to its inclusivity as a category it is also hard to be convinced of its merit when attempting to ascertain co-occurrences between this widely-varied category and other variables. Average size, for example, can only be measured as an estimated value for this category by using standard deviations and therefore individual variations in size have been collectivised and redistributed in order to produce estimates which may be far from an animal's actual average if complete. This therefore deems an analysis into the combinability of these two variables redundant.
Initial analysis has already been made in the above section (section 10.1) concerning handedness, but examining the dependences of individuals represented only by their head has also revealed a certain handedness: of the 13 depictions, 10 face left (engraved by a right-handed individual/s). This follows the same co-dependence between incomplete depictions and handedness, and yet the 'busts' are consistent in their design and aesthetically formal enough to have suggested affinity closer to the 'complete' category, thus following their trends which is obviously not the case.

However, unlike the incomplete category, 'busts' were only apparent within the *right panel* and the *chamber of the small reindeer*, insinuating that their application was dependent on placement (but not species) more so than engravings that derive from the 'incomplete' category.

10.1.2 *Size differentials*

The differences in average body sizes between depictions (the 'size differential') is the most apparent variation within this dataset. Visual dominance (i.e. the way that larger depictions attract the eyes more than smaller within panels) has been discussed in relation to the specific techniques used in their creation (*section 1.2*) and to overall trends (*section 10.1* (*page 65*)). In the dataset, size differentials are expressed as numerical values, allowing statistical exploration of the potential relationship between image size and the other variables. I have therefore carried out such statistical exploration of the potential relationship between size and these variables. Below are the results of an Analysis of Variance (ANOVA). In ANOVA the statistics calculated is called 'F'. (In a t-test we calculate the statistic 't'.) The table reports the degrees of freedom associated with each test (i.e. df=x,y), the value of the F statistic, and the p value associated with that F value for those degrees of freedom. This is similar to how a t-test is carried out, except the first degrees of freedom for a t-test is always 1 and so is not reported. As shown, the ANOVA has resulted in three categories of depictions that become statistically significant in the way they relate to size differentials: the species depicted; animated by facing right; and animated by species (table 1). None of the other relationships are statistically significant.

The basic conclusion is that it is clear size varies in relation to the depiction's species; that static and animated depictions differ in size depending on whether they are facing right or left; and the extent to which sizes of animated and static depictions differ depends on species. The effect of species on the depiction's size is unsurprising given that each of the animal taxa depicted do differ in size, but I can at least conclude is that the desire to depict them in broadly relative size was a factor in the art's creation. This is not unimportant: despite the difficulty of engraving on stone walls the depictions do not simply float with no relation to each other, and although they do not constitute 'scenes' from life the concern to depict varying relative sizes, in addition to the high degrees of stylistic realism observed on all engraved animals indicates that the artist/s was concerned with a good degree of naturalism. The depictions had to feel right in terms of the accuracy of how they look; how they related visually to each other; and how they interacted through positioning and posture. Therefore, although nothing convincing has been found to suggest a unifying grammar in this source data, I do not resign to the notion that these engravings are random doodles, but that a method of appropriate statistical analysis has yet to produce results that conform to an idea of consistent patterns throughout.

To explain the certain variations in size, I reintroduce the idea of handedness and the subjectivity of grammatical structures resulting from multiple artists initially discussed in *section 10.1*. This could potentially provide insight into why those animals that face right and are animate appear to have a certain degree of dependence on size. What was unexpected within these significant results was the absence of size variants that were effected by which panel these images were engraved on. As noted in section 2.6 (page 24), prior observations on what factors within the panels effected the size of the engravings had indicated that there was a noticeable difference attributed to panel placement: there is a stratigraphic delineation of sizes that are separated by panel. Because this method of

Table 1: The most significant findings from size differentials put against all other variables.

Species	df(1,70)	F=5.875	p<0.0179
Animated by Facing Right	df(1,70)	F=4.030	p<0.0486
Animated by Species	df(1,70)	F=5.558	p<0.0212

statistical analysis has not detected such observations on the source material, the data has been revisited with closer association to this variable in section 10.1.2 (page 67) in order to detect any size variables apparent that can be attributed to panel-specific determiners.

10.1.3 *Panel population*

Discussed initially in section 3.6 was the hypothesised affect the density of a panel's figurative population had on the average sizes of individual engravings within such panels. This pertained to the idea of both a pre-meditated concept of a heavily-ornamented panel as well as Bégouën's (*et al* 2014) conviction of a three-tiered system in the sanctuary that divided the cave wall horizontally by scale, with the smallest depictions at the lowest tier and largest at the highest (see section 2.6). However, to what extent could one determine the mutual exclusivity of the two ideas? Perhaps it is better explained by the notion that more populated areas required smallest depictions and the less attainable reaches of the chamber were unpopulated and thus 'freed-up' the artist to be more liberal with their scale formatting. From the count of figures from individual panels, it would appear that those closer to the ground contained more concentrated depictions. Thus I predict that the average size of all individuals in a panel shall correspond negatively to the panel's density of population. To determine the average scale over population density for each panel, I have provided a graph for reference below (for the purpose of this graph, the sorcerer has reacquired his solitary panel status (panel 5)).

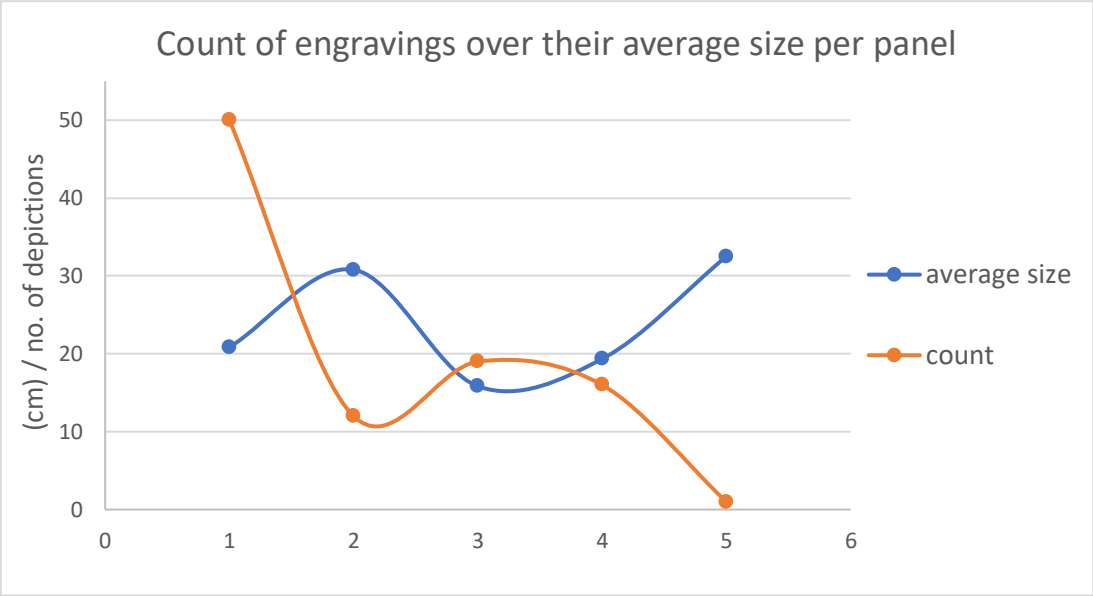


Figure 19: Graph displaying a 'double helix' design of average size (blue) and sum (orange) of each panel's population.

As was expected, one factor influences the other in symmetrically opposite ways. Yet this 'double helix' design that has occurred in the graph conflicts with the more linear prediction that there would be a positive trajectory of the 'average size' line and negative trajectory of the opposing 'sum' line. This may be that, in reality, the positioning of the panels are in actual fact only roughly associated with a meandering trajectory upwards and found in places that may have been easily accessible even though relatively high (see *chamber of the small reindeer*, section 4.5). Thus this data can provide adequate evidence to support the hypothesis that the scale of individual depictions are effected negatively by the density of the panel onto which they were engraved. This may have been an aesthetic rather than grammatical constraint of the size of these depictions, but even still, it is evident that an artistic structure was accordingly ascribed to these engravings.

However, proving Begouen's hypothesis is hard to do using the data collected in this thesis, as the panels studied do not represent an adequate sample to compare low panels with higher ones on the cave wall referred to by Begouen. However, with the inclusion in this thesis of the sorcerer's depiction high above the rest of the engravings and its respective scale, it would appear adequately convincing to suggest such a tiered system was in place. Although this, as mentioned above, may have pertained to accessibility if anything. Beyond settling the convictions of Begouen, what this shows is that there

is a discrepancy between how the cave wall was seen and the data recovered from the limited literature reviewed.

10.1.4 *Species-dependent scale differentials*

Examining the data in relation to species-dependent variables of scale is valuable to understanding whether visual grammar manifests within the cave's art through easily identifiable means. As panel 1 is the most populated, the representation of different species of animals depicted is higher (although this is not a standard trend in the data (see *chamber of the small reindeer*)). Therefore this is a valuable set to study when examining differentials of depicted scale in relation to species-determination. These determining factors of variables within the data is more pertinent when considering *relational* statistics, as scale is a relative measurement and therefore logically suited to a restricted visual 'unit', in this case a panel.

Calculating the average sizes of certain species' depictions is a good first step to take when understanding this variable within the dataset. Initially, making averages from one species' entire incorporation in the dataset across panels was considered but the results of this were mirrored different panels suggested that examining one panel's species variation magnifies overall trends without over-saturating the averages with broader data. In short, Bison have the largest average of panel 1 (28.8 cm), followed by Horse (19.1 cm), and in turn closely followed by Reindeer (17.8 cm). Another point to make when making the species scale differentials dependent on panels is that scale is a relative measurement between a depiction and those around it. Therefore, going back to the idea of a panel being one visual 'unit', it must be considered as an additional driving force behind the difference of average sizes between species. When comparing these animals it is interesting to compare these differentials to the sizes of these species in real life. An obvious issue with this is the use of the ancient horse breeds' contemporary counterparts as unrealistic substitutes when considering size (especially height). However, in Bernáldez-Sánchez & García-Viñas' recent publication (2019), the body proportions and colouring of horses depicted in cave art were studied in comparison to extant horse breeds today to determine which were most similar. The Konik breed was shown to have the closest bodily proportions of their ancient predecessors (2019:9), therefore we can use their anatomy as a substitute to those engraved into Trois-Freres' walls. Therefore, observing the body proportions of the modern-day examples of these species, it would appear that they are not only similar to the scale difference within the cave art but even match the relative distance between the average sizes for each species: Bison are 2.8-3.3m in length, and 1.8-2.1m in height; Reindeer at 1.8-2.1m length and 0.85-1.4m height; Konik Horses at 0.8m length and 1.3-1.4m height (Rousseau 2017:216). To convert these values into an overall average for each species, the average of the height and length were combined to make a single value, which equated a 'body' average. Bison body average is 252cm; reindeer 154cm; Konik 157cm. It must be noted that historically, European Bison were larger.

The results have been lain out in a table below:

Average body size	Bison	Horse	Reindeer
Engraved proportions (cm)	29.8	26.8	23.9
Real proportions (cm)	252.5	156.5	154

Scale difference (%)	Bison/Horse	Horse/Reindeer
Engraved	10.9%	12.1%
Real	61.3%	1.6%

Table 2: a) (top) The average body sizes of different depicted species from panel 1 in relation to their modern-day examples; b) (bottom) their respective scale differences between them.

On examining these tables, one can immediately see that there is a discrepancy between the scale difference of bison as a depicted species at Les Trois-Freres and how much bigger they are from horse and reindeer (two species that are close in size to one another in real life comparison but has a wider percentage difference in their representation than bison). Thus even though, as mentioned above, there is a trajectory in the art's scale differentials that matches the contemporary species in real life, it is suggestive of mirroring these real differentials to only a low level. This in itself is an interesting insight into how real observations of animals are brought together in a combined effort to accurately represent (though to a minor degree) the attributes of different species in *relation* to one another.

As mentioned above in the opening paragraph of this section, these variables are more easily identifiable when examining them by panel: when studying scale differences between species across the sanctuary, bison still have a bigger body average than the rest, but only by seven percent (as opposed to about eleven percent from the right panel), and the horse and reindeer averages are identical. It still appears, however, that the most pertinent difference between the animals seen in nature (i.e. bison are visually dominant in comparison to other frequently-depicted megafauna) is retained through collective/singular memory and transferred to the cave walls through art. This may not have resulted from an independently constructed visual grammar. Nevertheless, it demonstrates that integrity of a culturally-nurtured artistic constant was preserved to varying degrees across the panels, which prevailed the most within visually-isolated units of art (panels) where scale differences could be better measured against multiple species depictions.

10.1.5 *Summary*

To summarise this section, I have narrowed down the main arguments to bullet-points for ease of reference:

- Bison are the largest and most 'popular' animal taxon engraved on the panels overall, presented by numerical dominance. Its 'popularity' may not correlate with its visual dominance. Its dominance in scale correlates with real examples of its species in relation to other megafauna (horse and reindeer), where it has the largest body average.

- There is a substantial majority of engravings that face left rather than right, which correlates with an idea of right-handed individuals having the greater input to the creation of the panels overall.

- 'Special' animals are all engraved facing left (therefore by a right-handed author), including anthropomorph, bear and rhinoceros.

- Complete depictions outnumber the incomplete despite the latter category being composed of a more varied set of engravings.

- 'Head only' depictions have a slight dependency on panel but not of taxa.

- Animals that have been engraved on a densely populated panel are predictably smaller in average size.

10.2 Further detail

The above section examined the dominant trends in the data as a whole, encompassing any demographic within the depictions that were of a majority in order to discover implicit structuring of the cave's artistry. In this section, however, grammar is to be sought from a more marginal but seemingly selective aspect of these engravings – the individual depictions that possess the unusual attribute in this dataset of 'further detail'. This encompasses any depiction that has been engraved with additional semiotic symbols within – or going into – its outline; animals that indicate a highly important part of the life cycle (i.e. pregnancy); and any other animals that have unusual elements to their depiction.

This subsection of the paper is dedicated to the analysis of the first example of this particular category – semiotic symbols in association with engraved figures. The reason these are being elaborated on is because together they appear spatially close and appear to target particular species-specific populations within the panels. So too is there standardisation in the type of symbol employed – open angle and 'arrow-shaped' – which all points to the suggestion that a regulating structure or reference point was close at hand for the artist to have employed these symbols to such a deliberate degree.

Figure 20a: An example of clear 'arrow-shaped' designs on the flank of a reindeer from the *chamber of the small reindeer* (panel 3).

Figure 20b: Bison from the *right panel* (panel 1) with the zig-zag design on its posterior flank (circled).

From across the panel there are only five instances of individual engravings with non-figurative symbols drawn onto/into them: one bison from the *right panel* and four reindeer from the third panel (*chamber of the small reindeer*). The bison has a zig-zag design along its flank but the four reindeer all appear to have the open angle sign more common for this cave's stylistic date (see below). Besides the visual impact acquired by depictions that are further detailed, the reindeer from panel 3 that lie within this category have the highest range of size averages than any other. This is to say that all the individual depictions that form this category were without exception larger than the collective individuals that formed other categories from this panel. Its significance in relation to this paper is that this might suggest the presence of a co-dependent variable: the decoration of an animal's flank positively correlates with its average size. To determine its strength as a co-dependence, the average size of the bison (no. 5) from panel 1 is studied. It belongs to the same category as the decorated reindeer and therefore it should follow that it is also larger than the average bison. The decorated bison has an average measurement of 31.8 cm, exceeding the overall average of the bison from this panel (24.3 cm). However, exceeding the average does not equate to the level the decorated reindeer adhered to the largest average category in their panel. This being said, all the reindeer decorated with further detail have smaller average sizes than the bison from the *right panel* (ranging from 16.8 cm to

29.8 cm). Therefore these individual depictions are only large relative to the average sizes of other categories from their respective panel, making it clear that a depiction's affinity to its panel is necessary for visual dominance through relative size. How far this extends is unknown as positive correlations between relative size and other visual variables have not been found.

As mentioned above, the idea that this non-figurative design has semblance to the trope of a conceptually- or grammatically-charged symbol (rather than a sign) is furthered by a looser version of the same design found decorating the flank of an engraved horse on a sandstone plaquette in the adjoining Enlène cave. This connection between the examples below (figure 21) was initially made when Bégouën and Clottes examined the comparison between the portable art from Enlène cave and the parietal art from Les Trois-Frères (1991). In relation to the distribution of zig-zag designs across the two distinct caves, they suggested that the caves' art were not created by the same authors but shared the same 'conventions and concepts' (ibid.:77).

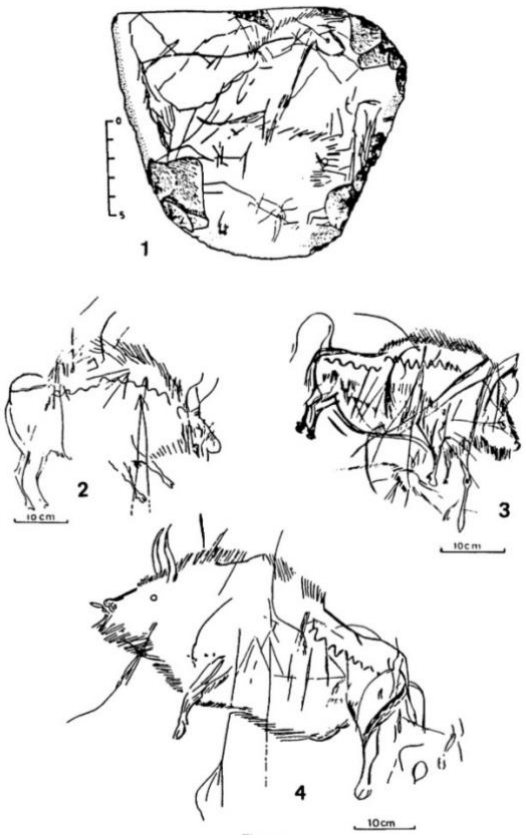


Figure 21:

Artefact 1 - The horse engraved on a plaquette/pebble from Enlène cave exhibiting a tentative, oblique zig-zag design along its flank;

Artefacts 2-4. Three examples of engraved bison with a more distinct zig-zag pattern from Les Trois-Frères.

(All after Bégouën & Clottes 1991:78).

It would appear from the above figure that there are two other instances from Les Trois-Frères cave of bison depicted with this zig-zag pattern ornamenting their flanks in the same manner as the bison from the *right panel* (the fourth illustration from the above figure). The other two examples of bison that were not included in the dataset for this investigation, and therefore unobtainable for further analysis, originated from a panel – or part of a panel – that I did not have access to (see section 2.6 (page 24)). As a consequence, what was previously seen as an exclusive example of non-figurative design on the bison is now revealed to be one of multiple, with the others even exhibiting open-angle signs that have semblance to the additional details present on the reindeer below.

It is also interesting to note that even though the instances from Les Trois-Frères of additional non-figurative designs were spatially divided by panel, a zig-zag pattern (from the *right panel*) can be accomplished if the open-angle signs depicted in the *chamber of the small reindeer* are repeated along a horizontal axis (turning a 'V' into a 'W'). Therefore, if the open-angle designs are seen as singular

units of a zig-zag, elaborated upon with the addition of a 'tail' line, then a connection between the bison from the *right panel* and the four reindeer from the third is made more immediate. Both appear in conjunction with one another in other cave sites and both are designs aimed at the flank of the engraved animals, furthering their connection and the standardisation of how the design was employed.

However, repeating the open-angle sign and creating a zig-zag pattern was comparatively rare throughout Palaeolithic art, only becoming more frequent with the arrival of the Holocene. This does not seem out of place with the stylistic dating of Les Trois-Frères, which is dated to the French Middle Magdalenian about 15,000 cal BP. In comparison, the open-angle signs, including when they coincide with animal depictions, are common occurrences in Magdalenian parietal as well as portable art (Igarashi & Floss 2019:205). Therefore, although spatially separate on different panels, the additional signs on the reindeer and bison respectively suggests Les Trois-Frères incorporated a mixture of well-used (and thus well-understood) symbols, with one more exclusive than most, both incorporated into these engravings via species dependence.

10.2.1 *Summary*

To summarise the section above, I have narrowed down the main arguments to bullet-points for ease of reference:

- There is evidence of non-figurative design evident on the flanks of a small number of engravings: 'arrow-shaped' (or open angle) markings on some reindeer from the *chamber of the small reindeer* (panel 3) and a zig-zag on a bison from the *right panel* (panel 1).

- The open angle designs have been attributed to the largest sample of reindeer from panel 3.

- A portable artefact from the sister cave of Enlène has evidence of a similar zig-zag design engraved onto the flank of a horse, suggesting a certain amount of symbolic design was shared between the authors of both caves.

10.3 Proportion ratios

To further investigate the possibility that animals in Les Trois-Frères were engraved under a governing grammatical format, the data has been arranged in order to establish which of the panel's animal taxa has the smallest deviation from a standard proportion ratio. In other words, which species was engraved in accordance to a predetermined idea of the animal's form? This is important to consider as it follows that the animal with the least deviation must have been engraved using a more restrictive set of grammatical rules than the rest. Furthermore it could lead to the suggestion that there is a partition set by animal species within the data that influences how the engraver engaged with grammatical bindings. In order to create a set of results from which one could deduce any conclusion (to the above effect or otherwise), the deviation from a standard proportion ratio respective to each species population per panel was calculated by first creating ratios through division of one length over another:

Of the five anatomical measurements initially taken for each animal in the methodology, four were used in the creation of ratios. The excluded measurement was the line going from the muzzle to nuchal crest (measurement A). By comparing this relatively small measurement with other anatomical proportions which were far greater in size would have created a ratio between them that was either too big or too small for adequate comparisons to the four other ratios produced. The base

measurement to which all ratios were created was the animal's body length, which is the most diagnostic measurement of the animal, as well as the easiest to measure, thus making the ratios more standardised and reliable. With this in mind, each proportion was measured thus: Body length / dorsal length (measurement B/D); Body length / body width (measurement B/C); (body length + body width) / hind leg length (measurement (B+C)/E); body length / hind leg length (measurement B/E). To see a visual demonstration of how these measurements were collected from the depictions, please refer to the *Methodology,* Chapter 5 (page 38).

Once this is done, each animal from every species has a corresponding ratio average with a standard deviation presented as a percentage of that ratio average. This helps standardise the deviation with the species' average, thus minimising results that reflect large measurements instead of large standard deviations. Although the issue with having incomplete specimens present in the dataset was partially alleviated with the calculation of an incomplete animal's estimated average, the individual measurements of incomplete specimens could not be. Therefore where certain anatomical references were unavailable, proportions ratios could not be calculated. Because of this, the line of investigation exhibited below is for those specimens which were complete. With this said, what is written below demonstrates that the complete specimens are still worthy of investigation:
To collectivise the results of standard deviation, a sum total of this was taken for each species population per panel, ordered from smallest to largest (i.e. smallest deviation to largest deviation throughout all four proportion ratios). When observing the average instead of the sum total of these measurements, the grading from smallest deviation to largest is the same, only the gap between standard deviation in different animal populations is more apparent when using the sum total of each measurement. Therefore the sum total has been used to enhance the visibility of these gaps:

Table 2: standard deviations of proportions for each species respective of their panel.

Species	Count of animals	M1	M2	M3	M4	Average	Sum	Panel
Horse	2	17.9%	11.5%	-	-	14.7%	29.5%	2
Reindeer	2	5.2%	6.5%	12.8%	14.7%	9.8%	39.2%	1
Reindeer	13	6.1%	11.2%	13.1%	11.5%	10.5%	41.8%	3
Bison	3	3.2%	12.9%	13.5%	17.5%	11.8%	47.1%	3
Bison	9	13.6%	13.5%	9.7%	13.1%	12.5%	49.9%	2
Bison	29	11.4%	12.2%	13.1%	16.5%	13.3%	53.3%	1
Horse	9	7.5%	20.9%	15.0%	14.0%	14.3%	57.4%	4
Horse	2	3.1%	19.2%	24.2%	28.6%	18.8%	75.1%	3
Horse	9	12.2%	15.6%	29.2%	27.2%	21.0%	84.1%	1
Bear	2	19.0%	43.1%	22.1%	34.2%	29.6%	118.4%	4

The smallest (39.2%) and second smallest (41.8%) sum deviations overall were of reindeer from panel 1 and 3 (*right panel* and the *chamber of the small reindeer* respectively). In panel 1 there are only two examples of this species depicted and therefore is unsurprising that they represent the smallest deviation overall (see below). However, the second smallest proportion deviation in this dataset is attributed to the reindeers found in panel 3. There are a total of 13 individual animals for this criteria, making up over two thirds (68%) of the panel's population. This result appears to be more substantial, with a restriction on deviating from a standard applied to a far greater number of individuals, thus repeatedly adhering to a certain range in proportion ratio. In ascending order from smallest to largest (narrow to wide) deviation, is the bison in panel 3. As the reindeer from the same panel possess one of the smallest deviation totals as well, this suggests that the animals on panel 3 were subject to a higher degree of grammatical fixture which was distributed to both species groups. This, however, is

only true for the bison and reindeer populations, as the two examples of horse have a sum standard deviation of 75.1% which is the second largest deviation throughout the set. As we shall see in the second pivot table findings, standard deviation is somewhat species dependent.

The next most rigorous standard deviation is of the same species (bison) population but from panel 3, of which there are 9 examples. However, one cannot tell whether horse – the only other animal present in this panel – is similar to that of the bison in its proportion deviation, as of the two examples one is incomplete and therefore a standard deviation between them cannot be accurately known. The bison population on the first panel, which has the largest species representation on any of the panels studied, has the sum standard deviation of 53.3%, the next largest of the dataset. After that, the horse from this panel has the next largest - 84.1%. As mentioned above, the reindeer on this same panel have the smallest deviation through the panels overall, therefore panel 1 embodies both the smallest and one of the largest of the deviations. However, the largest sum standard deviation of the panels overall was of the depictions of two bears from panel 4 (*climb to the sorcerer*) - 118.4%. This deviation sum is disproportionally large considering it was taken from just two bear depictions. Therefore, in both the smallest and largest case of sum deviation for this pivot table, they were the result of studying just two examples, putting into question the quantity of input as a factor of standard deviation in these cases.

To employ further analysis to the proportions' standard deviation data, each individual proportion was examined in order to see whether there was consistency in which one had the smallest or largest deviation. The first proportion measurement was assumed to be the smallest as it is the difference between muzzle to coccyx as a straight line and the same measurement but via the dorsal line, incorporating the contours of the back. For the nine species populations, eight of them have this predicted proportion ratio. The one exception is of panel 2 bison (*left panel*), whose smallest proportion ratio was the third proportion measured (M3) ((body length + body width) / hind leg length). The other three proportions from this population all sit within a small bracket between 13.1% and 13.6% (the largest being the body length over dorsal length measurement (M1)).

When examining the distribution of the *largest* deviation throughout the engravings' proportion measurements, it appears less regimented than the more predictable results of the smallest deviation (above). However, when examining these panel-by-panel and species-by-species, more structure emerges. In panel 1, where all the smallest measurements are from M1, the largest are from M3 (horse) and M4 (bison and reindeer). Panel 2's measurement for bison is the odd one out (see above). Panel 3 and 4 is similar to the first panel in that all their smallest measurements come from M1. Panel 3's largest proportion ratio comes from M3 (reindeer) and M4 (bison and horse). Panel 4 has the most regimented of any, with both bear and horse species having M2 as the largest proportion deviation. These findings suggest that on the level of individual proportions, there is a minimal indication of the presence of regimented, or ordered, governing grammar that sets perimeters on how certain species populations are depicted panel by panel. However, one can further explore this point in order to identify whether there is a species-dependent variation in standard proportion deviation. As there were not enough complete specimens of ibex and anthropomorphs from each panel to include them in the previous analysis, they will be introduced here.

Table 3: standard deviations of proportions for each species irrespective of their panel.

Species	**M1**	**M2**	**M3**	**M4**	**Sum**	**Average**
Bison	11.25%	12.44%	12.03%	15.34%	51.06%	12.76%
Reindeer	5.32%	11.81%	19.44%	17.14%	53.71%	13.43%
Horse	10.34%	17.72%	17.95%	17.22%	63.24%	15.81%
Ibex	4.76%	48.68%	9.42%	4.44%	67.31%	16.83%

Anthropomorph	14.29%	23.11%	20.50%	13.64%	71.53%	17.88%

After inputting more collectivised data into another table - now table 3 – observations on standard proportion deviation can be examined for species group irrespective of panel determiners. As before, the deviations are presented as percentages, dividing the standard deviation by the average, as was performed on the data in the first pivot table above. To certify no anomalies were produced when transferring the data from the first to second pivot table, the percentages produced for the second one has been cross-checked with the findings from the first pivot table and fit within their broad ranges. In isolating species grouping as a factor of proportion consistency, one is removing spatial determiners (i.e. different panels) from the equation. Therefore it makes changes in proportion more visibly accountable to species. There will be, as is the nature of the data, *some* variation in the result. On a surface level examination, the question of species determination is answered - proportions do vary dependent on species - but the data (and thus the proportion ratios) vary according to any factor one wishes to interrogate it with. Therefore one must acknowledge that *some* variation is arbitrary and random, whereas *significant* variation is merited with justification to suggest that the variation in proportion deviation is due to conscious determiners (such as grammatical rules/constructs) more so than random determiners.

It is evident from the results that the bison appear to have the smallest standard proportion deviation, with a sum of 51.1% in comparison to the other species present throughout the panels. This contrasts with the findings from pivot table 2 which segregates species groups into their respective panel, in which bison deviation is only of note in panel 2 (as it is only the bison standard deviation that is available). Reindeer follows as the second smallest (sum of 53.7%) by a small margin. This conforms to pivot table 2, where reindeer have a small deviation on a panel-by-panel basis, which may justify a stronger case for suggesting this species has a more observable connection to underlying grammatical rules that govern its more structured depictions. Horse follows, with a sum of 63.2%, around 10% more than the previous species - reindeer. This perhaps is a more significant gap than the one existing between bison and reindeer proportion deviations. Horse also consistently produces high deviation sums in table 2 throughout all the panels in which standard deviation is found for this species (that being panel 1,3,4). This consistency connecting horse with large proportion deviation should not be mistaken for a pattern in itself, as it represents constantly high levels of randomisation in its proportion ratios.

With only four representations throughout the panels, ibex have a disproportionally large standard deviation (second largest throughout). This presents an inherent problem in such forms of analysis, as few examples create a large standard deviation (the exception being reindeer in panel 1, table 2), which may be an overestimation and species which have more examples often have lower standard proportion deviation percentages. In this vein, it is with some caution that these infrequent species groups have been incorporated, concluding that the anthropomorphs (two examples of which are present throughout) have the highest sum percentage of standard proportion deviation (71.5%). The large standard proportion deviation of this 'animal' group - anthropomorphs - could, however, be the result of their depicted behaviour. The difference in posture and activity are factors that may manipulate proportion ratio more so on them than they do others. Therefore, comparison between two obviously unusual depictions and the wider dataset of quadrupeds (not just for this cave but throughout cave art of this period) is approached with caution. Distinctions of this kind have been made, with other authors in recent years distinguishing anthropomorphic figures from quadrupeds (Archambeau 1984; Fuentes 2013a; 2013b; Ucko & Rosenfeld 1972).

10.4 Reindeer

It is interesting to expand on the finding that reindeer are, of all the species, the ones that have come up as having one of the smallest standard deviation of proportion ratios (among other factors) because it might indicate that they were the product of a singular artist: the concentration of reindeer found in the chamber of the small reindeer suggests that there was some dependence of species depiction to that area of the sanctuary chamber (making up around two-thirds of that panel's depictions) and exhibiting a narrow deviation of standard measurements promotes the idea that they were the product of something beyond a grammatical structure attributed to one culture, and instead perhaps to one person.
This point is furthered by evidence of handedness (discussed in the above section) and the application of further detail to this species in the chamber of the small reindeer (panel 3). In terms of handedness, reindeer sit well above the other frequently depicted animals (bison and horse) for their dependence on orientation, as out of the 16 depicted across the panels, 13 reindeer face left. As discussed above in section 8.1, the direction an animal faces has been proven (in localised examples of engraved art) to correlate with the hand used in its production. Although an in-depth examination of the engravings using high-resolution digital recording methods to determine the chronology of mark-making is needed (see future work section), it would suggest the possibility that the *majority* of reindeer were engraved by a right-handed individual/s. In relation to the further detail attributed to animal depictions, a large majority of them (of which there are few) are found on reindeer from panel 3. As discussed in section 9, these semiotic signs are slightly varied in their form but all seem to ascribe depictions with addition graphic symbolism. This is supported by the fact that they are not liberally applied to the depictions but reserved to a minority within the dataset.

Count of FD	**Column Labels**		
Row Labels	**1**	**0**	**Grand Total**
Other		**7**	**7**
Reindeer	**4**	**12**	**16**
Reindeer	4	12	16
Horse	**1**	**21**	**22**
Bison	**1**	**40**	**41**
Grand Total	**6**	**80**	**86**

Pivot table illustrating

With all this evidence, it seems undoubtable that reindeer were allocated to a different and distinct criteria of depiction which may have occurred through restricted production – one where it was ascribed to a singular individual. If these were engraved by one individual artist, it could have interesting implications for promoting the idea of species-specific artists across panels. However, the qualities that one can ascribe to the reindeer as an indicator of their link to one individual are not present in other animal populations. Moreover, many of the aforementioned qualities can be attributed to the few other species engraved on panel 3, so suggests that perhaps this panel – and not a particular species – attracted special attention.

10.4.1 *Summary*

To summarise the section above, I have narrowed down the main arguments to bullet-points for ease of reference:

- When analysing the standard deviation of proportion ratios for each species on a panel-by-panel basis, the reindeer and bison depicted in *the chamber of the small reindeer* (panel 3) were the smallest (excluding the horse which had a large standard deviation). For its

population size, the bison from the first panel was relatively small too, with the largest deviation coming from the horse from the *right panel* and *climb to the sorcerer,* incorporating the bear from the latter panel too.

- What seems to have the narrowest proportion ratio from all four measurements is determined by panel and by species, with the most regimented coming from horse and bear from *the climb to the sorcerer* (panel 4).

- When analysing the standard deviation of proportion ratios with species as its sole determiner, bison have the smallest deviation followed closely by reindeer. Horse come after with a distinct gap between. Then ibex anthropomorph and bear but this grouping is approached with caution as determiners such as size of population, posture and behaviour (the latter two concerning the anthropomorphic depictions) are factors of standard deviation in themselves.

- Reindeer have been engraved with an unusual level of standard deviation, unifying orientation, additional semiotic markings and panel-dependence. They were produced with qualities that are so synchronised to an elevated sense of unity that it heavily suggests the majority of this species' production was ascribed to an individual artist.

10.5 Statistical analysis and other means of investigation

In the statistical analysis of cave art, as mentioned previously in this chapter, the relation between depictions is lost in categorising each figure individually, overlooking the visual elements of the panel as a whole. The investigation of cave art by Sauvet & Wlodarczyk's (2008) discusses this disadvantage of isolating semiotic groups for a clearer input into analytical software. They use the cave of Chauvet as a case study, stating that '[a] point to consider at Chauvet-Pont-dArc is the *construction of the panels*. Two of them are particularly interesting because of their amplitude and *complexity*' [author's italics] (ibid.:176). Here they refer to the inter-relations between panels forming spatially organised scenes in triptychs (Panel of the Horse) that even dictate onto which panel an animal species should be placed. They conclude this insight by adding that '[…] such a complex pattern shows that the thematic composition of a panel is only a part of its meanings. The figurative syntax and the morphological features of the individual figures are also very important'. This acknowledgement that the minute variations in how figures have been drawn/engraved/painted on an *individual* level transgresses the premise of a statistical analysis. Yet when understanding the grammar of this haphazard visual culture, it may be a productive line of enquiry. Therefore an additional chapter below has been composed in order to find out whether the dimensions of engraved figures at Les Trois-Frères are indeed influential to the panel composition and thus concomitant to a grammatical structure.

Chapter 11 Alterative hypothesises

As the data set studied was not able to produce an adequate indication of grammatical formatting through statistical analysis, I returned to the depictions themselves to analyse the art form in a manner that excluded the categorisation of the depiction's attributes. This is a chapter that aims to deliver the possibilities of alternative suggestions as to how this art was structured.

The deconstruction of the cave art by means of statistical analysis has revealed that this art is constructed on a grammatical basis driven far more by fluid aesthetics than by ordered criteria. This is not to say that there is no pattern that cannot be discerned from criteria and statistics alone, and instead what seems to have developed in this case is a haphazard hybrid wherein multiple animals interact aesthetically with one another through the use of negative space (something that parallels the use of cave wall morphology) and, almost countering that, instances where aesthetics are ignored – abstract lines intersect across bodies and features are obscured by other animals drawn over them. When viewed panel by panel, or by individual species, certain patterns emerge (see *results*) but it does not equate to something one can deliberate on with certainty. It is the same with standard deviation – some species, such as reindeer, do have higher levels of standardisation than others but it is a tiered system that does not remain stable when different variables are applied.

11.1 An aesthetic explanation

Collecting the data in a digital capacity may have disrupted the search for grammatical patterns. Moving from a statistical analysis to a more intuitive approach, I revisit the panels to assess the nature of grammar from an aesthetic point of view, the results of which have been very interesting. This may, to some degree, undermine what this investigation aimed to achieve through statistical means, bringing into question what determined the variations in proportion ratios, orientation, behaviour and size of individual animal depictions. In some instances, these variations may have come from a motive more sympathetic to aesthetics than standardised, covert coding. To expand upon this idea, the left panel and the chamber of the small reindeer have been sampled as examples where aesthetics appear to be a contributing factor for their existence. Accompanying annotations of the panels' animal representations have been included for ease of reference.

The aesthetic hypothesis expanded on below is in tune with Conkey's innovative study of cave art which integrated the artists themselves into the discussion around parietal art from this period (see *section 2.4* (page 21)), taking into account many more human relations potentially being mirrored through the animal representations.

To analyse the engravings of Les Trois-Frères sanctuary chamber in this thesis, a very unstructured and organic composition of animal depictions had to be formed into a set of numbers and data (see Appendix: Data derived from the sanctuary engravings as illustrated by Breuil. (page 91)). This neglected to address how depictions of various animals corresponded aesthetically with each other, such as when the contours of one animal's outline mirrors, or is appropriated for, the contours of another. For the examples presented below, however, the dynamic does not seem to be derived from the pairing of two animals together through a shared outline (although this is recurrent throughout other panels presented in this investigation and decorated caves beyond Les Trois-Frères), but rather the outline of one '*central* animal' was observed and respected by the outlines of animals in close proximity. This can be seen in the way their outlines do not intersect with that of the 'central animal'. Instead they actively appropriate the available negative space by taking into consideration the 'central animal's' orientation, size and proportions. On examining the *left panel* (figure 22 below) the eye is immediately drawn to what I will be referring to as the central animal, a large bison. This stands out as a dominant figure in both size and the high level of detail ascribed to it. The sense of its power is

conveyed through its large horns, prominent mane, muscularity and overall stature. Even its expression shows neither fear nor aggression suggesting a comfortable position of dominance. It is depicted 'on top' of the other animals which probably directly correlates with its ecological status on the steppe (Pettitt 2020:212). The second example comes from the *chamber of the small reindeer*, whose 'central animal' is a relatively small and marginal character when viewing the panel as a whole. However, in case of confusion as to the term 'central animal' I shall reiterate that its characteristics are defined by its aesthetic relation to other animals, where its outline is respected on multiple occasions by multiple depictions. Overall, this opens the possibility that what underlies the variation in some of the depictions is not in fact a fixed grammatical coding, but actually determined by how *appropriate* an animal's depicted design is (that is, what constitutes their representation in visual variables i.e. size, orientation, etc.) in relation to certain animal's outlines and the negative spaces it creates.

To demonstrate this point further, the first example is presented below:

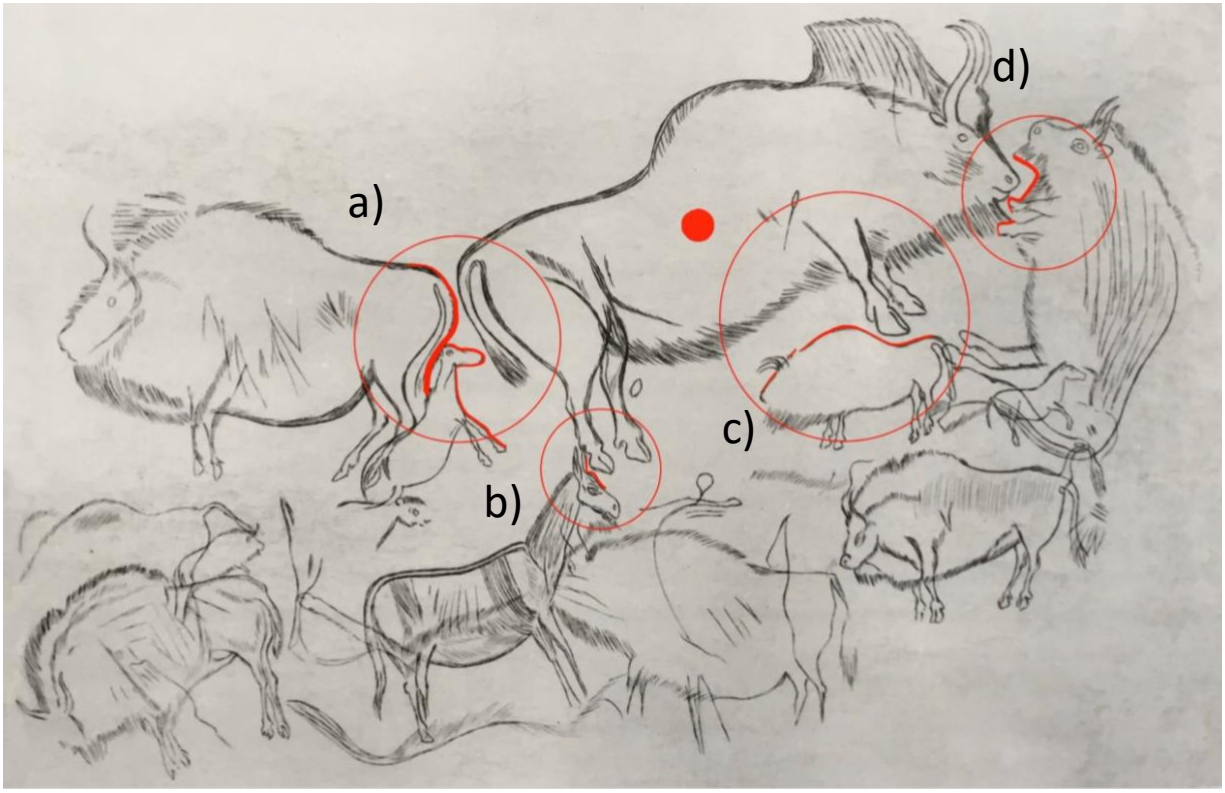


Figure 22: *Left panel* (after Breuil (1958) in Bégouën *et al* 2014:124) annotated to highlight animals interacting with the outline of the 'central animal' (annotated with a red dot). The letters represent the departmentalisation of its analysis.

The image above is from the *left panel* and shows how the bison annotated by a large red dot on its flank (number 53) has been positioned in relation to the other animals to become the 'central animal', consequently dictating the dimensions of the animals around it (explored further below). However, an acknowledgement must be made before one is to proceed further into this hypothesis: one cannot know whether it was the initial engraving of the 'central animal' that then subsequently influenced the secondary wave of engravings; or that negative space created by the outlines of the multiple smaller engravings created the space for the 'central animal'. At this point I will assume that the surrounding animals were drawn around the 'central animal'. Therefore we shall proceed through the examples from figure 22, from left to right:

a) The first example encompasses two different 'radiating' animals – a horse and a bison. As can be seen, the bison's tail has been positioned as a reflection of the contours of the 'central animal's' tail, creating a negative space that has an angular apex with two symmetrical tails branching off from it. The whole form of the horse that sits within this negative space is therefore utilising the outline of both bison, the mane of the horse fitting perfectly into the contour of the bison's tail. Following its dorsal line, it becomes clear that the horse is heavily appropriating the outline of the hind leg of the left facing bison (the one *next to* the 'central' bison), putting into question which animal it relates to. And yet when considering the design of its anterior and forelimb across its ventricle line, it appears to follow the contours of our 'central animal'. So, this section aims to decipher the aesthetic nature of animals in relation to one central animal. This example suggests that this relationship is more multifaceted than previously thought, adding complexity to the hypothesis.

b) This example concerns a more close-fitting alignment of outlines that slightly intersect. The angular design of the 'central' bison's hoof, which creates a roughly stepped negative space, comes up to the head of a European ass (see figure 23 below). The angle of the 'central animal's' hoof coincides closely with where the dorsal outline of the ass's cranium leads to its vertical ears, using the angular nature of the negative space. Although this is a more precise alignment, the outline of the central animal has been slightly intersected by the tip of the ass's ear. It seems that the artist was not arbitrarily ignoring the outline; due to the sharpness of the ear, it appears as an overemphasis of the angularity of the 'central' bison's hoof, therefore still respecting the *design* (if not the outline) of the 'central animal'.

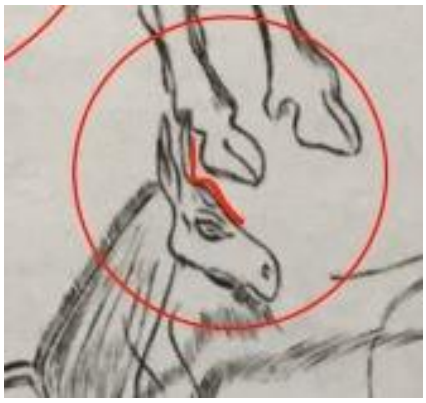


Figure 23: A magnified image from figure 14a to illustrate the detailed interaction between the European Ass and the 'central animal'. (After Breuil 1958 in Bégouën *et al* 2014:124)

c) The dorsal line of the bison depicted in this example meets the ventricle line of the 'central animal'. Therefore the aspect of the bison's depiction most appropriate to consider in respect to the other is its dorsal line. Running alongside the underneath of the 'central' bison, noticeable modifications to its size and proportions had occurred. As seen in figure 22 (above), the dorsal line of the radiating bison undulates a lot more drastically than others of the same panel and indeed elsewhere from the sanctuary's engravings, making it appear that the modification of its outline was of a higher degree, suggesting it was heavily informed by relational aesthetics. Moreover, the curvature of the dorsal line undulates parallel to the outline of one of the front hooves which extends downwards from the main ventricle line of the 'central' bison. This runs between the features of two separately engraved animals which fits well with this alternative hypothesis: design is determination by relational aesthetics. This configuration between these animals continues with the anterior dorsal line of the radiating bison runs parallel to the further ventricle trajectory of the 'central' bison. There is no detail within the outline of this bison, which places more emphasis on how it relates to the negative

space surrounding it, further promoting how this example supports this alternative hypothesis.

d) The final instance to support this example of a 'central animal' in the *right panel* is a bison that sits at the conjunction of the 'central animal's' head. This meets the forelimbs of a smaller bison, orientated upwards so as to position each foot either side of the 'central animal's' angular 'beard'. The ventricle line of the smaller bison then extends to follow the contours of the 'central' bison's muzzle from a moderate distance, creating a concave space in which the convex anterior of the 'central' bison can fit. Overall, these four examples form a negative space into which the 'central animal' resides, the latter two suggesting a more considered and more reflective adherence to the 'central animal's' outline than the former, adding weight to the argument presented in this chapter.

The second example chosen to illustrate the existence of 'central animals' as factors in animal depiction comes from the *chamber of the small reindeer*. Unlike the first example above, scale is not a factor that characterises the 'central animal', and in fact it is one of the smallest reindeer depictions that I will refer to as the 'central animal'.

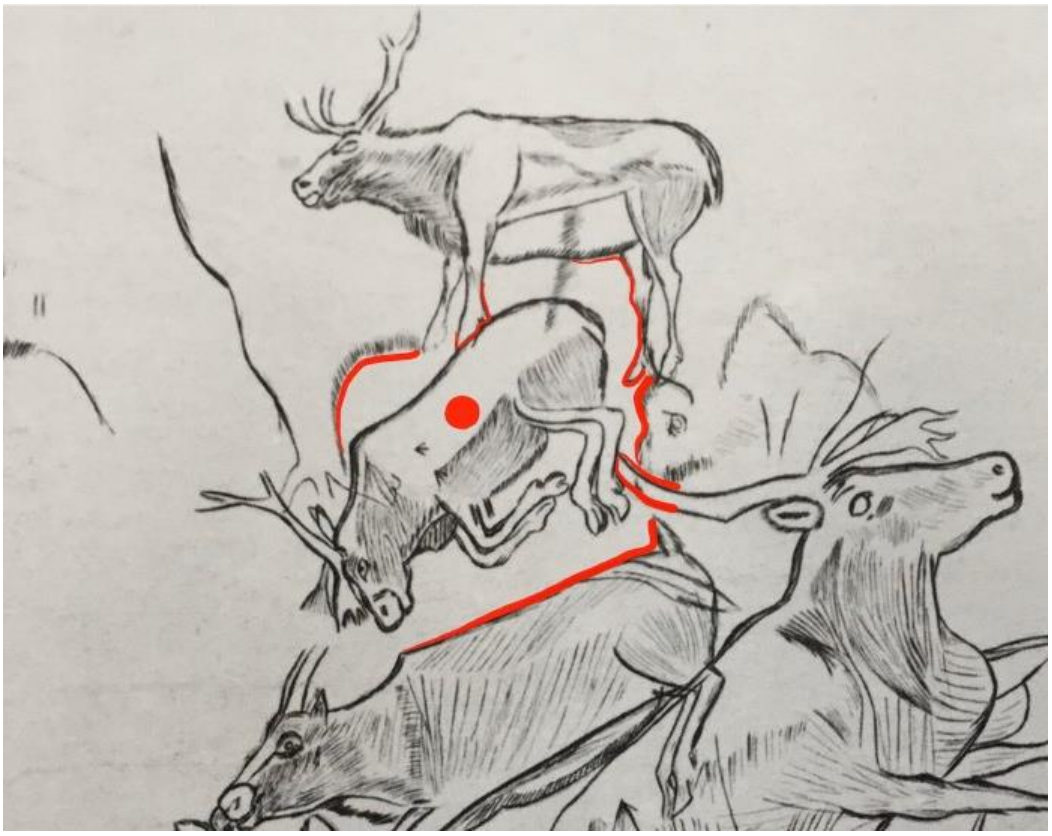


Figure 24: A section of the *chamber of the small reindeer* (traced by Breuil (1958) in Bégouën *et al* 2014:127) with annotation highlighting the instances of animals interacting with the outline of the 'central animal', annotated with a red dot.

However, this 'central animal' (indicated with a red dot in figure 24 above) is still a complete depiction and has two open-angle non-figurative designs on its anterior flank. Although there are four examples of reindeer with this particular design, there are multiple animal representations that engage with its outline. Moreover, as shall be illustrated, it would appear that this central animal is most likely centred within a pre-determined spatial structure itself, which is composed from the surrounding depictions.

For the purposes of comparison between the examples in this chapter, each surrounding animal is referred to in relation to the one positioned centrally.

Each depiction that relates to this 'central animal' will be examined separately, working around the animals from the first to last in an anti-clockwise fashion, therefore beginning with left-facing reindeer positioned below the 'central animal': although in other species, this dorsal depiction being so linear would appear abnormal, but for reindeer, this part of their anatomy is repeatedly depicted as relatively straight. Due to its position and angle, this appears to resemble a base-line which constantly runs parallel to the ventricle extremities of the 'central animal'. This trajectory ends with the vertical direction of its tail upwards. However, the consistency in its aesthetic between it and the 'central animal's' outline remains, even emphasising the outline that leads around the hoof up to its posterior. Just where the tail ends, the antler of the large right-facing reindeer begins, subsequently becoming the focus of the second example.

This antler protrudes backwards and 'fits' (that is, coincides with but does not intersect) the outline of the 'central animal's' hind leg. As with the previous example from the *left panel*, there seems to be the use of 'concave-convex' or 'male/female' outlines from different animals that are linked together and perhaps noticed more visibly by the author of the art as a potential for use.

The third instance is positioned higher up the hind leg where the bend of the 'central animal's' knee is. Although the animal's species cannot be determined or which part of the anatomy it may represent, its outline sits constantly parallel to the 'central animal's', although only briefly; mirroring the anatomical undulations.

The fourth instance is immediately above, and almost continues, the outline of the third. This depiction is identified as a complete reindeer and meets or corresponds with the outline of the 'central animal' on multiple occasions. It could be argued that the entirety of the ventricle line between the hind and forelimbs of this reindeer created the niche in which the posterior of the 'central animal' was positioned. However, the two closest instances where this animal's outline corresponds with the 'central's' one in the inside of its hind leg and the extremity of its forelimb's cloven hoof. From the lowest extremity of the hind leg, including its hoof, its outline curves in a manner that appears to constantly respect the outline of the 'central animal'. The inside shape of its hind leg meets the ventricle outline of its belly, creating a rough right-angle. The vacancy this creates is filled by the 'central' reindeer's posterior. Due to the convex nature of the 'central animal's' outline, the ventricle line of the reindeer above has a trajectory that is not parallel to that of the former, however, the forelimb of the reindeer extends vertically from this and 'fits' onto the outline of the 'central animal'. Although this conjunction is small, the angle of the hoof as well as its exact positioning *onto* the outline of the other animal, suggests there was a degree of deliberateness to its positioning in respect to the 'central animal', or vice versa.

The final instance from this panel is perhaps the most obscure, where the curvilinear line that forms round the anterior flank of the reindeer is unidentified and most simplistic. Due to it being composed of many striated lines, an engraving technique found to correspond with fur in other examples from the same panel and beyond, one would assume it is not an abstract symbol but belongs to an animal no longer identifiable. The interesting formation of this one line is that it does not conform to mirroring the outline of the 'central animal' as closely as the others from this example, but is positioned in order to not obscure or intersect it. Additionally, it begins from the forelimb of the previous reindeer's depiction, extending the almost unbroken continuation of surrounding engravings right up to the neck of the 'central animal'. This may be a coincidence, yet taken as a whole, the collectivisation of these individual animals form an unbroken parallel of the central animal's outline which is visually noticeable. The last instance, therefore, arches over the linear dorsal line of the

central animal and terminates just to the left of the highest part of its shoulders. Together, these surrounding animals encompass the entire outline of the reindeer's body, except for its head, which suggests a sturdy base onto which ideas of deliberate agency can be considered.
As discussed at the start of this example, it is more apparent that, due to the scale of the central animal and how the larger surrounding animal depictions are larger, the central reindeer may have been placed within a previously defined negative space. This suggestion is enhanced when comparing it with the first example, where there is a more strict respect for the outline of the dominant animal in the centre. This may serve to provide more questions as to the underlying theme of these interactions than it answers, especially when considering temporality. Either way there is a definable characteristic in these examples that negative space formed from the outline of collective animals has been used to place one depiction at the centre of a group, thus elevating it aesthetically as a focal point of a 'piece' or artistic 'unit'.

The implications of the examples exhibited above, therefore, show that data collection in the manner put forth in the *methodology* does not encompass the multi-faceted complexity of the dependences between individual depictions. What one sees when analysing this numerical data, therefore, is a set of fluctuations in animal species and design, in which in-depth statistical analysis can uncover only the most stable and 'sanitised' variable dependences present. By 'sanitised' I mean variable dependences that have been stripped of their complex aesthetic interacts in order to be viewed purely from a numerical point of view.

But this method ignores any potential *relational* determiners that may influence the designs of only *some* depictions. The word 'some' is emphasised here to readdress the fact that the cases found above may be suggestive or even conclusive of a *relational* determination of design but they only form a very weak minority compared to the whole of the chamber's engravings. Because of this, they do not correspond with the model of a reoccurring pattern or predictable trajectory. On the other hand, out of the twelve engravings examined from the *left panel*, six of the animals were engaged in the aforementioned interaction – half of the total animals. This, it is presumed, was aided by the fact that the 'central animal' was the largest there, thus incorporating more animals to 'fit' around its outline was not hard to achieve. As well as this, the population of the panel was comparatively small, restricting how many animals could be represented, and therefore six animals can be an impactful quantity.

Although there are so far only two 'central animals' identified, and plenty of examples of animal interactions that counter this suggestion for a plausible alternative to the hypothesis set out by this study, the apparently undecided nature of the rules of relational engagement between individual animals contributes still to a pattern of proportion and size more complicated than can be seen through this investigation's statistical analysis. In other words, this investigation has collected data from individual animals, making note of their dimension, direction, behaviour, orientation, etc. in order to find out whether one criteria is linked to another. This method of data collection makes individual depictions only identifiable by which criteria each one belongs. In doing so, the characteristics that cannot be measured – such as how one engraving's tail meets another's and the negative space created is used to determine the size of another's head is looked over. To come to a conclusion that there is an appreciation for 'negative space' between animals and that in some way it contributes to the 'grammar' to which these engravings subscribe cannot be verified through numerical analysis and instead only by examining the panels in a direct visual manner can these be reached.

An attempt was made to incorporate such interactions between animals into the dataset but making a column which recorded additional information about individual animals. For example, this was used

to record interactions such as any animal that was either depicted within another's outline or two animals that faced each other. On the other hand, as was mentioned above, it is evident that engraved animals may have been positioned the way they were in some panel due to the utilisation of negative space between other animals. If this is the case, then however detailed or precise the animal annotations were, and even if one was able to collectivise such data into a criteria-based statistic, it still remains that one animal's depiction relies on too many other depictions as their specific determination of orientation, direction and even species. Thus it would not be possible to recreate the complicated relational determiners through statistical means.

As this hypothesis works on the assumption that some depictions are reliant on others for their dimensions and spatial layout, it is thus necessary to revisit ideas of the art's temporality. Therefore, it cannot be an uncertainty that the engraved units of peripheral/central animals were produced within a very close time span of each other. This is an additional narrowing of the time span already eluded to through stylistic analysis of the art. Although we can determine how contemporary engravings are by aesthetic respect for one another, determining the inverse (i.e. aesthetic disregard equals chronological distance) is a less arbitrary measurement.

Another point to be made is that in appropriating an animal's dimensions to a pre-destined design sits perfectly within the artistic culture of the Magdalenian: animals engraved onto plaquettes at Les Trois Freres' sister cave are mostly making use of the set dimensions of their material, in the same way the design of a peripheral animal engraved to curl around the negative space presented by the presence of the 'central' animal.

11.2 Summary

To summarise this chapter, I have narrowed down the main arguments to bullet-points for ease of reference:

- There is no clear evidence from the statistical analysis undertaken in this investigation for the presence of an explicit grammatical convention. Therefore I revisited the panels as art and not as quantifiable data.

- What was found was evidence for an aesthetic convention which holds investigative merit. This consists of a 'central animal', whose negative space around its outline conducts the dimensions of other depictions. This influences the size, proportion ratio, behaviour, orientation and (to an extent) species of the animals that surround it.

- Visual examples were presented to demonstrate the validity of this hypothesis, in which it would suggest the outline of 'central animals' dictates its surrounding animals to varied extends. However, all engage with this outline in a manner that is convincing of an aesthetic relationships between engravings with their outline dimensions as the interface between them.

Chapter 12 Conclusions

To conclude, this investigation produced results from a dataset which compiled a localised set of individual depictions in order to find co-occurrences that are indicative of an underlying grammatical structure. From the data studied, the results suggest that there is only a minimal indication of such a structure, with dominant trends indicating that certain demographics were responsible for the depiction of anthropomorphs and the 'rare' predatory animals depicted. This, however, does not suggest that the artists were abiding by a particular 'grammar' as such. They may have had some spiritually-charged motive or were responding to a hierarchy within the group of artists, but neither defines grammar – wherein the art itself is the system through which one reiterates implicit codes and semiotics. The scale of individual depictions is influenced by the population density of the panel in which they reside, but that too bears more semblance to aesthetic notions than grammatical ones. However, when examining the standard deviation for the proportions of each species, instead of an aesthetic notion coming from the artist, there is an indication of other restraints. The most significant example of this is the reindeer of the *right panel* and *the chamber of the small reindeer* which are drawn to the highest standardised proportions present within this dataset. This therefore suggests there was a grammar relating to the standardisation of ratio-proportions which were specific to the species represented.

Within the dataset, the category that produced the most interesting result was the 'Further Detail' (FD). The animals found to have been represented with additional features either overlaid or intergraded into their anatomy opened an avenue of investigation into non-figurative artistry that is more explicitly coded than the animal representations they interacted with. The majority of them were found decorating the flanks of the reindeer from *the chamber of the small reindeer*, the same animals that had the smallest proportion deviations (above) and connected the semiotics from some of the plaquettes from Les Trois-Frères' sister cave, Enlène.

When examining the statistics as a whole, we cannot conclude that the art studied was structured solely by a particular or specific grammar. A second examination of the art, this time from a purely aesthetic point of view, revealed an alternative hypothesis: that there existed a certain structure underpinning the art dictated not only by grammar but also by aesthetic conventions. There are several examples where the proportions and orientation of an animal are tailored to respect the outline of a 'central animal'. In proposing this new hypothesis, I would like to make clear that the use of statistics was still necessary to understand the extent of an *implicit* grammar, with both perspectives respecting each other's investigative validity.

Therefore, overall, it would appear that the investigation failed to find a grammatical structure implicit within the animals studied and analysed from Les Trois-Frères cave, wherein there was minimal suggestion that inter-thematic dependences and co-occurrences within the data constituted a pattern one could identify as grammatical in nature. What was discovered, however, was that there was a certain dependence on handedness (and thus individual selection) of artists for certain criteria within the art process and that aesthetic appreciation and the relationship between individual depictions constituted somewhat to the variations exhibited within the art at Les Trois-Frères.

Chapter 13 Further work

13.1 Hindrances

Accomplishing a feat of investigation that sets the groundworks for uncovering the grammatical structure behind Upper Palaeolithic European cave art is not without need of further attention. The aim of this thesis was to investigate cave art on a scale manageable for testing out certain analytical tools that could accomplish a high resolution for co-occurrences and inter-thematic associations. What was found was that even at this level, just like at the other end of the spectrum with Sauvet & Wlodarczyk's work incorporating huge quantities of material, there was a gap in the literature that had to be filled. When discussing the prospect of further work in their 2008 article, they discuss the fact that…

> 'The task is in progress but is difficult for two reasons. First, some of the necessary information is missing in the literature and must be gathered by long and patient field work. Secondly, new methods able to integrate the new information must be developed. We anticipate that a more sophisticated analysis taking into account technical and morphological characteristics may lead us to discover diachronic and synchronic variations that could be correlated with the archaeological contexts.' (Sauvet and Wlodarczyk 2008:175)

In regards to the second point, alluding to the progression of analytical tools to aid investigation into grammatical underpinnings, it is evident that, as discussed in section 10.4 (page 79), using statistics may cause more problems than it solves: the structural underpinnings for the cave art studied in this thesis cannot be easily configured to suit a mass collation of data. Instead examples show that there are more delicate, aesthetic relations between individual depictions (previously stated in Chapter 11 Alterative hypothesises (page 80)). This could have only been seen when studying the art panel-by-panel, image-by-image which generates scepticism towards bulk inputting of data into high-powered analytical software that focuses on dismantling and thus destroying the delicate mesh of aesthetic relations within the art.

Despite this, the analysis undertaken in this study should be seen as an invitation for future work, adopting and adapting the methodology of measuring individual depictions on other sample data. The level to which this is an effective or appropriate method will be dependent on the data set chosen for study, as collating art that transcends what is often an indicator of cultural (and thus grammatical) consistency – such as technique or stylistic typology – will generate results that are unreliable for comprehensive analysis and interpretation (see *section 2.6*).

13.1 Continuing analysis of Les Trois-Frères

As covered extensively in the initial chapters (*section 2.6* especially), the outcome of my research was strongly influenced by a literary bias within the source material. The lack of access to a full unabridged version of the source data hindered my analysis. As the source data in its entirety was unavailable for this thesis, applying the recording methods to every panel traced from the sanctuary chamber, as laid out in the methodology (see Chapter 5 (page 38)) would be valuable for future research. An example of the impact of this bias is found in the discussion on additional features in section 10.2 (page 72).

When discussing the significance of an additional non-figurative sign on the flank of a bison, it was considered a solitary phenomenon within Les Trois-Frères' engravings. Subsequently, such assumptions were incorrect. Because of the unavailability of tracings from other panels throughout the sanctuary, multiple other occasions where this phenomenon occurred were not incorporated into

this dataset. This suggests that certain conclusions from the data were the result of, or influenced by, the underlying biases from the literature studied. In accumulating the entire set tracings from this sanctuary chamber, a wider holistic analysis of the engravings could be achieved; one where the only variables within the art come from the artist and not from the limited selection of Breuil's original tracings as excerpts in secondary publications.

To further this, creating a database that is formed from the analysis of high-quality digital recording can potentially empower the statistics further: adding more detailed information allows for the study of specific conventions in more depth. As discussed in chapter 8.3 issues with the dataset pertaining to a limited data source would be easily resolved through digital recording, as would the possible biases consequential in the statistical analysis. Here is also an opportunity to examine the temporality of mark-making which, in the study of superimpositions, may reveal significant patterns, while some instances of proximity may have been created by chance.

13.2 The prospect of Enlène cave and Le Mas d'Azil

Taking the methodology from this thesis and applying it to all the engravings in the sanctuary chamber at Les Trois-Frères is a first step to further research. Furthermore, this study could be expanded and applied to Enlène and Le Mas d'Azil caves. The former cave has been mentioned throughout this thesis due to its cultural and geographical proximity to Les Trois-Frères. The latter has only been given brief inclusion in the introduction (section 3.1), yet it has potential as a host cave for this kind of statistical analysis. The reasons for this are discussed below.

An immediate direction would be to catalogue the art that appears as plaquettes from the cave adjoining Les Trois-Frères: Enlène. As mentioned in section 3.1 (and extensively in Bégouën & Clottes 1991 article), animal depictions from both caves have a strong technical and stylistic affinity with each other. The plaquettes appear to be a potentially attractive subject for the analytical techniques exhibited in this thesis as each animal is relatively isolated on its own pebble, thereby confounding the theory that inter-animal aesthetic relations play a part in their dimensions. Although this dataset cannot be looked at and analysed in the same way as the engraved figures at Les Trois-Frères (in which one could segregate the images into panels) a comprehensive analysis of each animal depicted on a plaquette would not jeopardise the possibility of finding grammatical formula underlying, say, the correlation between plaquette size and depicted species.

The above investigation would require collecting measured illustrations of all plaquettes from the cave of Enlène, and, being portable art, means that they can be examined in a more controlled environment than the parietal art of its sister cave. This makes it less susceptible than the literary biases which constrain the documenting of art at Les Trois-Frères.

To counter this, their portable nature may also be seen as a difference between the art of these two caves, as they would have been made under different conditions and for different reasons. Therefore although these two caves may be seen to resemble each other's art, differences in material and context proves there is a clear distinction between the two art forms on a social and more spiritual level. The parietal art of Les Trois-Frères remains fixed in the 'dark zones' of caves whereas the portable art of Enlène could traverse across the liminal boundary between above and below ground. These points conclude that Enlène's art is not suitable for analysis in conjunction with Les Trois-Frères' and its associated findings in this thesis, leading us to consider the prospect of investigating the art from another cave site.

As mentioned previously, the decorated cave of Le Mas d'Azil is affiliated with the Volp cave system by its archaeological evidence for tool assemblages mirroring those of Enlène. This suggests that these

caves were visited by the same culturally-bound group who explored Les Trois-Frères. Furthermore, the manner in which Le Mas d'Azil has been decorated is exactly the same as Les Trois-Frères, in that the majority of the art produced is concentrated in its 'sanctuary chamber'. This is highly significant in directing future research. In collating the depictions from Le Mas d'Azil, one would have compiled the art from two cave sites without breaching the limits of a tight cultural sample. By comparing the two sets of artistry, there is the possibility of discovering recurrent themes in species-dependent size differentials and proportion ratios, spatial delineation and handedness in relation to 'rare' depicted animals. This leads to the decipherment of grammatical structure underpinning (or differentiating) the art of both sites. Applying the alternative hypothesis formed around particular depictions in this study would enable it to be tested in relation to a wider catchment of art, and thus potentially enhance and enrich our understanding of Magdalenian parietal traditions.

Appendix: Data derived from the sanctuary engravings as illustrated by Breuil.

Key to table headings	
Heading	*Description*
Panel #	1 = Right panel 2 = Left panel 3 = Chamber of the small reindeer 4 = Climb to the sorcerer
Animal	Anthro is short for Anthropomorph
Est. av	Estimated average of measurements using proxy data from other measurements where the animal is incomplete. '-' indicates that an estimate cannot be derived due to the small population size.
Ave	Average of known measurements
C	Completeness of animal: 1 = complete; 0 = Incomplete
H	1 = Head only; 0 = complete or other parts visible
FR	1 = Animal is facing right
FL	1 = Animal is facing left
ABO	1 = Animal's orientation is abnormal
AMAN	1 = Animal's anatomy is ambiguous
O	1 = Parts of the animal are obscured
LD	1 = Animal is lacking detail
FD	1 = Animal has further detail
S	1 = Animal is static
A	1 = Animal is animated
N/A	1 = Animal cannot be deciphered as either static or animated

Panel #	Animal	Est. av	Average	C	H	FR	FL	ABO	AMAN	O	FD	LD	S	A	N/A
1	Bison	29.7	29.8	1	0	0	1	0	0	0	0	0	1	0	0
1	Bison	25.1	25.5	0	0	0	1	0	0	0	0	0	0	1	0
1	Bison	20.3	23.0	0	0	0	1	0	0	0	0	0	0	1	0
1	Bison	45.8	47.2	1	0	1	0	0	0	0	0	0	1	0	0
1	Bison	31.0	31.8	1	0	0	1	0	0	0	1	0	0	1	0
1	Bison	32.6	32.5	1	0	0	1	0	0	0	0	0	0	1	0
1	Bison	28.6	31.4	0	0	0	1	0	0	0	0	0	0	1	0
1	Bison	39.3	12.0	0	0	1	0	0	0	0	0	0	1	0	0
1	Bison	24.9	25.8	1	0	0	1	0	0	0	0	0	1	0	0
1	Bison	35.6	35.7	1	0	0	1	0	0	0	0	0	1	0	0
1	Bison	18.0	8.8	0	0	0	1	0	0	0	0	0	1	0	0
1	Bison	23.0	7.6	0	0	0	1	0	0	0	0	0	0	0	1
1	Bison	55.3	55.4	1	0	1	0	0	0	0	0	0	0	1	0
1	Bison	19.9	20.5	0	0	1	0	0	0	0	0	0	0	1	0
1	Bison	16.8	16.1	1	0	0	1	0	1	0	0	0	1	0	0
1	Bison	23.0	7.6	0	1	0	1	0	0	0	0	0	0	0	1

Panel #	Animal	Est. av	Average	C	H	FR	FL	ABO	AMAN	O	FD	LD	S	A	N/A
1	Bison	16.5	16.3	1	0	1	0	0	0	0	0	0	0	1	0
1	Bison	32.4	33.8	1	0	1	0	0	0	0	0	0	1	0	0
1	Bison	16.7	12.0	0	0	0	1	0	0	0	0	0	0	1	0
1	Bison	30.3	30.4	0	0	0	1	0	1	0	0	0	0	1	0
1	Bison	25.4	30.9	0	0	0	1	1	0	0	0	0	0	1	0
1	Bison	34.5	33.9	1	0	1	0	0	0	0	0	0	1	0	0
1	Bison	20.4	14.5	0	0	1	0	1	0	0	0	0	0	0	1
1	Bison	34.7	35.3	1	0	0	1	0	0	0	0	0	0	1	0
1	Bison	22.5	22.1	1	0	0	1	0	0	0	0	0	0	1	0
1	Bison	18.8	18.8	1	0	0	1	0	0	0	0	0	0	1	0
1	Bison	34.5	10.7	0	1	1	0	0	0	0	0	0	0	1	0
1	Bison	50.8	15.1	0	1	0	1	0	0	0	0	0	0	1	0
1	Horse	24.0	31.4	0	0	0	1	0	1	0	0	0	1	0	0
1	Horse	14.5	5.3	0	1	0	1	0	0	0	0	0	0	0	1
1	Horse	15.1	14.5	0	0	0	1	0	0	0	0	0	1	0	0
1	Horse	10.3	10.3	1	0	0	1	0	0	0	0	0	0	0	1
1	Horse	30.7	30.4	1	0	1	0	0	0	0	0	0	0	1	0
1	Horse	10.3	9.6	1	0	1	0	0	0	0	0	0	1	0	0
1	Horse	31.4	12.5	0	1	0	1	0	0	0	0	0	0	0	1
1	Horse	18.4	17.5	0	0	0	1	0	0	0	0	0	0	0	1
1	Horse	19.5	19.7	1	0	0	1	0	0	0	0	0	1	0	0
1	Horse	24.3	28.6	0	0	1	0	0	0	0	0	0	1	0	0
1	Horse	17.7	18.2	1	0	0	1	0	0	0	0	0	0	1	0
1	Horse	15.9	5.9	0	1	1	0	0	0	0	0	0	0	1	0
1	Reindeer	12.1	12.3	1	0	0	1	0	0	0	0	0	0	1	0
1	Reindeer	21.2	21.3	1	0	0	1	0	0	0	0	0	0	1	0
1	Reindeer	23.8	21.8	0	0	0	1	0	0	1	0	0	0	1	0
1	Ibex	-	8.8	0	1	0	1	0	0	0	0	0	0	0	1
1	Ibex	-	11.2	0	1	1	0	1	0	0	0	0	0	0	1
1	Ibex	-	5.3	0	1	0	1	0	0	0	0	0	0	0	1
1	Anthro	-	17.6	1	0	0	1	0	0	0	0	0	0	1	0
1	Rhino	-	19.5	1	0	0	1	0	0	0	0	0	0	1	0
2	Ass	-	28.8	1	0	1	0	0	0	0	0	0	1	0	0
2	Bison	30.3	31.5	1	0	0	1	0	0	0	0	1	1	0	0
2	Bison	21.8	29.7	0	0	0	1	0	0	0	0	0	1	0	0
2	Bison	46.7	44.6	1	0	0	1	0	0	0	0	0	1	0	0
2	Bison	9.5	9.4	0	0	1	0	0	0	0	0	0	1	0	0
2	Bison	62.0	64.7	1	0	1	0	0	0	0	0	0	1	0	0
2	Bison	32.4	37.4	0	0	0	1	0	0	0	0	0	1	0	0
2	Bison	20.6	20.9	1	0	0	1	0	0	0	0	1	1	0	0
2	Bison	28.6	28.8	1	0	0	1	0	0	0	0	0	0	1	0
2	Bison	40.6	41.3	1	0	0	1	1	0	0	0	0	1	0	0
2	Horse	17.0	21.1	0	0	1	0	0	0	0	0	0	1	0	0
2	Horse	13.6	11.4	1	0	1	0	0	0	0	0	0	0	1	0
3	Reindeer	25.6	27.2	1	0	1	0	0	0	0	1	0	1	0	0

Panel #	Animal	Est. av	Average	C	H	FR	FL	ABO	AMAN	O	FD	LD	S	A	N/A
3	Reindeer	18.0	18.0	1	0	0	1	1	0	0	0	0	0	1	0
3	Reindeer	20.0	19.0	1	0	0	1	0	0	0	0	0	0	1	0
3	Reindeer	16.5	16.8	1	0	0	1	0	0	0	1	0	1	0	0
3	Reindeer	29.6	29.8	1	0	1	0	0	0	0	1	0	0	1	0
3	Reindeer	26.9	25.7	1	0	0	1	0	0	0	0	0	0	1	0
3	Reindeer	22.5	8.6	0	0	0	1	0	0	0	0	0	0	1	0
3	Reindeer	15.6	6.9	0	0	0	1	0	0	0	0	0	1	0	0
3	Reindeer	20.6	6.9	0	1	0	1	0	0	0	0	0	0	0	1
3	Reindeer	26.4	8.2	0	1	0	1	0	0	0	0	0	0	0	1
3	Reindeer	22.2	19.3	0	0	0	1	1	0	0	1	0	1	0	0
3	Bison	32.5	9.6	0	1	0	1	1	0	0	0	0	0	1	0
3	Bison	12.9	12.9	1	0	1	0	0	0	0	0	0	0	1	0
3	Bison	47.7	26.9	1	0	1	0	1	0	0	0	0	1	0	0
3	Horse	11.1	11.1	1	0	0	1	0	0	0	0	1	0	1	0
3	Horse	18.8	18.8	1	0	1	0	0	0	0	0	0	1	0	0
3	Ibex	-	11.8	1	0	0	1	0	0	0	0	0	1	0	0
4	Horse	31.6	21.6	0	0	0	1	0	0	0	0	0	1	0	0
4	Horse	14.0	14.2	1	0	1	0	0	0	0	0	0	0	1	0
4	Horse	12.7	12.8	1	0	1	0	0	0	0	0	0	0	1	0
4	Horse	19.9	13.6	0	0	0	1	0	0	0	0	0	1	0	0
4	Horse	20.9	20.8	1	0	1	0	0	0	0	0	0	1	0	0
4	Horse	22.8	23.3	1	0	0	1	0	0	0	1	0	0	0	1
4	Horse	16.6	15.6	1	0	0	1	0	0	0	0	0	1	0	0
4	Horse	22.3	23.0	1	0	0	1	0	0	0	0	1	1	0	0
4	Horse	37.5	38.8	0	0	0	1	0	0	0	0	0	1	0	0
4	Horse	14.9	14.9	1	0	0	1	0	0	0	0	0	0	1	0
4	Horse	14.9	7.7	0	0	0	1	0	0	1	0	0	1	0	0
4	Horse	22.5	22.7	1	0	1	0	0	0	0	0	0	0	1	0
4	Bison	-	37.6	0	0	0	1	0	0	1	0	0	0	0	1
4	Bear	-	11.2	1	0	0	1	0	0	0	0	0	0	1	0
4	Bear	-	11.7	1	0	0	1	0	0	0	0	0	0	1	0
4	Anthro	-	32.5	1	0	0	1	0	0	0	0	0	0	1	0

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