Sexual dimorphism in Upper Palaeolithic hand stencils

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Sexual roles in deep prehistory are among the most intriguing puzzles still to solve. Here the author shows how men and women can be distinguished by scientific measurement in the prints and stencils of the human hand that occur widely in Upper Palaeolithic art. Six hand stencils from four French caves are attributed to four adult females, an adult male, and a sub-adult male. Here we take a step closer to showing that both sexes are engaged in cave art and whatever dreams and rituals it implies.

Keywords: France, Upper Palaeolithic, cave art, handprints, gender studies

Introduction

Human handprints and hand stencils appear in the archaeological record as pictographs in all inhabited continents. Typically they occur as either positive handprints or negative hand stencils. In the former case someone dipped a hand in pigment, then applied the print to a reasonably flat stone surface. In the latter case the hand was pressed against the surface and pigment was applied around it to create a stencil (negative pictograph). For reasons explained below, analysis of handprints and hand stencils must be carried out with reference to a related living population. Consequently this paper discusses hand stencils that occur amongst other images in the parietal art found in caves in south-western Europe.

Upper Palaeolithic art has been the subject of a vast literature. While this paper touches on the broader subject, the central topic here is limited to a specific analytical approach to hand stencils. I claim no competence in a wide variety of other possible technical approaches, little command of many descriptive treatments of the broad range of cave art, and no interest in non-scientific interpretive approaches. For a broader perspective I direct the reader to some recent general works and their extensive bibliographies (Bahn 1998; Bahn & Vertut 1988, 1997; Clottes 1996).

Many sources, particularly popular ones, implicitly assume that hand stencils were left in the caves of France and Spain by men and boys; small hand stencils and footprints found in the caves are typically attributed to the latter, particularly in the popular literature (Canby 1961: 30-38; Prideaux 1973: 115). However, John Manning has shown that hands are sexually dimorphic, and that one can usually determine sex by measuring ratios of digit lengths (Manning 2002). I use 'sex' here with the standard meaning of biologically male or female. 'Genders' are cultural categories that are sometimes equivalent to sex but at other

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Received: 6 August 2004; Accepted: 5 January 2005; Revised: 22 October 2005

ANTIQUITY 80 (2006): 390–404

times differ significantly. Gender is more rarely (if ever) discernible in the archaeological record. Manning uses the ratio of index and ring finger lengths (D2/D4) as a key measure. In a Liverpool sample the ratio was 1.00 for women (the fingers being of equal length on average), but 0.98 for men (whose ring fingers tend to be longer on average). Manning did not focus on the little finger (D5), but it is relatively short in females, even compared to the ring finger (D4), which is itself short in women relative to the index and middle fingers (D2 and D3).

In most if not all populations the hand stencils of adult males can usually be distinguished from those of adult females by overall size alone. However, adult female hand stencils cannot necessarily be distinguished from those of boys on the basis of size alone. Neither can the hand stencils of children be sorted by sex on the basis of size. However, various measures combined with indices derived from digit lengths provide a means for distinguishing between hand stencils left by females and those left by males regardless of their ages. Because there is significant overlap between males and females in these as in many other measures, the technique does not accurately predict sex in all individual cases. However, the success rate is high enough to be informative regarding trends in larger populations.

Population differences

While there are statistically significant differences between male and female digit ratios in Europe, one should not assume that this is necessarily true of all populations of *Homo sapiens sapiens*. Napier observes anecdotally that '*women's hands are notoriously slender*' in Southeast Asia (Napier 1993: 25). There appears to be little or no sexual dimorphism in digit ratios in a population from the Nalgonda District of India (Ramesh & Murty 1977). A comparison of nine populations shows that while significant male-female differences can be detected in most or all of them, there are large differences between populations. Thus most Zulu, Finnish, and Jamaican women have male-like digit ratios that are more pronounced than those of Polish, English, or Spanish men (Manning 2002: 19-20). This suggests that we should not attempt to draw inferences about pictographic hand stencils unless we have data from living populations associated biologically with those responsible for the prints.

These circumstances forced my attention to focus on European cases, where the data on living populations are readily available. A potential problem is that the best samples of hand stencils come from Upper Palaeolithic cave sites. Some of the hand stencils in the caves of southern France and northern Spain are among the oldest known examples of rock art. Some date to 27 000 years ago, and others might be older. The risk here is that so much time has passed that the modern European reference population is not representative of the population(s) that left the hand stencils. Fortunately, recent genetic research shows that over 95 per cent of all modern European Y chromosomes belong to a set of ten lineages that have been present there since the Upper Palaeolithic. The M173 marker is an old Eurasiatic trait that appears to have spread westward into Europe with the movement of Aurignacian culture after 40 000 years ago (Semino *et al.* 2000). Thus apart from Gypsies, Hungarians and a few other more recent arrivals, the European gene pool until very recently has been largely of Upper Palaeolithic origin and we need not be overly concerned that comparison of modern European hands to archaeological hand stencils will produce spurious results.

Table 1. Hand sizes of Europeans (Napier 1993: 26)

	Sample	Mean of hand length (mm)	Mean of hand breadth (mm)	Shape Index (mhb/mhl)
Men	9883	190.8	87.3	0.458
Women	8848	173.5	77.0	0.444

We have sufficient measurements of hands in European populations to generalise about their sexual dimorphism. The hands of European adult men are larger on average than the hands of adult women. Table 1 shows that on average male hands are about 17mm longer and 10mm wider than female hands in this population. Thus we can use absolute measures to separate those hand stencils probably made by European adult males from those probably made by females or subadult males. Unfortunately (and perhaps surprisingly) an index of breadth to length reveals very little difference between European males and females. This means that it is not possible to use this proportion to distinguish between the hand stencils of women and those of preadolescent boys, at least not in that population. The common perception that women have more slender hands than men is probably related to the demonstrable fact that in women both the carpals and metacarpals of the fourth and fifth digits are relatively shorter than they are in men. This difference makes male palms appear more squarish than female hands, which in turn makes them seem to be relatively broader.

Fortunately digit ratios do allow us to distinguish between males and females. This dimorphism is present in infants and is probably established in utero (Manning *et al.* 1998). Indeed, one can easily observe that unlike most of their other proportions, infants have hands that look very much like miniature adult hands. Thus we need not worry about possible changes in puberty that would confound our efforts to distinguish female hand stencils from those of immature males. The reasons for early development of the dimorphism remain uncertain. While some have speculated that the ratios develop as a result of differential exposure to testosterone in utero, the male ratios do not appear to be associated with other indications of masculinity (Koehler *et al.* 2004).

John Manning found that in the population of 1052 subjects from Liverpool, the right hand digit ratio (D2/D4) for men was 0.98 ± 0.03, while the ratio for women was 1.00 ± 0.03, $t = 3.31$, $p = 0.001$ (Manning 2002: 8). The overlap is substantial, but for any particular subject one can calculate the probabilities that the ratio belongs to a male or a female. I built upon Manning's work by measuring the handprints of a sample of 57 females and 54 males of European descent in central Pennsylvania as a means to acquire a data set for comparison with archaeological examples.

A trip to southern France in May 2004 allowed me to acquire measurements on a sample of six hand stencils from four caves to use in a preliminary test of the hypothesis.

On the other hand

European Upper Palaeolithic hand stencils are negative images. Hand stencils appear to have been made using one of two techniques. Some were probably made by individuals holding one hand against a rock surface while holding a pigment-filled tube in the other

hand and blowing through the tube to spray the pigment on to the rock surface around the splayed target hand. In other cases the artist probably spit the pigment directly from the mouth through pursed lips (Bahn 1998: 113; Lorblanchet 1991, 1995). Most modern people are right-handed and when a pigment tube is used there is a tendency for right-handed individuals to put their left hands on a rock wall and to hold the tube with the right hand. Faurie and Raymond have shown that this tendency has been stable since the Upper Palaeolithic, indicating that there has been no change in handedness since that time. Curiously, a sample of 179 living people made negative prints of their right hands 22.8 per cent of the time, a frequency far greater than the frequency of left-handedness, which was 8.9 per cent and 7.8 per cent for males and females respectively in the sample. They were not coached in any way, and they chose which hand to paint without discussion. This suggests that some people are less strongly handed than others and that random choice leads some right-handers to handle the tube with their left hands. There was no significant difference in the behaviours of males and females in the sample population (Faurie & Raymond 2004).

Assuming that most stencils were made with the palms against the rock surfaces, the relatively high frequency of left hands in Palaeolithic caves suggests that right-handedness was as dominant prehistorically as it is today. Their creation required dexterous use of a free hand, usually the right one. Beyond that archaeologists have tended to assume that hand stencils were usually applied by men or adolescent boys. While there has been much speculation about the ancient meaning and purpose of this and other forms of rock art, it is surprising to me that so little attention has been paid to the possibility of determining the sexes of the individuals who left their hand stencils in the caves. I turn now to demonstrating that it can be done, albeit still imperfectly.

Upper Palaeolithic hand stencils

Dozens of cave sites in France and Spain contain hand stencils. At least eighteen of them are open to researchers (subject to permission) and contain hand stencils that are legible enough for study. Table 2 shows 27 of them and indicates the kinds (positive handprints or negative stencils) and minimum numbers of examples in them as I have been able to determine from selected published sources and online descriptions. The most important site is clearly Gargas in southern France, which has been extensively studied (Barrière 1976; Leroi-Gourhan 1967a). Hand stencils in Gargas might date to around 27 000 BP. In this case many stencils depict fingers with missing elements. There is still a debate about these cases, with some researchers arguing that portions of fingers were actually missing for one or more of several possible reasons, while others argue that the stencils could have been made palm up with fingers selectively bent (Bahn 1998: 113). The problem remains unresolved despite much discussion, and it has implications for the application of statistics derived from living populations as discussed below.

In Spain, El Castillo has at least 56 examples. Maltravieso has 71 examples (Ripoll López *et al.* 1999; 2000). The caves of La Garma and Fuente del Salín have 32 and 14 examples of stencils and handprints respectively. Like those found in Gargas, many of the Maltravieso stencils have incomplete fingers. In this case the researchers most familiar with the site generally argue that the ends of the fingers were missing when the stencils were made, not

Table 2. Selected Upper Palaeolithic caves with the minimum number of handprints and stencils indicated. Some totals exceed the sums of the columns because specifics are underreported

		Hand Stencils		Handprints		
Cave	**Country**	**Red**	**Black**	**Red**	**Black**	**Total**
Abri du Poisson	France		1			1
Altamira	Spain		3	1	1	6
Altamira II	Spain	2				2
Arcy-sur-Cure	France					6
La Baume-Latrone	France				5	5
El Castillo	Spain	56				56
Bayol (Collias)	France			6		6
Bayol II (Collias II)	France			1		1
Chauvet	France	9		442*		451
Les Combarelles	France		1			1
Cosquer	France					65
Ebbou	France			1		1
Les Fieux	France	2	4			6
Font-de-Gaume	France	2	2			4
Fuente del Salín	Spain					14
Fuente del Trucho	Spain	15				15
Gargas	France	51	85			231
La Garma	Spain	32				32
Maltravieso	Spain	71				71
Moulin de Laguenay	France					2
La Pasiega	Spain				1	1
Pech-Merle	France	1	6			16
El Pindal	Spain			1		1
Rocamadour	France	1	1			2
Roucadour	France					9
Tibiran	France					18
Trois-Frères	France	5				5

* Most of these are palm print dots.

simply bent over. Cosquer, near Marseille, was reported to have 46 handprints and stencils in 1996, but another 19 have been found since then (Clottes 1996 and pers. comm.). Altamira, El Castillo, Altamira II, El Pindal, Fuente del Trucho, and La Pasiega all have some examples. Lascaux contains hand stencils but is no longer open for study. Similarly, Chauvet, which has at least twelve handprints, nine stencils, and nearly 500 palm prints that sometimes have intact finger prints associated with them, is not open to most professional archaeologists. One panel of palm prints at Chauvet was clearly made by a large man, considering the sizes of the prints and their height above the cave floor. Another large panel of small prints was probably made by a woman or a boy (Clottes 2003: 164).

Les Combarelles, Font-de-Gaume, and Abri du Poisson

I obtained permission to visit and photograph hand stencils in les Combarelles, Font-de-Gaume, and Abri du Poisson in May 2004. Digital photos with scales are important

Table 3. Digit lengths and hand lengths (mm) of single hand stencils in three caves

Hand stencil	Style	D2	D3	D4	D5	Length
Abri du Poisson	Black Negative	61	68	65	47	154
Les Combarelles	Black Negative	35	37	34	32	116
Font de Gaume	Black Negative	75	85	76	61	189

because published photographs do not include scales. In most (probably all) cases it is impossible to determine digit lengths or hand sizes photogrammetrically from published images. Thus visits to key cave sites were necessary even for this preliminary study. I digitally photographed hand stencils multiple times in the three caves both in colour with flash and in monochrome using the night vision option allowed by a Sony 5.0 megapixel Cybershot camera. A 10cm scale was held next to each hand stencil for most shots. While Font-de-Gaume has a total of four hand stencils known, only one was legible enough to allow measurement. Les Combarelles and Abri du Poisson each have a single legible hand stencil.

In all cases I found that the hand stencils were most legible in night vision images after brightness and contrast enhancement. I measured hand lengths and digit lengths multiple times on different days after returning from France. Although I obtained slightly different measurements on each of those occasions, the resulting assignment of the probable sex of each hand stencil never changed. Consequently, although it is difficult to measure digit lengths on these nearly illegible hand stencils, the resulting error appears insufficient to influence the outcome when the equations are applied. Table 3 reports the measurements that I regard as typical of my multiple trials, not their averages, for the sexual identifications are the same in either case.

All of the measurable hand stencils in these three caves were of left hands assuming that all three stencils were made with the palms against the rock surface. The only hand stencil in les Combarelles is very small and faint. At an overall length of 116mm it is shorter than the shortest adult female hand I have measured in my sample of living people of European descent. The hand stencil is located deep in the cave, at the end of the portion of the cave that is open to public access. Measurement of hand length would have been impossible had it not been for a small curved ledge in the rock face that cradled the bottom of the left palm of the person who made the hand stencil. This enabled me to measure the length of the hand, from the base to the end of the relatively distinct end of the middle finger (D3). Other digits were less easily discerned but measurable. The position of the thumb, although faint, is enough to convince the viewer that this is a small hand with complete fingers, not a larger one that has lost the last joints of digits D2-D5. Font de Gaume has a single legible hand stencil out of four known. It is a black stencil of a hand with the thumb to the right. The hand stencil is large, and that alone would suggest that it was made by a male, but the data eventually showed that this initial impression was deceptive. The hand stencil at Abri du Poisson is small, although not as small as that found at les Combarelles. Nevertheless, the length is outside the range of normal male variation and within that of females and subadult males.

Pech-Merle

I also visited Pech-Merle but I did not have the necessary special permission to take digital photographs with scales. However, in this case it was possible for me to obtain measurements directly from three hand stencil replicas in the museum near the cave entrance. I also attempted to use the published size of a fish pictograph as a scale in the case of six (black) hand stencils associated with the famous 'Spotted Horses' mural in Pech-Merle. The published length of the fish pictograph is 1.40m (Lorblanchet 1989: 12). A full-sized copy of the fish in the museum exhibit measured only 1.35m, but the tail of the copy was truncated by about 5cm, indicating that the published length is accurate. Published photographs of the Spotted Horses mural often show all six hand stencils as well as the fish pictograph, which is superimposed on one of the horses (Figure 1).

Because of parallax and other problems, photogrammetric comparison of the fish and the hand stencils in published photos of the entire mural does not allow sufficiently accurate direct measurements to compute digit ratios based on the known size of the fish pictograph. However, measurements derived this way are precise enough to reveal that several of the hand stencils are relatively small, in the range of adult females and subadult males. The data are also sufficient to indicate that the museum replicas are faithful copies of the originals and thus useful for this project. However, greater certainty would result if the original hand stencils measured from close-up digital images including scales. Two of the six hand stencils (A & C) associated with the Spotted Horses were among the measurable museum replicas. A photograph of hand stencil A was published at approximately its actual size on the inside front cover of *Treasures of Prehistoric Art* (Leroi-Gourhan 1967b). Like the other five hand stencils around the Spotted Horses this one is a black stencil. There are three hands with thumbs to the right and three with thumbs to the left (Table 4).

The red hand stencil is located in another part of Pech-Merle, as shown in Figure 2. One of the museum replicas is of this hand stencil, which I refer to as hand stencil G. As in the case of Pech-Merle hand stencils A and C, I have calculated digit ratios of this hand stencil from the museum replica. The hand stencil is relatively large, almost certainly that of an adult male on the basis of that measure alone.

Stage 1 analysis

After consulting with statisticians about the most appropriate statistics I used the predictive discriminant analysis function of the SPSS (Statistical Package for the Social Sciences), deriving predictive equations from the data set provided by living subjects using Fisher's linear discriminant functions. The exercise was similar to that used by Thomas to distinguish between arrow points and atlatl dart points (Thomas 1978). My students and I took four scans from each of the 111 subjects: right and left hands with fingers closed and spread. Pictographic hand stencils were almost always made with the fingers spread, and scans of handprints with the fingers spread also proved to provide more accurate digit length measurements. Those measurements were used to carry out the predictive discriminant analysis, and scans of hands with fingers closed were set aside.

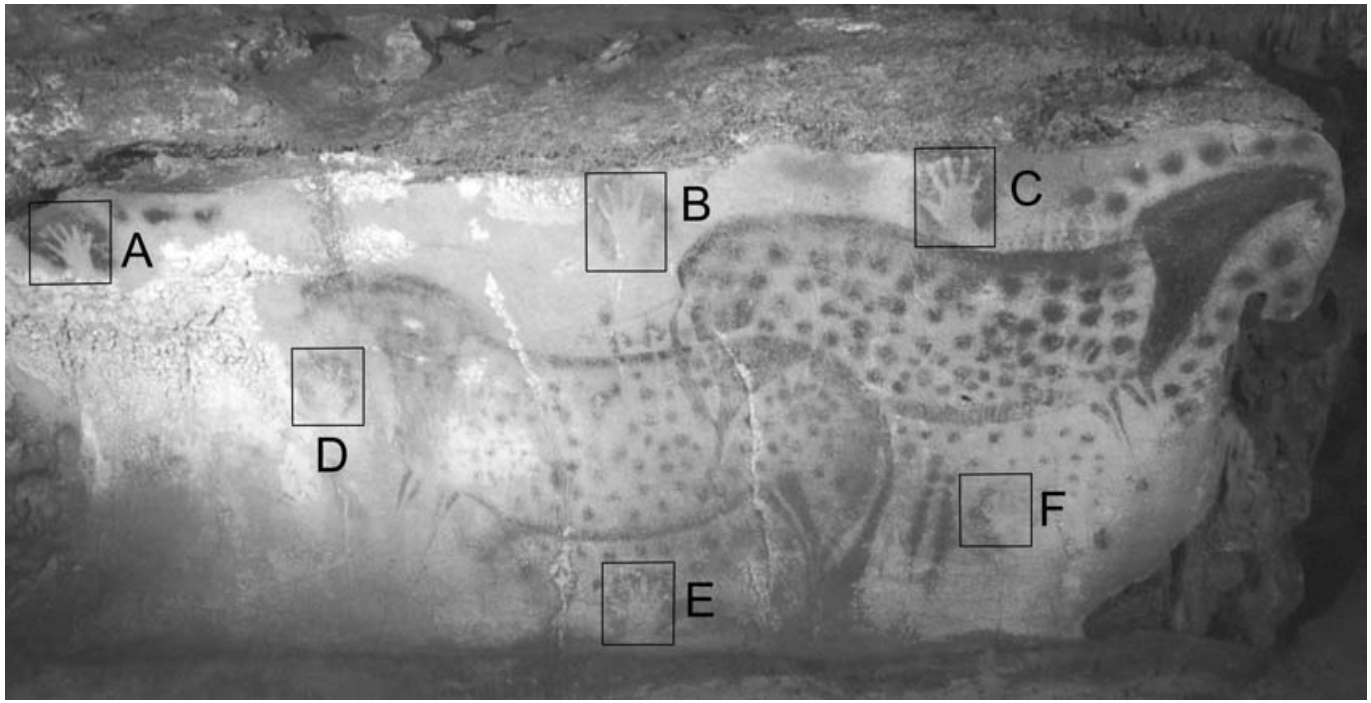

Figure 1. Spotted Horses mural in Pech-Merle.

Method

Table 4. Measurements derived from Pech-Merle museum replicas

Hand stencil	Style	D2	D3	D4	D5	Length
A	Black Negative	76	73	64	50	171
C	Black Negative	68	75	70	47	171
G	Red Negative	73	85	83	64	194

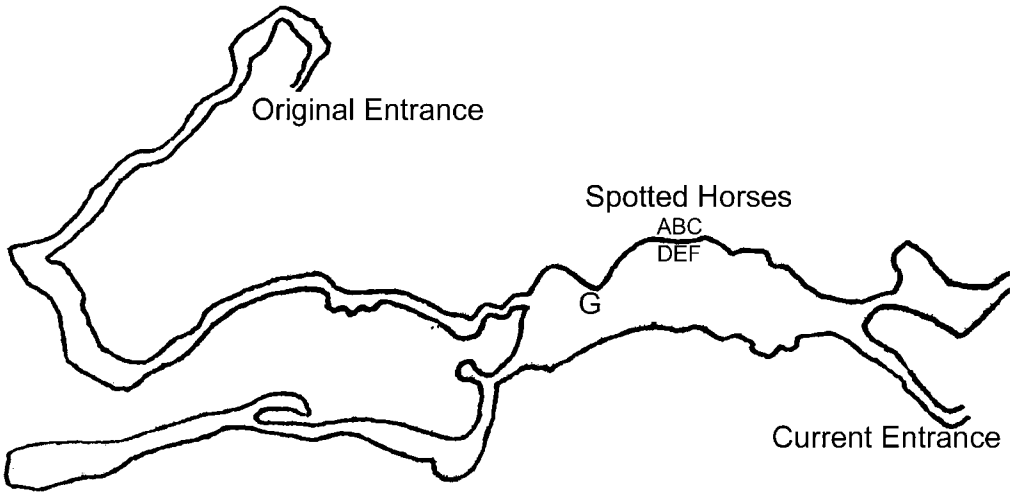

Figure 2. Plan of Pech-Merle showing locations of hand stencils.

Many runs were conducted on these data with varying results. The most successful approach proved to be one that used five measures, the lengths of digits D2, D3, D4, D5, and overall hand length. The analysis produced the following predictive equations:

Left Handprints:

$$\text{Male} = (D2^{*}\text{-}0.870) + (D3^{*}\text{-}0.880) + (D4^{*}1.889) + (D5^{*}\text{-}0.423) + (L^{*}1.942)\text{-}180.552$$

$$\text{Female} = (D2^{*}\text{-}0.698) + (D3^{*}\text{-}0.448) + (D4^{*}1.643) + (D5^{*}\text{-}0.692) + (L^{*}1.742)\text{-}154.992$$

Right Handprints:

$$\text{Male} = (D2^{*}\text{-}0.890) + (D3^{*}\text{-}3.665) + (D4^{*}3.495) + (D5^{*}0.924) + (L^{*}2.436)\text{-}217.259$$

$$\text{Female} = (D2^{*}\text{-}0.513) + (D3^{*}\text{-}3.429) + (D4^{*}3.340) + (D5^{*}0.690) + (L^{*}2.154)\text{-}184.909$$

The last value in each case is a constant. The lengths of digits are fed into both these equations, and the one which results in the higher value indicates the sex associated with

Table 5. Summary of results of the stage 1 analysis

Handprint	Style	Probable Sex
Abri du Poisson	Black Stencil	Strongly Female
Les Combarelles	Black Stencil	Strongly Female
Font de Gaume	Black Stencil	Weakly Female
Pech-Merle A	Black Stencil	Strongly Female
Pech-Merle C	Black Stencil	Strongly Female
Pech-Merle G	Red Stencil	Strongly Male

the hand as a whole. When I applied the equations to each of the 111 handprints in each sample I found that they correctly predicted sex in 77 per cent of the left hand cases and 81 per cent of the right hand cases. Pooling all 222 handprints in a single predictive analysis led unsurprisingly to a 79 per cent success rate. Twenty-one of 114 female hands were classified as male and 26 of 108 male hands were classified as female. Inasmuch as the left and right hand results are very similar and there is a continuing debate about whether the Palaeolithic artists made stencils with their palms up or down, I decided at this point that it is reasonable to pool the data for right and left hands. Doing that and running the discriminant analysis again produced the following predictive equations, which can be used to discriminate adult males from all others (nominally females).

$$\text{Male} = (D2^{*}\text{-}1.062) + (D3^{*}\text{-}2.192) + (D4^{*}2.632) + (D5^{*}0.364) + (L^{*}2.176)\text{-}195.626$$

$$\text{Female} = (D2^{*}\text{-}0.806) + (D3^{*}\text{-}1.853) + (D4^{*}2.426) + (D5^{*}0.13) + (L^{*}1.934)\text{-}166.24$$

The reason for the last qualification is that the subjects were all adults, and absolute size dominated the results. Any subadult males would be classified with females in this analysis. Further analysis (Stage 2) showed that using only digit length ratios prevented the classification of subadult males with females, but produced less satisfactory results overall. Consequently, it is best to analyse archaeological data in two stages, the first using the absolute measures just described and the second using digit ratios.

Dividing in each case the female product by the male product yields a quotient that can be used to scale all 111 right or left handprints on a continuum from most feminine to most masculine. Not surprisingly, the misclassified cases clustered around the midrange of the continuum, reflecting the overlap of small male and large female hands. My next step was to include measurements from the six cave hand stencils in the analysis. The results, summarised in Table 5, were striking.

Four of the cave stencils were at or very near the female end of the continuum, far from the region where male and female measures overlap. The equations not only predicted that all four hand stencils were probably made by females, they indicated that there was only a very small chance that any of them were made by males. Pech-Merle G was similarly near the male end of the continuum, indicating that there is almost no chance that it was made by a

female. The hand stencil from Font de Gaume was classified as female, but fell ambiguously near the middle of the continuum, where there are several cases of males misclassified as females in my sample of living people.

The stage 1 analysis was based on absolute digit and hand lengths, a procedure that implicitly assumes that all of the people leaving hand stencils behind were adults. Absolute size was a strong determinant in this analysis. The youngest individual in my sample of 111 was 18 years of age. Furthermore, the analysis made no provision for the relative digit length ratios advocated by Manning. Consequently, I carried out the stage 2 analysis to separate the hand stencils of females from those of similarly-sized, usually subadult, males.

Stage 2 analysis

The initial analysis clearly distinguished between adult male hands and those of all others, either adult females or subadults. The second predictive discriminant analysis examined both the ratio of the index finger to the ring finger (D2/D4) and the index finger to the little finger (D2/D5). Simple inspection suggests that both ratios should be high for females. Discriminant analysis produced the following equations:

Male = (D2/D4*1071.558) + (D2/D5*1042.846)-990.746

Female = (D2/D4*1060.57) + (D2/D5*1026.336)-965.801

This analysis of quotient values produced results that were accurate for only 59 per cent of the cases. Fifty-one of the 114 female cases were classified as male while 39 of the 108 male hands were classified as female. While the results were statistically significant, the approach is not robust enough to allow an archaeologist to use these measures alone move from the general to the specific and identify the sex of any particular handprint or stencil with much confidence. The best approach to hand stencils is to carry out the stage 1 analysis described above and then use the stage 2 analysis to (potentially) clear up ambiguous cases involving confusion between females and subadult males (subadult females will be identified as female by both analyses). The second analysis supported the previous identifications of the Abri du Poisson, Font de Gaume, Pech-Merle A, and Pech-Merle C hand stencils as female. The Pech-Merle G hand stencil was again found to be male, but less strongly so. The surprising finding was that the hand stencil from Les Combarelles fell at the extreme male end of the continuum of quotients produced by dividing in each case the female product by the male product of the stage 2 analysis. No hand in my sample of 222 living individuals was as strongly male as this one in the Stage 2 analysis. While identified as strongly female when absolute measures were used, it was identified as strongly male in terms of digit ratios. Only one female in my sample of 111 living individuals had a hand this masculine when measured that way. Although the error rate is high for the stage 2 analysis, the finding supports the identification of this hand stencil as probably having been made by a subadult male (Table 6).

Discussion

I later assigned two students to acquire and measure hand scans of an additional 100 individuals. My purpose was to test the previous discriminant analysis while at the same

Table 6. Summary of results of the stage 2 analysis

Hand stencil	Style	Probable Sex
Abri du Poisson	Black Stencil	Strongly Female
Les Combarelles	Black Stencil	**Strongly Male**
Font de Gaume	Black Stencil	Weakly Female
Pech-Merle A	Black Stencil	Strongly Female
Pech-Merle C	Black Stencil	Strongly Female
Pech-Merle G	Red Stencil	Weakly Male

time testing the abilities of inexperienced data collectors working under minimal supervision. The stage 2 analysis correctly discriminated males from females in the new sample in only 57 per cent of the cases, slightly more disappointing than the previous results. While even these disappointing results were statistically significant, and they indicated that the procedures developed for the initial dataset were appropriate, the exercise highlights the difficulties inherent in any effort to argue from the general to the specific. While further research might yield an improved success rate in predicting the sex of a given handprint, current values indicate that we should expect to succeed in no more than 80 per cent of cases involving archaeological unknowns. For that reason alone much larger archaeological samples must be measured before any generalisations can be made with any confidence.

This preliminary study shows that it is possible to determine the sexes of individuals who left hand stencils behind in the Upper Palaeolithic cave sites of south-western Europe. By using a two-step analytical procedure, one can distinguish first between adult males and all others, then second between males and females in the latter group. Analysis of a sample of only six hand stencils from four caves yielded evidence for four females, one adult male, and one subadult male.

There has been much written about sex and gender in recent archaeological literature. Interest in the subject has grown as the number of women in the profession has grown and implicit male bias in past interpretations has become more obvious to modern readers. AltaMira Press has an entire series dedicated to gender and archaeology.

Despite the high level of interest, it has been difficult for archaeologists to move beyond position statements to the solution of specific archaeological problems relating to sex and gender (Donald & Hurcombe 2000; Nelson & Rosen-Ayalon 2002). Tuohy's study of long-handled weaving combs is perhaps typical. After much effort she concluded that it was not possible to determine the sex of either the makers or the users of these artefacts (Tuohy 2000: 151).

It is usually difficult to find ways to identify either the makers or the users of artefacts by archaeological means. Some success has been achieved through the study of burials (where sex can be determined) and associated offerings (Arnold & Wicker 2001). Even in these cases, however, one must usually make assumptions about the manufacture and use of burial offerings. My own research has shown that late prehistoric Iroquoian women made cooking pots in two sizes, one large enough to accommodate a nuclear family and the other for single servings. The latter were typically used exclusively by women during their menstrual periods and often buried with them, but this association would not be clear were it not for a

historical reference to the practice (Sagard 1968: 67, 109; Snow 1994: 57). Indeed it would not even be clear that women, not men, made pottery were it not for Sagard's observations. Even then we dare not project what we know from ethnohistoric sources very far back into prehistory.

In rock art cases we may be able to discern sexual differences in petroglyphs or pictographs but at the same time be unable to determine whether the art was made by men or women. My own research has defined clear differences between male and female figures and symbols in Eastern Algonquian petroglyph art, but no information at all about who made it. Leaving aside the older popular belief that the Eastern Algonquian rock art was left by naughty boys, we can infer that it was probably made by male shamans. However, were it not for ethnohistorical sources that make it clear that Eastern Algonquian shamans were usually (but not always) adult males, even this inference would be risky. The same problem can be observed in many other works on rock art in North America and elsewhere (Hays-Gilpin 2004; Shoocongdej 2002).

Hand stencils in parietal art offer a rare opportunity to identify the sexes of at least some of the artists with a high level of probability. The sexes of the human figures they sometimes drew or carved can also be determined, but in these cases there is no clear direct link between the sex of the artist and the sex of the subject, although many authors have speculated on this (McDermott 1996). Gender categories, to the extent that they differ from sexual ones, would be even harder to discern. Many American archaeologists avoid the study of rock art altogether simply because it is so difficult to devise testable hypotheses in this domain.

Conclusions

My preliminary study of hand stencils demonstrates that it is possible to determine the sex of the people who made pictographic representations of their hand stencils in Upper Palaeolithic caves. If one assumes that all hand stencils were left by adults, then one can include hand length as one of the measures used in a predictive discriminant analysis. However, the single handprint from the French cave Bayol II (Collias II) is reportedly that of a very small child, and many others are small enough to fall into the size range of females and subadults of both sexes. That means that we can use the equations based on digit and hand lengths only to make a first cut between adult males and all others. The less robust equations based on digit ratios can then be used to determine sex amongst those cases that are clearly not adult male hand stencils. Further research might yield methods that are consistently adequate to distinguish sex within all age groups, making determinations based on ratios alone possible. This would allow photogrammetric sex determinations from published photos that consistently lack scales, because relative digit lengths would be as good as absolute ones for determining ratios. However, more research on handprint and hand stencils on which absolute measurements are possible is needed before we can be sure that simple photogrammetrically derived ratios will be sufficient, and it may never be. Further research on living populations is also needed if we are to make convincing sexual identifications of hand stencils left by people from populations other than European ones.

Further research in French and Spanish caves will illuminate part of an area of current interest in archaeology, namely the roles of males and females in one kind of archaeological

site formation. The current small sample of hand stencils from a few French sites indicates that females were present and suggests that they were more active in the production of parietal art than has been previously assumed. But the sample is too small to allow generalisation across the range of similar cave sites in south-western Europe. More research will be carried out based on these preliminary findings, particularly but not exclusively in caves having large numbers of hand stencils (Table 1). The National Geographic Society has committed funding to support the research. I am hopeful that other archaeologists will take up this line of research in other parts of the world, first acquiring comparative measurements from relevant living descendant populations.

This preliminary project is an example of a tightly-bounded and well-defined archaeological problem having limited scope and modest but clear and achievable objectives. It offers a rare example of a testable hypothesis in the study of parietal art. So far the results indicate that we can move beyond the implicit assumption that males dominated in the production of this art. The project thus advances the solution of one very small scientific problem and informs larger debates regarding the purpose and meaning of Upper Palaeolithic cave art.

Acknowledgements

I am very grateful to David Whitley, Jean Clottes, and François Djindjian for their advice as I was getting started on this project. I also thank D. Barraud and Jean-Jacques Cleyet-Merle, who facilitated approval of my request to photograph hand stencils in three caves in Aquitaine, and to Georges Levy, who arranged for the visits. I had the expert guidance of Annie Laval at Font-de-Gaume and Claude Archambeau at Abri du Poisson and Les Combarelles, both of whom were extraordinarily generous with their time and patient with my limited ability in French and guided my wife Jan and me through the caves with admirable charm, knowledge, and patience. Ryan Hudson and Cristina Feather recruited volunteers and took over 400 hand scans. Jeremy Zukas and Joshua Stulman took additional hand scans from living individuals, data from which were used to test the algorithms. Rebecca Courrier carried out much of the data entry. Paul Bahn and an anonymous reader provided many valuable criticisms of and corrections to an early draft. Jean Clottes spotted some important omissions in a later draft, but like others I have named he bears no responsibility for any lingering errors. Finally, I thank Jan for her enduring support and companionship in all things archaeological.

This report is preliminary in two ways. First, only a small number of cases have been studied thus far, and a much bigger sample is desirable. Second, it might be possible to refine and improve the statistical methods used, thereby increasing the accuracy of results separately from the improvements afforded by a larger sample size. I have secured a grant from the National Geographic Society to extend and expand the study in both ways in 2006.

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