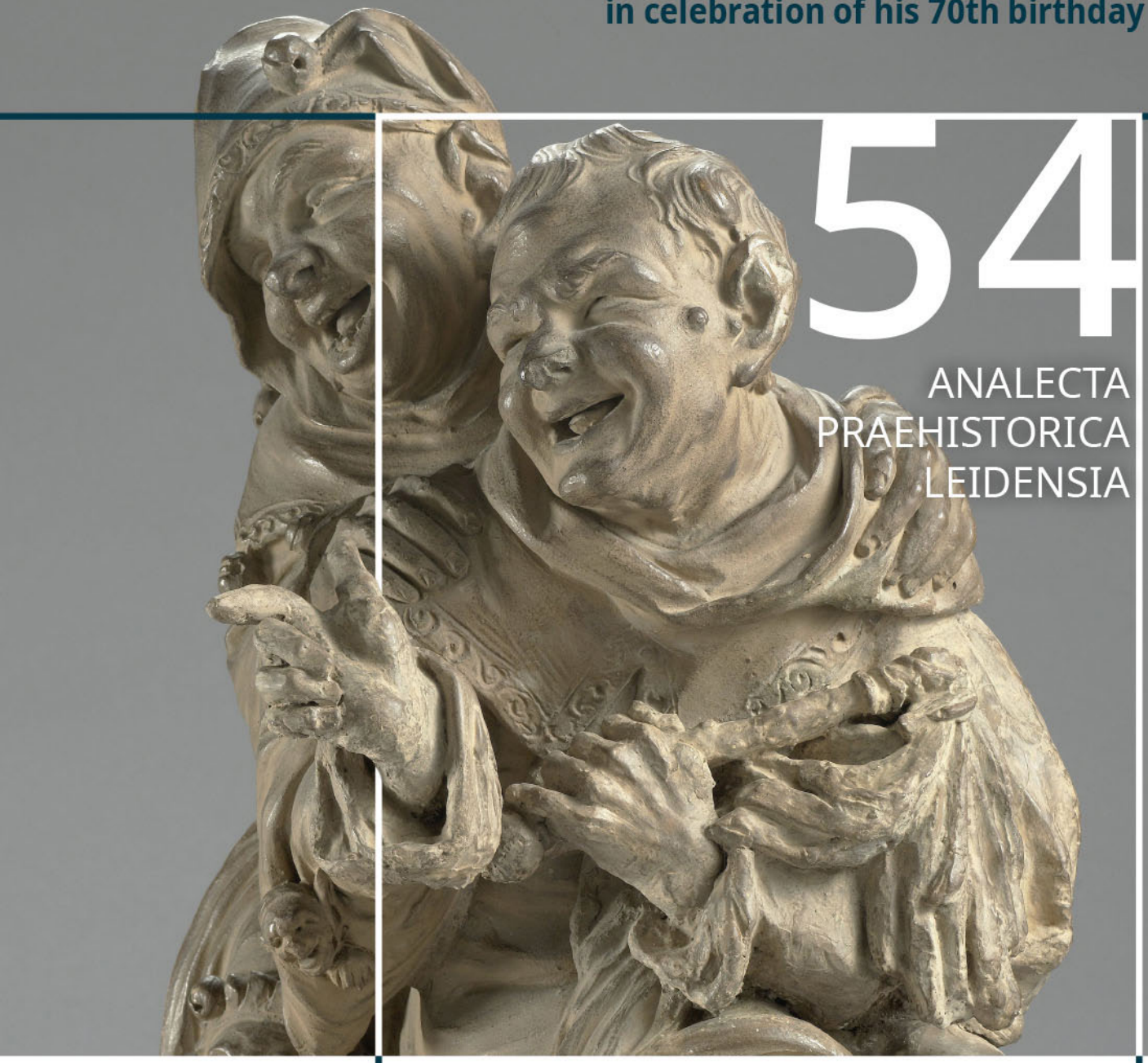
SITTING ON THE FENCE: NEGOTIATING ARCHAEOLOGY, ANTHROPOLOGY AND PHILOSOPHY

Festschrift for Prof. Dr Raymond H.A. Corbey in celebration of his 70th birthday



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ANALECTA PRAEHISTORICA LEIDENSIA

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Contents

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Religious sacrifice in the Ice Age? Ritual finger amputation and the Gravettian hand images with incomplete fingers

Mark Collard, Brea McCauley

Abstract

More than 200 hand images with incomplete fingers (HIIFs) have been found at cave sites in France and Spain that are associated with the Gravettian archaeological culture (27,000-22,000 BP). In 2018, we reported a cross-cultural study designed to shed light on the possibility that the Gravettian HIIFs reflect finger amputation. We concluded that, when the contexts and what we can infer about the sex and age of the participants are considered, the hypothesis that best fits the images is that they were produced by individuals whose fingers had been amputated in religious rituals. In this paper, we respond to the criticisms that have been levelled at our study in the intervening period. Drawing on the results of an expanded cross-cultural study, we show that the critics' arguments are unfounded. We also explain why amputation deserves to be taken seriously as a potential explanation for the Gravettian HIIFs, and why religious sacrifice is the motivation that best fits the currently available data pertaining to the images. Lastly, we outline the potential implications of the Ritual Amputation Hypothesis for our understanding of Gravettian social life and the evolution of human cognition.

Keywords: Rock art; parietal art; cave painting; Upper Palaeolithic; permanent body modification; finger amputation.

Introduction

Over 200 hand images with incomplete fingers (HIIFs) have been found among Europe's Ice Age cave paintings. These images are in France and Spain and are thought to be associated with the Upper Palaeolithic Gravettian archaeological culture (27,000-22,000 BP) (Jaubert 2008). Some examples of Gravettian HIIFs at Cosquer Cave, France, are shown in figure 1A. The geographic distribution of sites with Gravettian HIIFs is depicted in figure 1B.

The term 'hand image' refers to both handprints and hand stencils. These can be thought of as positive and negative hand images, respectively (Snow 2006). To produce a positive hand image, the front of the hand is covered with pigment and then pressed on a surface. In contrast, a negative hand image is created by pressing the hand against a surface and applying pigment around it.

The Gravettian HIIFs vary along several dimensions. Both left and right hands were used to make the images, and it is believed that they represent the hands of both males and females (Barriére 1976). In addition, the number of incomplete fingers per image varies considerably between and within sites. Some images have just one incomplete finger, while others have only one complete finger (figure 1C).

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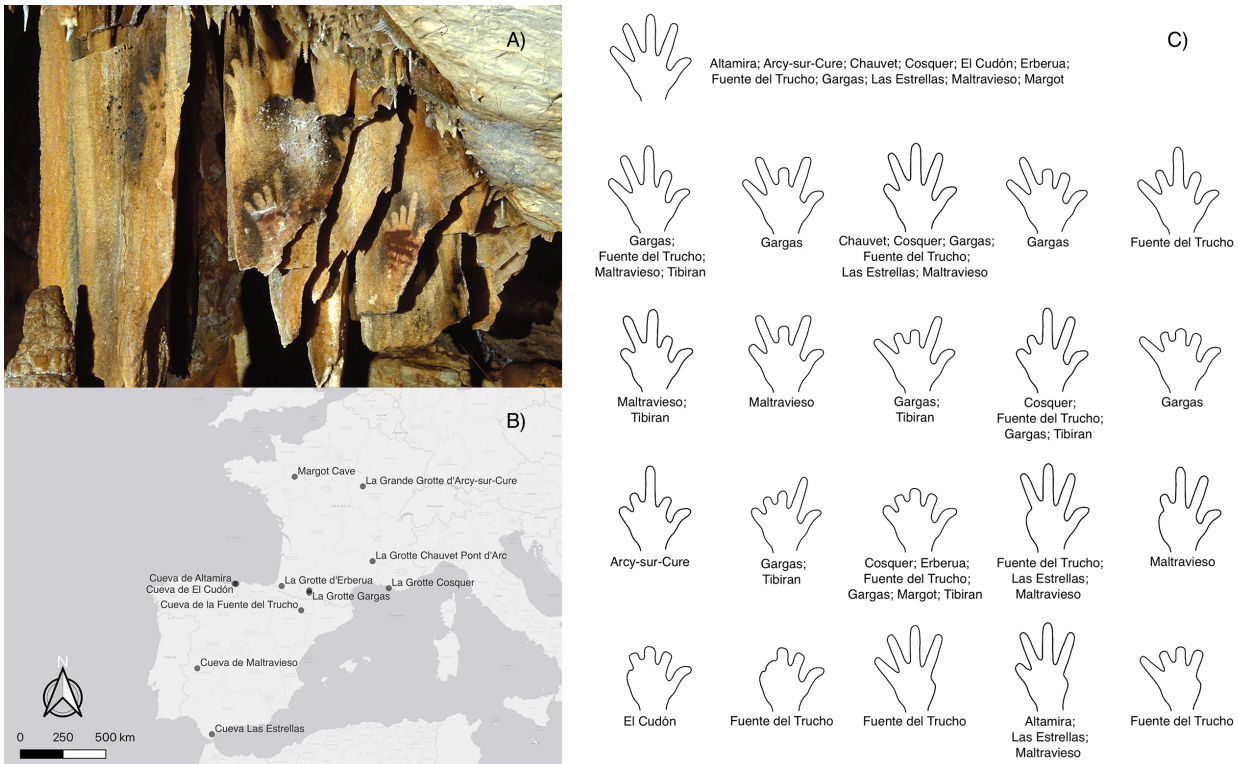

Figure 1. Gravettian hand images with missing finger segments. A) Photo of hand images from Cosquer Cave, France. Credit: Jean Clottes, used with permission. B) Geographic distribution of archaeological sites with Gravettian hand images with incomplete fingers. C) Drawings of hand images illustrating the variability in missing finger segments. All images drawn as left hands. The top left drawing lists sites with complete hand images. The incomplete hand drawings do not distinguish between one and two missing segments. Images redrawn from Sahly (1966), Leroi-Gourhan (1967), Baffier and Girard (1998), Clottes (2001), Clottes *et al.* (2005), Pigeaud *et al.* (2006), Larribau (2013), Groenen (2016), Collado Giraldo *et al.* (2018a-e), and Collado Giraldo *et al.* (2019).

Currently, the significance of the Gravettian HIIFs is unclear. Some authors have argued that the individuals who produced the images had all their fingers and simply manipulated their hands so that one or more finger segments were not visible. Others have argued that the images were produced by individuals who had undergone finger amputation.

In 2018 we reported a study designed to shed light on the possibility that the Gravettian HIIFs reflect finger amputation (McCauley *et al.* 2018). We identified 121 recent groups that practised finger amputation and distinguished ten motivations for the custom, nine of which did not involve a medical goal. We concluded that, when the contexts and what we can infer about the individuals' sex and age are considered, the hypothesis that best fits the Gravettian HIIFs is that the people who produced them had undergone amputation in rituals intended to elicit help from supernatural entities.

Some colleagues have dismissed our study. Most notably, in media coverage of the study, Prof. Paul Pettitt called it "ill-informed" and argued that amputation cannot explain the Gravettian HIIFs because many lack more than just the little finger and that is not what is seen in the ethnographic record (Pappas 2018). In fact, Pettitt went beyond the claim that it is not seen ethnographically. He implied it is inconceivable, as can be seen in the following quotations:

> *"Ethnographically, if amputations occur, they are typically of the little finger: It would be idiotic to amputate more!," Pettitt quoted in Pappas (2018).*

"Nobody would be idiotic enough to remove every finger bar the thumb. That simply makes no sense," Pettitt quoted in Marshall (2018).

A similar argument can be found in a recent story for *New Scientist* by Dr. Alison George (2023). George's piece focused on the sites of Gargas and Cosquer in France. She noted that the most common HIIF pattern at these sites is an extended thumb with all other fingers incomplete and argued that this "extreme mutilation […] would have been catastrophic for the recipient" (George 2023, 40). When combined with the fact that there are no incomplete fingers on the positive Upper Palaeolithic hand images, she suggested, this observation rules out "the mutilation idea […] at least at Gargas and Cosquer" (George 2023, 40).

Inspired by Prof. Corbey's jousterly approach to the academic enterprise, the present paper is a response to Pettitt's and George's criticisms of our 2018 study. We begin with the basics – the definition of a HIIF and the geographic distribution of the Gravettian HIIFs. We then provide an overview of the hypotheses that have been put forward to explain the Gravettian HIIFs. Next, we evaluate Pettitt's and George's criticisms of the Ritual Amputation Hypothesis and show they are flawed. Thereafter, we explain why amputation deserves to be taken seriously as a potential explanation for the Gravettian HIIFs and why religious sacrifice is the motivation that best fits the available data pertaining to the Gravettian HIIFs. Subsequently, we outline the implications of the Ritual Amputation Hypothesis for our understanding of Gravettian social life and the evolution of human cognition. In the final section of the paper, we clarify what we are, and are not, arguing in relation to the Ritual Amputation Hypothesis.

The Gravettian HIIFs

We define a HIIF as a positive or negative image of a human hand in which more than one, but less than all, of the finger segments are visible. A finger segment comprises a phalanx and its associated soft tissues. The phalanges of the hand are the bones at the core of the fingers. Normally there are 14 phalanges in a human hand. The thumb has two – a proximal phalanx and a distal one. The forefinger, middle finger, ring finger, and little finger all have three – a proximal phalanx, a middle phalanx, and a distal phalanx. Thus, in principle, a HIIF can have between one and 13 finger segments visible.

We have specified that a HIIF must have at least one finger segment visible to exclude palm prints, which are uninformative regarding the absence of finger segments. Our definition of a HIIF also excludes the so-called crooked thumb images, which are stencils of flexed thumbs (Clottes 2008). It has been suggested to us that these may be a type of HIIF but we are not convinced. Crucially, it is unclear whether the hands featured in the crooked thumb images had all their other fingers.

In our 2018 paper we provided an overview of Gravettian HIIFs (McCauley *et al.* 2018). We have since identified additional sites and revised the number of HIIFs at some of the sites in our original list (McCauley and Collard, in press). Our current tally of Gravettian HIIFs is 203. These images are distributed among 12 sites in France and Spain (figure 1B). The 203 images are not evenly distributed among the sites (table 1**)**. Ninety-three of them are found at Gargas Cave in southwest France, 42 occur at Maltravieso in western Spain, and 28 are found at Cosquer Cave in southern France. A further 23 occur at Fuente del Trucho, which is in northeast Spain. None of the remaining eight cave sites has more than ten HIIFs.

Potential explanations for the Gravettian HIIFs

A number of explanations have been put forward by those who believe the individuals who produced the Gravettian HIIFs manipulated their hands so that certain finger segments were not included. Several researchers have argued the Gravettian HIIFs reflect use of a sign language. Pettitt and George are proponents of this hypothesis (George, 2023). Support for the Sign Language Hypothesis can also be found in Patte (1960), Leroi-Gourhan (1967, 1986), Delluc and Delluc (1993), Clottes and Courtin (1994), and Etxepare and Irurtzun (2021). Van den Broeck (1950) proposed another explanation, which is that the Gravettian HIIFs were created as 'visiting cards'. Lastly, Rouillon (2006) and Overmann (2014) have posited that the Gravettian HIIFs represent a counting system.

As we mentioned earlier, in our 2018 paper we argued that the Gravettian HIIFs reflect finger amputation during life to appeal for supernatural assistance (McCauley *et al.* 2018). We were not the first researchers to support this hypothesis. Baudoin (1927), Casteret (1951), and Nougier (1963) all argued that Gravettian HIIFs were made by hands from which fingers had been removed as sacrificial offerings. Others have proposed related hypotheses. Breuil (1952)

Site	Country	Complete	HIIF	Unclear	Total	Are the HIIFs positive or negative?	Source
Cueva de Altamira	Spain	3	1	5	9	Negative	Freeman and González Echegaray (2001); Collado Giraldo *et al.* (2018b)
Cueva de El Cudón	Spain	0	1	1	2	Negative	González Echegaray and Sáinz (1994); Collado Giraldo *et al.* (2018a)
Cueva de la Fuente del Trucho	Spain	12	23	21	56	Negative	Utrilla *et al.* (2013); Collado Giraldo *et al.* (2018c)
Cueva de Las Estrellas	Spain	1	4	0	5	Negative	Collado Giraldo *et al.* (2019)
Cueva de Maltravieso	Spain	4	42	13	59	Negative	López *et al.* (1999); Collado Giraldo and García Arranz (2018)
Grotte Chauvet Pont d'Arc	France	10	1	0	11	Positive	Clottes (2001)
Grotte Cosquer	France	21	28	0	49	Negative	Clottes and Courtin (1994); Clottes *et al.* (2005)
Grotte d'Erberua	France	2	1	0	3	Negative	Larribau (2013)
Grotte Gargas	France	17	93	83	193	Negative	Leroi-Gourhan (1967); Barrière (1976); Groenen (2016)
Grotte d'Arcy-sur-Cure	France	7	1	1	9	Negative	Baffier and Girard (1998)
Grotte Tibiran	France	0	7	3	10	Negative	Sahly (1966)
Margot Cave	France	4	1	0	5	Negative	Pigeaud *et al.* (2006)

Table 1. Archaeological sites that contain Gravettian hand images with incomplete fingers. Complete = number of complete hand images. HIFF = number of hand images with incomplete fingers. Unclear = number of hand images where preservation does not allow for a designation as either complete or HIIF. Total = sum of complete, HIIF, and ambiguous. HIIFs positive or negative? = are the HIIFs at the site positive or negative hand images?

suggested that the HIIFs reflect ritual amputations carried out to ensure a successful hunt, and Narr (1966) argued that the HIIFs reflect voluntary amputation in the context of rites of illness and death. More recently, Lundborg (2014) argued that Gravettian HIIFs reflect finger amputation in connection with initiation rites.

Medical amputation has also been proposed as an explanation. Janssens (1957), for example, argued that the Gravettian HIIFs reflect Raynaud's syndrome. This medical condition involves a narrowing of the arteries that reduces blood flow to the fingers and toes and can, in severe cases, require amputation of the affected parts. Little is known about its etiology, but cold is thought to be one trigger, which is why Janssens (1957) suggested it might explain the Gravettian HIIFs. More recently, Gilligan (2010) suggested the Gravettian HIIFs reflect amputation to deal with gangrene caused by frostbite.

In sum, then, the hypotheses that have been put forward to explain the Gravettian HIIFs can be divided into those that aver the missing finger segments were folded over and those that argue that they were amputated. The latter hypotheses can be divided into those that contend that the finger segments were amputated for ritual reasons and those that argue they were amputated to deal with a medical condition affecting the targeted segments.

Pettitt's and George's criticisms of the Ritual Amputation Hypothesis

As we explained earlier, Pettitt's rejection of the Ritual Amputation Hypothesis is based on two arguments. One is that amputation cannot explain

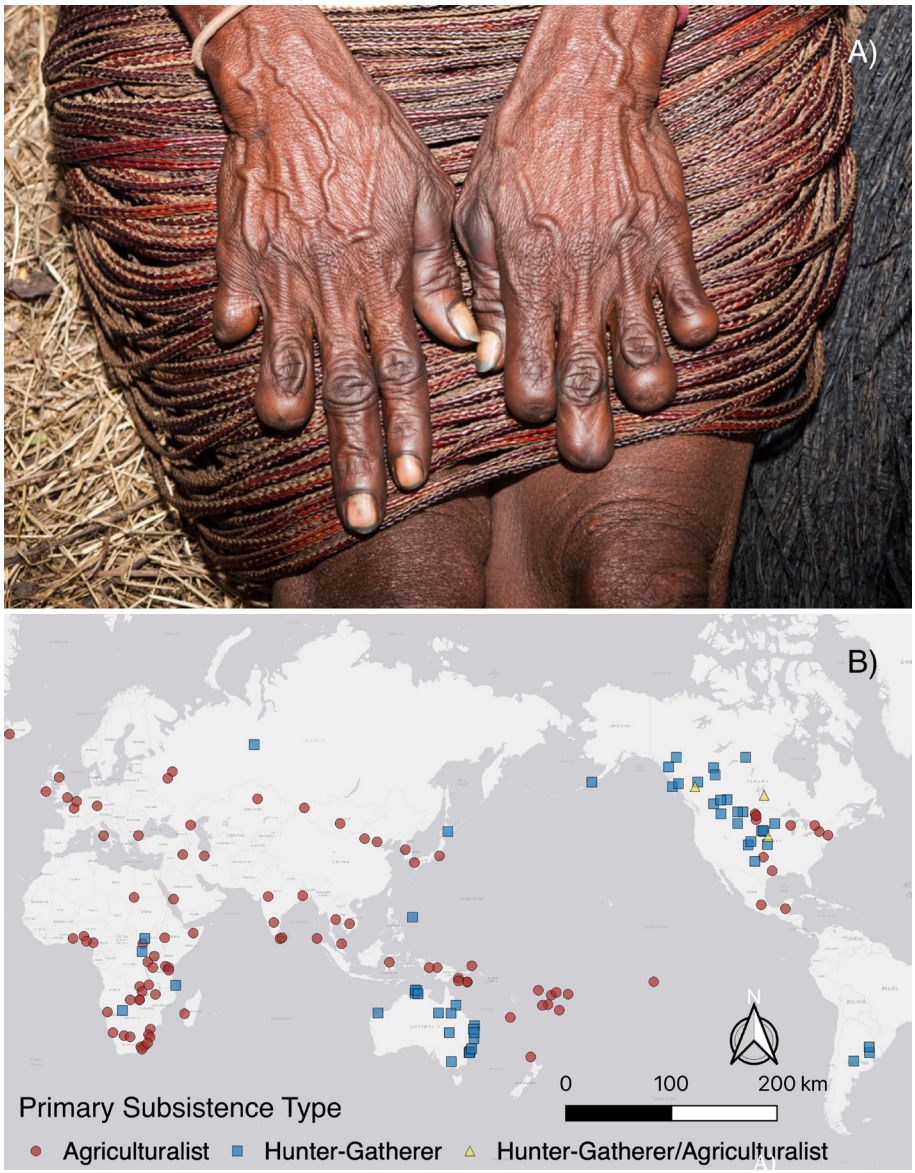

Figure 2. Finger amputation in the present and recent past. A) Hands of a Dani woman with missing finger segments. The Dani live in West Papua, Indonesia, and amputate finger segments to mourn deceased relatives (Credit: imageBROKER/R. Dirscherl/ Alamy). B) Distribution of 177 ethnographically-documented societies that engage(d) in finger amputation (McCauley and Collard, in press). Markers coloured based on the groups' mode of subsistence.

the Gravettian HIIFs because the latter tend to have multiple incomplete fingers whereas ethnographic cases of amputation usually involve just the little finger. The other argument that underpins Pettitt's rejection of the hypothesis is that amputation cannot explain the Gravettian HIIFs because removing multiple fingers is "idiotic" (see quotations from Pettitt in Pappas (2018) and Marshall (2018)).

George's (2023, 40) rationale for rejecting the Ritual Amputation Hypothesis as an explanation for the HIIFs at Gargas and Cosquer is similar to Pettitt's second argument. George noted that the commonest pattern of incomplete fingers at Gargas and Cosquer is an extended thumb with all other fingers truncated, and she averred that this "extreme mutilation [...] would have been catastrophic for the recipient". Additionally, George contends the Ritual Amputation Hypothesis can be rejected because it is inconsistent with the fact that none of the positive hand images at European Upper Palaeolithic cave art sites has incomplete fingers.

These arguments do not withstand scrutiny. As part of the follow-up to our 2018 study, we expanded our search of the ethnohistoric literature for evidence of finger amputation, and one of the variables for which we collected data was the finger targeted (McCauley and Collard, in press). We found mentions of finger

amputation unrelated to medical problems with the amputated finger in connection with 177 groups. Data on the finger that was targeted were available for 90 of these groups. Five groups focused on the thumb, seven targeted the forefinger, two selected the middle finger, one concentrated on the ring finger, and 48 focused on the little finger. A further four groups targeted all the fingers, and 20 focused on a combination of fingers. Three groups only amputated supernumerary fingers. Thus, contrary to what Pettitt averred, it is not the case that ethnographically documented groups limited amputation to the little finger. The little finger was the one most frequently targeted, but the other fingers were partially or completely amputated by multiple groups.

Similarly, the idea that the removal of multiple finger segments is "idiotic" and "catastrophic for the recipient" is not supported by our expanded sample. Data on the number of finger segments removed during an individual's life were available for 135 groups. Forty-four groups removed a single finger segment, while 41 amputated an entire finger. Of the remaining groups, 27 removed a variable number of finger segments, ranging from two to 20, and 23 removed a variable number of fingers, ranging from two to ten. Thus, while it was most common for just one finger segment to be amputated, it was not unknown for an individual to have more than ten finger segments removed in their lifetime. We have included figure 2A to illustrate this point. It shows the hands of an elderly female member of the Dani tribe in West Papua, Indonesia, who has had multiple fingers amputated in mourning rituals. The scars are manifestly old, from which we can infer that she lived for years without many of her fingers. How difficult she found it is unclear, obviously. But the loss of the fingers does not appear to have been catastrophic for her. While Pettitt and George may find it hard to comprehend that an individual would accept the loss of multiple finger segments for ritual purposes, it clearly occurred in several societies and evidently was not necessarily disastrous for the amputee.

George's argument against the Ritual Amputation Hypothesis is unconvincing for two reasons. First, it is not the case that all the Gravettian HIIFs are negative hand images. Most are, but the HIIF at Chauvet is a positive hand image (Clottes 2001: 154). Second, George's argument ignores the fact that negative hand images greatly outnumber positive hand images in Upper Palaeolithic cave art. A marked bias towards negative hand images among HIIFs is what we would expect given that negative hand images are much more numerous than positive ones. That the percentage of Gravettian HIIFs that are negative hand images is higher than the percentage of all Gravettian hand images that are negative can be explained by sampling effects. Work on genetic and cultural drift has shown us that we should not expect a small sample to have the same distribution for a given variable as the population from which the sample is drawn (*e.g.*, Neiman, 1995).

Reasons for taking finger amputation seriously as an explanation for Gravettian HIIFs

Having shown that Pettit's and George's arguments against the Ritual Amputation Hypothesis do not hold water, we will now outline the reasons why the hypothesis is worth taking seriously. The first is that amputation of finger segments from living people for reasons other than trying to resolve a medical problem with the amputated segment(s) was surprisingly common in the recent past. In the follow-up to our 2018 study (McCauley and Collard, in press), we identified mentions of finger amputation in documents pertaining to 181 societies. Four of these societies are only recorded as having engaged in finger amputation to try to resolve a medical problem with the amputated segment(s), which hereinafter we will refer to as 'surgical amputation'. Twenty-six of the societies only removed finger segments from recently deceased individuals. The remaining 151 societies had at least one custom that involved amputating finger segments from living people for non-surgical reasons. Importantly for present purposes, these societies are widely distributed (figure 2B). This precludes the possibility that non-surgical finger amputation is specific to a particular geographic region or language family. Instead, it is clear from the distribution of the 151 societies that non-surgical finger amputation was likely invented multiple times in different parts of the world. Equally importantly, there are hunter-gatherers among the 151 societies, which means that non-surgical finger amputation is not tied to food production (*e.g.*, via increased social hierarchy). Given that non-surgical finger amputation was carried out by over 100 societies, was clearly invented independently multiple times, and was engaged in by some recent hunter-gatherer societies, it is entirely possible, in our view, that some Gravettian groups engaged in the practice.

The second reason for taking seriously the possibility that the Gravettian HIIFs reflect finger

Site	Country	Date	Complete	HIIF	Unclear	Total	Source
Abo Pueblo	USA	Pre 279 BP	0	1	0	1	Wellmann (1972)
Babamandil	India	ND	0	1	0	1	Dubey-Pathak and Clottes (2020)
Balaro	India	ND	45	11	0	56	Dubey-Pathak and Clottes (2020)
Ballawine (M86/6)	Australia	23,000-18,000 BP	15	1	0	16	Harris *et al.* (1988)
Blood of the Ancestors Grotto	USA	450-150 BP	0	1	0	1	Stelle (2012)
Hamtha	India	ND	35	11	0	46	Dubey-Pathak and Clottes (2020)
Jabbaren	Algeria	8,000-7,000 BP	1	1	0	2	Sansoni (1994)
Jogdadeo	India	ND	29	12	0	41	Dubey-Pathak and Clottes (2020)
Karnasahi 06	Chad	ND	ND	>1	ND	ND	Zboray (2018)
Kejimkujik Lake	Canada	ND	62	2	0	64	Lenik (2016)
Leang Lompoa	Indonesia	27,400-26,000 BP	2	1	0	3	Aubert *et al.* (2014)
Mackerel Beach Rockshelter	Australia	ND	ND	1	ND	ND	McDonald (2008)
Middle Park Highland Province Sites	Australia	28,000-4,800 BP	1282	5	2	1289	Wade *et al.* (2011)
Ramel Pahar	India	ND	ND	1	ND	ND	Dubey-Pathak and Clottes (2020)
Sefar	Algeria	8,000-7,000 BP	0	1	0	1	Sansoni (1994)
Texas Rock Art Site 2	USA	ND	2	3	0	5	Jackson (1938)
Texas Rock Art Site 42	USA	ND	5	1	0	6	Jackson (1938)
Texas Rock Art Site 51	USA	ND	1	1	0	2	Jackson (1938)
Texas Rock Art Site 56	USA	ND	14	4	0	18	Jackson (1938)
Texas Rock Art Site 142	USA	ND	2	1	0	3	Jackson (1938)
Texas Rock Art Site 150	USA	ND	0	2	0	2	Jackson (1938)
Wadi Sura/Sora Site WG45	Egypt	7,500-7,000 BP	ND	25	ND	917	Kuper (2013), Zboray (2013, 2018)

Table 2. Hand images with incomplete fingers at archaeological sites outside of Europe. Complete = number of complete hand images. HIFF = number of hand images with incomplete fingers. Unclear = number of hand images where the preservation does not allow for a designation as either complete or HIIF. Total = sum of complete, HIIF, and ambiguous. ND = No data.

amputation is that there is other evidence of finger amputation that is thought to date to the same period. Sahly (1966) and Barrière (1976) both noted the presence of impressions of human hands in calcitic clay in the 'Chinese Pavilion' at Gargas. One of these impressions is of a right hand with a truncated little finger (Barrière 1976). The other impression is of fingertips with what Sahly (1966) interpreted to be evidence of scarring from amputation. The impressions are thought to be the same age as the cave art at the site (Barrière 1976). Impressions of hands with truncated fingers have also been found at the site of Lascaux, according to Sahly (1966). This author reports that one of the hands that created impressions in the clay at the site had undergone amputation of the index, middle, ring, and little fingers. He also reports that another hand impression at the site was made by a teenager who was missing a little finger. To these discoveries we can add evidence from Obłazowa Cave, Poland (Valde-Nowak *et al.* 1987; Valde-Nowak 2003). Two human finger bones have been found in the Gravettian layers at this site along with several objects

that have been argued to be of symbolic significance including three Arctic fox tooth pendants, a bone needle, and what may be the world's oldest boomerang (Valde-Nowak 2003). It has been suggested these finds indicate that ritual activities were carried out at the site including finger amputation (Valde-Nowak 2009). Thus, we have reasons to believe that some Gravettian groups engaged in finger amputation that are independent of the HIIFs. Obviously, the HIIFs, the impressions, and the Obłazowa phalanges may not be contemporaneous. The Gravettian lasted for several thousand years, after all. But the most parsimonious explanation for the HIIFs, hand impressions, and Obłazowa phalanges is that they were produced by people who engaged in finger amputation. That the site with the largest number of HIIFs, Gargas, has yielded impressions of hands with incomplete fingers is especially compelling in this regard.

The third reason for taking seriously the possibility that the Gravettian HIIFs reflect finger amputation is that HIIFs are not limited to Europe. So far we have been able to identify HIIFs at a total of 22 archaeological sites outside of Europe. Four of these sites are in Africa, three are in Australia, nine are in North America, five are in South Asia, and one is in Southeast Asia (table 2). Not all the sites have been dated but those that have range in age between 27,400-26,000 BP and 450-150 BP. The occurrence of HIIFs at sites on multiple continents is consistent with the ethnographic evidence indicating finger amputation was practised by groups from all inhabited continents.

The fourth and final reason for taking seriously the possibility that the Gravettian HIIFs reflect finger amputation relates to the number of *incomplete* finger segments. Some sites, such as Gargas and Cosquer, have images with multiple incomplete fingers, but other sites, such as Chauvet and Maltravieso, have images that are only missing a small number of finger segments (figure 1C). This is in line with the results of our follow-up study (McCauley and Collard, in press). As we explained in the previous section, we found considerable cross-cultural variation in the fingers that were targeted, and the number of finger segments removed. Some groups only removed one segment from one finger, but other groups targeted multiple fingers and removed multiple segments per finger. Thus, the inter-site variation in the Gravettian HIIFs is like the inter-group variation in the ethnohistorical record.

Is religious sacrifice still the finger amputation motivation that best fits the Gravettian HIIFs?

To reiterate, in our 2018 study we identified ten motivations for finger amputation and concluded that, when the contexts and what we can infer about the characteristics of the amputees are considered, the hypothesis that best fits the Gravettian HIIFs is that they were produced by individuals who had undergone finger amputation as part of a religious ritual (McCauley *et al.* 2018). Given that in the intervening period we have expanded our sample of recent societies that engaged in finger amputation (McCauley and Collard, in press), an obvious question is, 'is religious sacrifice still the motivation that best fits the Gravettian HIIFs?'.

Based on the additional ethnographic and historical data, we have made a few changes to our taxonomy of motivations (McCauley and Collard, in press). To begin with, we have added eight motivations to the taxonomy. Second, we have dropped one motivation, *Veneration*, which we had defined as forced amputation to produce a magical object or worshipping device. This motivation was originally associated with the Sioux but additional sources we consulted in our follow-up study made it clear that the custom involved amputation of the whole hand rather than fingers. Third, we have subdivided the motivation type we had called *Medical* into *Surgery*, which we define as amputation to try to deal with a medical condition affecting the amputated finger segment(s) such as frost-bite-induced gangrene, and *Remedy*, which we define as amputation to try to resolve a medical condition that does not directly involve the amputated segment(s), such as bleeding sickness out of the amputee. Lastly, we have re-ordered the taxonomy so that the highest-level split is between surgical amputation and amputation for cultural reasons. The revised taxonomy, which includes 18 motivations, is shown in figure 3.

None of the newly identified motivations fits what we know about the Gravettian HIIFs better than sacrifice to try to elicit the assistance of supernatural entities. The newly identified motivations are 1) avoiding the draft, 2) expressing extreme love, 3) penance, 4) betting, 5) torture, 6) oppression, 7) confirming death, and 8) creating a charm. The last two of these motivations – confirming death and creating a charm – both involve the amputation of phalanges from recently deceased individuals. Previously we argued it is unlikely that the Gravettian HIIFs were

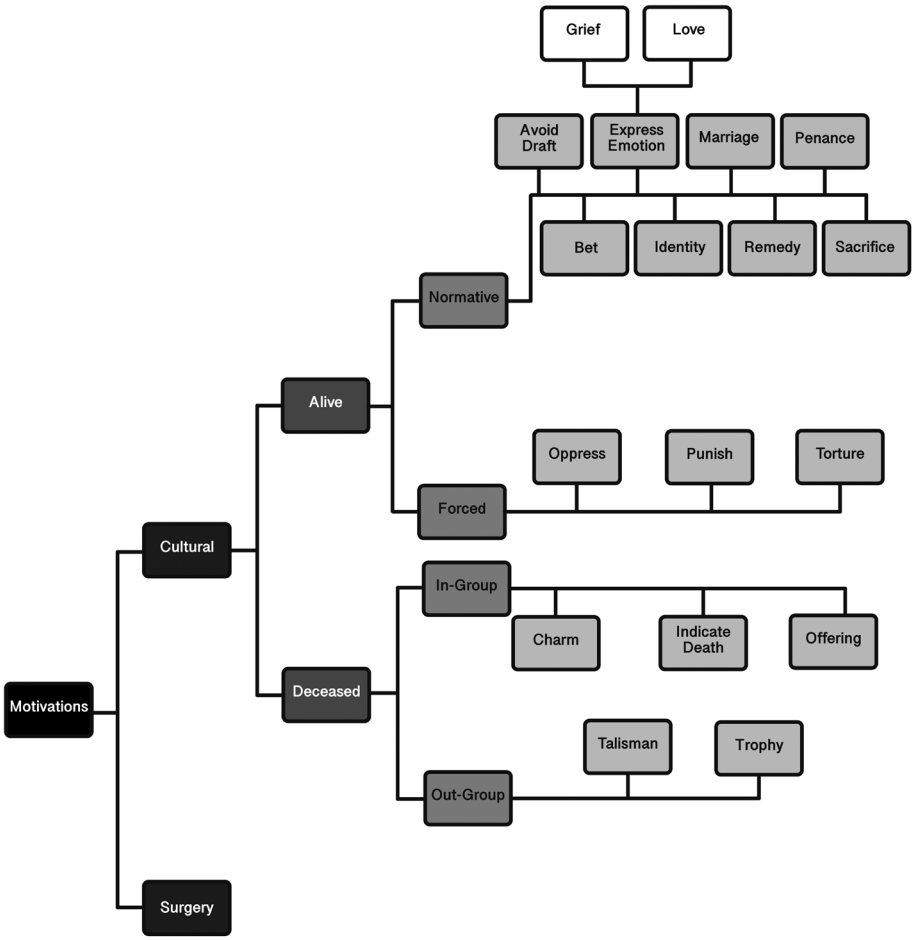

Figure 3. Revised typology of motivations for finger amputations presented by McCauley and Collard (in press).

produced after the death of the amputee because of the large number of individuals thought to have been involved in the creation of the images at some sites and the location of the images (*i.e.*, inside caves) (McCauley *et al.* 2018), and we think that argument still holds. As such, we believe we can discount confirming death and creating a charm as motivations for the acts of amputation reflected by the Gravettian HIIFs. Of the remaining six newly identified motivations, avoiding the draft can be dismissed. This is partly because forced military service is unlikely to have existed in the Upper Palaeolithic and partly because analyses suggest that the Gravettian HIIFs were produced by women as well as men (Groenen 1988). Among the ethnohistorically-documented cases, finger amputation to avoid the draft was only practised by men. Similarly, we think betting and penance can be discounted because they only involved men in the ethnohistorically-documented cases. Oppression also seems to be unlikely to have been a motivation for engaging in finger amputation in the Upper Palaeolithic, because in our ethnohistorical sample, the oppression involved members of a low status group undergoing forced amputation by members of a much higher status, and status differences of such magnitude are not thought to have existed during the Upper Palaeolithic. The remaining two newly-identified motivations – expressing extreme love and torture – were not restricted to a particular sex or class, which means that they could potentially explain the Gravettian HIIFs. However, they were much less common in our expanded ethnohistorical sample than religious sacrifice. Finger amputation to express extreme love was found in only one group, while finger amputation was a form of torture was practised by six groups. In contrast, amputating finger segments to appeal to a supernatural entity for assistance was normative in 33 groups. Thus, based on the ethnographic data we have been able to assemble to date, religious sacrifice is a much more likely motivation

for finger amputation than expressing extreme love and torture.

There is another reason for considering religious sacrifice to be the finger amputation motivation that best fits the Gravettian HIIFs. As we explained in our 2018 study, the religious sacrifice motivation fits well with one of the major hypotheses concerning the nature of Upper Palaeolithic art in general – namely, that it is religious in nature. Numerous scholars have posited that the caves with Upper Palaeolithic rock art were places of ritual significance (*e.g.*, González 1985; Owens and Hayden 1997). The religion of the people who produced the art has been argued to have been animistic (Glory 1964; Sax 1994) and to have involved aspects of shamanism (*e.g.*, Clottes and Lewis-Williams 1996; Lewis-Williams 2002; Winkelman 2002; Hayden 2003).

Implications of the Ritual Amputation Hypothesis

If the Ritual Amputation Hypothesis is correct, there are some interesting implications for our understanding of social life during the Upper Palaeolithic and the evolution of human cognition.

In recent years, scholars in the interdisciplinary field known as the Cognitive Science of Religion have investigated the psychological and social consequences of rituals that elicit intense negative emotions through fear, pain, or temporary or permanent alteration of the body (*e.g.*, Whitehouse 2018; Xygalatas *et al.* 2013a; Fischer *et al.* 2014). These 'dysphoric rituals' tend to be extreme sensory and emotional experiences and have been suggested to be self-shaping and transformative events (Whitehouse 1992; Xygalatas *et al.* 2013b). In addition, it has been found that rituals of this type can create strong bonds among participants and related spectators (Konvalinka *et al.* 2011; Xygalatas *et al.* 2013a). The increased amygdala activation in states of fear and pain can result in the conditioned association of arbitrary stimuli with heightened emotional significance (Damasio 1998). This can have long-term effects on memory and is motivationally powerful (McCauley and Lawson 2002; Alcorta and Sosis 2005). Given these proposed social bonding effects, dysphoric rituals have been argued to be important when a high level of group cohesion is desired, such as in secret societies, military units, and terrorist cells (Whitehouse *et al.* 2014; Raffield *et al.* 2016).

Because of the proposed transformative nature of dysphoric rituals, it has been suggested they may cause the psychological phenomenon known as "identity fusion" (Swann *et al.* 2009, 2012; Whitehouse and Lanman 2014; Whitehouse 2018). Identity fusion involves group members identifying as if they are kin (Swann *et al.* 2014a; Buhrmester *et al.* 2015). This can happen due to a similar worldview within the group or through shared experiences, especially traumatic ones (Jong *et al.* 2015; Newson *et al.* 2016; Segal *et al.* 2018). Identity fusion can have important repercussions. For example, individuals who have fused to a group may feel motivated to act in what they perceive to be the best interests of the group even at considerable personal cost (Swann *et al.* 2010, 2012, 2014a, 2014b; Newson *et al.* 2022). Similarly, fused individuals may also be less trusting of, and hostile to, outsiders, whom they view as a threat (Sheikh *et al.* 2016; Vázquez *et al.* 2020; Newson *et al.* 2022).

Even with the use of effective anesthesia and pain relief, undergoing finger amputation is likely to be a dysphoric experience. Therefore, if the Gravettian HIIFs reflect ritual finger amputation, it is probable that the groups that produced them had exceptionally strong interpersonal bonds and may have even undergone identity fusion.

The people who produced the Gravettian HIIFs may not have been alone in seeking out dysphoric experiences. Pfeiffer (1982) argued that rituals during the Upper Palaeolithic likely involved the revelation of startling images in conditions of emotional and sensory arousal. He focused on caves as the most common surviving evidence of Upper Palaeolithic ritual activity. These environments, he averred, would be ideal for traumatic and mystical experiences. Whitehouse (1995) has also argued that cave art images were designed to provide an emotionally stimulating experience. According to this author, many of the images were placed in locations where they would appear abruptly out of the darkness. In a similar vein, Lewis-Williams and colleagues have raised the possibility that European Upper Palaeolithic groups were engaged in dysphoric ritual practice (*e.g.*, Lewis-Williams and Dowson 1982; Clottes and Lewis-Williams 1996; Lewis-Williams and Clottes 1998a, 1998b). They have suggested that much of the imagery used in Upper Palaeolithic cave paintings reflects features of altered states of consciousness related to shamanism (but see Bednarik 1990; Ross 2001; Kehoe 2002).

It is therefore possible that it was common for members of Upper Palaeolithic groups to engage in dysphoric rituals and hence to be both intensely bonded to one another and hostile towards other

groups. We think it is worth considering whether this might help explain not only the ability of Upper Palaeolithic groups to outcompete non-modern hominins like the Neanderthals but also the emergence of the ethnolinguistic groups that appear to be reflected in the personal ornaments of the European Upper Palaeolithic (Vanhaeren and d'Errico 2006). Another interesting possibility is that finger amputation and other dysphoric rituals played a role in the evolution of what seems to be our psychological propensity for tribalism (Haidt 2012).

Conclusions

The main goal of this paper was to respond to criticisms of a study we published in 2018 that focused on an intriguing feature of the rock art at several Gravettian sites – hand images with incomplete fingers or 'HIIFs' (McCauley *et al.* 2018). Since the early 1900s, several scholars have argued that these images were made by people who had undergone finger amputation. Some of these researchers have argued that the amputations were carried out to resolve medical conditions directly affecting the amputated fingers, while others have proposed that the amputations were performed for ritual reasons. In the study we published in 2018 we sought to shed light on these hypotheses via a cross-cultural survey of finger amputation. We found that the practice was surprisingly common in the recent past and was carried out not only to resolve medical problems but also for non-medical reasons. We concluded that, when the contexts and what we can infer about the identities of the participants were considered, the hypothesis that best fits the Gravettian HIIFs is that they were produced by individuals who had experienced amputation as part of a religious ritual.

Some colleagues have argued that the Ritual Amputation Hypothesis cannot explain the Gravettian HIIFs because the latter involve multiple fingers, and they think it is unlikely that people would have been able to survive after having multiple fingers amputated. It has also been argued that the Ritual Amputation Hypothesis is implausible because the HIIFs are all negative hand images when we would expect them to be both negative and positive hand images if the hypothesis were correct. In this paper, we have shown that neither argument withstands scrutiny. We have demonstrated that many recent societies engaged in the amputation of multiple fingers for cultural reasons. We have also demonstrated that the Gravettian HIIFs are not limited to negative hand images.

In addition to showing that the arguments against the Ritual Amputation Hypothesis do not hold water, we have outlined evidence that suggests the hypothesis should be taken seriously as a potential explanation for the Gravettian HIIFs, and discussed some of the implications for our understanding of social life during the Upper Palaeolithic if the hypothesis is correct.

We want to end by stressing that we are not claiming the Ritual Amputation Hypothesis is the *only* explanation for the Gravettian HIIFs. Our position is that there are reasons to take seriously the Ritual Amputation Hypothesis as an explanation for Gravettian HIIFs, *not* that it is the only hypothesis to take seriously. We think it is too soon to decide which of the various hypotheses that have been put forward to explain Gravettian HIIFs is the correct one. Indeed, we urge our colleagues to allow for the possibility that there is more than one explanation for the absence of fingers on some Gravettian hand images. As Groenen (2011) has suggested, it is possible that multiple processes were involved in the creation of Gravettian HIIFs. This means that the best hypothesis for HIIFs at one site may differ from the best hypothesis for HIIFs at another site. It could even mean that the best explanation for one HIIF at a site may differ from the best explanation for another HIIF at the same site.

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References

Alcorta, C.S., and R. Sosis. 2005. "Ritual, emotion, and sacred symbols." *Human Nature* 16 (4), 323-359.

Aubert, M., A. Brumm, M. Ramli, T. Sutikna, E.W. Saptomo, B. Hakim, M.J. Morwood, G.D. van den Bergh, L. Kinsley, and A. Dosseto. 2014. "Pleistocene cave art from Sulawesi, Indonesia." *Nature* 514, 223-227.

Baffier, D., and M. Girard. 1998. *Les Cavernes d'Arcy-sur-Cure*. Paris: La maison des Roches.

Barrière, C. 1976. *L'Art Pariétal de la Grotte de Gargas, Parts I and II*. Oxford: British Archaeological Reports.

Baudouin, M. 1927. "L'opération culturelle du sacrifice de doigt." *Journal des Practiciens* 1927, DXXXI-DXLVIII.

Bednarik, R.G. 1990. "On neuropsychology and shamanism in rock art." *Current Anthropology* 31 (1), 77-84.

Breuil, H. 1952. *Quatre cent Siècles d'art Pariétal*. Montignac: Centre d'études et de Documentation Préhistoriques.

Buhrmester, M.D., W.T. Fraser, J. A. Lanman, H. Whitehouse, and W.B. Swann Jr. 2015. "When terror hits home: Identity fused Americans who saw Boston bombing victims as "family" provided aid." *Self and Identity* 14 (3), 253-270.

Casteret, N. 1951. *Dix ans Sous Terre*. Paris: Librairie Académique Perrin.

Clottes, J. 2001. *La Grotte Chauvet. L'Art des Origines*. Paris: Seuil.

Clottes, J. 2008. *Cave Art*. London: Phaidon.

Clottes, J., and J. Courtin. 1994. *La Grotte Cosquer: Peintures et Gravures de la Caverne Engloutie*. Paris: Seuil.

Clottes, J., J. Courtin, and L. Vanrell. 2005. *Cosquer Redecouverte*. Paris: Seuil.

Clottes, J., and D.J. Lewis-Williams. 1996. *Les Chamanes de la Préhistoire: Transe et Magie dans les Grottes Ornées*. Paris: Seuil.

Collado Giraldo, H., M. Bea, J. Ramos-Muñoz, P. Cantalejo, S. Domínguez-Bella, J.R. Bello, J. Angás, J. Miranda, F.J. Gracia Prieto, D. Fernández-Sánchez, A. Aranda, A. Luque, J.J. García Arranz, and J.C. Aguilar. 2019. "Un nuevo grupo de manos paleolíticas pintadas en el sur de la Península Ibérica. La cueva de Las Estrellas (Castellar de la Frontera, Cádiz)." *Zephyrus* 83, 15-38.

Collado Giraldo, H., and J.J. García Arranz. 2018b. "Cueva de Maltravieso." In *HANDPAS: Manos del Pasado. Catálogo de Representaciones de Manos en el Arte Rupestre Paleolítico de la Península Ibérica*, edited by H. Collado Giraldo, 367-468. Mérida: Consejería de Cultura e Igualdad de la Junta de Extremadura.

Collado Giraldo, H., J.J. García Arranz, and R.M. Barquín. 2018c. "Cueva de Cudón (Cudón / Miengo, Cantabria)." In *HANDPAS: Manos del Pasado. Catálogo de Representaciones de Manos en el Arte Rupestre Paleolítico de la Península Ibérica*, edited by H. Collado Giraldo, 119-126. Mérida: Consejería de Cultura e Igualdad de la Junta de Extremadura.

Collado Giraldo, H., J.J. García Arranz, P. Fatás, C. de las Heras, A. Prada, L.M. Diaz, and D. Ordás. 2018d. "Cueva de Altamira." In *HANDPAS: Manos del Pasado. Catálogo de Representaciones de Manos en el Arte Rupestre Paleolítico de la Península Ibérica*, edited by H. Collado Giraldo, 93-118. Mérida: Consejería de Cultura e Igualdad de la Junta de Extremadura.

Collado Giraldo, H., J.J. García Arranz, P. Utrilla, and M. Bea. 2018a. "Cueva de la Fuente del Trucho." In *HANDPAS: Manos del Pasado. Catálogo de Representaciones de Manos en el Arte Rupestre Paleolítico de la Península Ibérica*, edited by H. Collado Giraldo, 289-366. Mérida: Consejería de Cultura e Igualdad de la Junta de Extremadura.

Damasio, A.R. 1998. "Emotion in the perspective of an integrated nervous system." *Brain Research Reviews* 26 (2-3), 83-86.

Delluc, B., and G. Delluc. 1993. "Images de la main dans notre préhistoire." *Dossiers d'Archéologie* 178, 32-45.

Dubey-Pathak, M., and J. Clottes. 2020. "Hands in Chhattisgarh rock art." *Adoranten* 2020, 1-21.

Echegaray, J.G., and C.G. Sáinz. 1994. "Conjuntos rupestres paleolíticos de la cornisa cantábrica. Arte Paleolítico." *Complutum* 5, 21-43.

Etxepare, R., and A. Irurtzun. 2021. "Gravettian hand stencils as sign language formatives." *Philosophical Transactions of the Royal Society B* 376 (1824), 20200205.

Fischer, R., D. Xygalatas, P. Mitkidis, P. Reddish, I. Konvalinka, and J. Bulbulia. 2014. "The fire-walker's high: affect and physiological responses in an extreme collective ritual." *PLoS ONE* 9, e88355.

Freeman, L.G., and J. González Echegaray. 2001. *La Grotte d'Altamira*. Paris: La Maison des Roches.

George, A. 2023. "Cave paintings of mutilated hands could be a Stone Age sign language." *New Scientist*, March 15, 2023. https://www.newscientist.com/article/mg25734300-900-cave-paintings-of-mutilated-hands-could-be-a-stone-age-sign-language/.

Gilligan, I. 2010. “The prehistoric development of clothing: archaeological implications of a thermal model.” *Journal of Archaeological Method and Theory* 17, 15-80.

Glory, A. 1964. “L’énigme de l’art quaternaire peut-elle être résolue par la théorie du culte des Ongones?” *Revue des Sciences Religieuses* 38 (4), 337-388.

González García, G. 1985. “Aproximació al Desenvolupament i Situació de les Manifestacions Artístiques Quaternàries: a les Cavitats del Monte del Castillo.” Unpublished Doctoral Dissertation., University of Barcelona.

Groenen, M. 1988. “Les représentations de mains négatives dans les grottes de Gargas et de Tibiran (Hautes-Pyrénées). Approche méthodologique.” *Bulletin de la Société Royale Belge d’Anthropologie et de Préhistoire* 99, 81-113.

Groenen, M. 2011. “Images des mains dans la préhistoire.” *La Part de L’œil: Revue de Pensée des Arts Plastiques* 25-26, 56-69.

Groenen, M. 2016. *L’Art des Grottes Ornées du Paléolithique Supérieur*. Brussels: Académie Royales des Sciences, des Lettres, et des Beaux-Arts de Belgique.

Haidt, J. 2012. *The Righteous Mind: Why Good People are Divided by Politics and Religion*. New York: Vintage.

Harris, S., D. Ranson, and S. Brown. 1988. “Maxwell River archaeological survey 1986.” *Australian Archaeology* 27, 89-97.

Hayden, B. 2003. *Shamans, Sorcerers, and Saints*. Washington, DC: Smithsonian Institution.

Jackson, A.T. 1938. *Picture-Writing of Texas Indians*. Austin, TX: University of Texas Press.

Janssens, P.A. 1957. “Medical views on prehistoric representations of human hands.” *Medical History* 1, 318.

Jaubert, J. 2008. “L’«art» pariétal gravettien en France: éléments pour un bilan chronologique.” *Paléo: Revue d’Archéologie Préhistorique* 20, 439-474.

Jong, J., H. Whitehouse, C. Kavanagh, and J. Lane. 2015. “Shared negative experiences lead to identity fusion via personal reflection.” *PloS ONE* 10, e0145611.

Kehoe, A.B. 2002. “Emerging trends versus the popular paradigm in rock art research.” *Antiquity* 76, 384-385.

Konvalinka, I., D. Xygalatas, J. Bulbulia, U. Schjødt, E.-M. Jegindø, S. Wallot, G. Van Orden, and A. Roepstorff. 2011. “Synchronized arousal between performers and related spectators in a fire-walking ritual.” *Proceedings of the National Academy of Sciences* 108 (20), 8514-8519.

Kuper, R., ed. 2013. *Wadi Sura – Cave of Beasts: A Rock Art Site in the Gilf Kebir (SW Egypt)*. Cologne: Heinrich-Barth-Institut.

Larribau J.-D. 2013 *La Grotte d’Erberua: Art Pariétal Préhistorique du Pays Basque (Isturitz-Oxocelhaya-Erberua)*. Orthez: Jean-Daniel Larribau.

Lenik, E.J. 2016. “The human hand in northeastern rock art: communicating with the spirits.” *Bulletin of the Massachusetts Archaeological Society* 77 (1), 1-11.

Leroi-Gourhan, A. 1967. “Les mains de Gargas: essai pour une étude d’ensemble.” *Bulletin de la Société Préhistorique Française* 64 (1), 107-122.

Leroi-Gourhan, A. 1986. “The hands of Gargas: toward a general study.” *October* 37, 19-34.

Lewis-Williams, J.D. 2002. *The Mind in the Cave*. London: Thames and Hudson.

Lewis-Williams, J.D., and J. Clottes. 1998a. “The mind in the cave – The cave in the mind: Altered consciousness in the Upper Paleolithic.” *Anthropology of Consciousness* 9 (1), 13-21.

Lewis-Williams, J.D., and J. Clottes. 1998b. “Shamanism and Upper Palaeolithic art: a response to Bahn.” *Rock Art Research* 15 (1), 46-50.

Lewis-Williams, J.D., and T.A. Dowson. 1982. “The signs of all times: entopic phenomena in Upper Palaeolithic art.” *Current Anthropology* 29 (2), 201-245.

López, S.R., E.R. Perelló, H. Collado Giraldo, M.M. Cornélla, and J.F. Jordá Pardo. 1999. “Maltravieso. El santuario extremeño de las manos.” *Trabajos de Prehistoria* 56, 59-84.

Lundborg, G. 2014. *The Hand and the Brain: From Lucy’s Thumb to the Thought-Controlled Robotic Hand*. London: Springer.

Marshall, M. 2018. “Stone Age people may have ritually cut off their own fingers.” *New Scientist* November 30, 2018. https://www.newscientist.com/article/2186994-stone-age-people-may-have-ritually-cut-off-their-own-fingers/

McCauley, B., and M. Collard. in press. “Finger amputation in cross-cultural perspective.” In *The Oxford Handbook of the Archaeology and Anthropology of Body Modification*, edited by F. Manni and F. d’Errico. Oxford: Oxford University Press.

McCauley, R.N., and E.T. Lawson. 2002. *Bringing Ritual to Mind: Psychological Foundations of Cultural Forms*. Cambridge: Cambridge University Press.

McCauley, B., D. Maxwell, and M. Collard. 2018. "A cross-cultural perspective on Upper Palaeolithic hand images with missing fingers." *Journal of Palaeolithic Archaeology* 1, 314-333.

McDonald, J. 2008. *Dreamtime Superhighway (TA27): Sydney Basin Rock Art and Prehistoric Information Exchange*. Canberra: ANU Press.

Narr, K.J. 1966. *Handbuch der Urgeschichte*, Volume 1. Bern: Francke Verlag.

Neiman, F.D. 1995. "Stylistic variation in evolutionary perspective: Inferences from decorative diversity and interassemblage distance in Illinois Woodland ceramic assemblages." *American Antiquity* 60 (1), 7-36.

Newson, M., M. Buhrmester, and H. Whitehouse. 2016. "Explaining lifelong loyalty: The role of identity fusion and self-shaping group events." *PloS ONE* 11, e0160427.

Newson, M., F. White, H. Whitehouse. 2022. "Does loving a group mean hating its rivals? Exploring the relationship between ingroup cohesion and outgroup hostility among soccer fans." *International Journal of Sport and Exercise Psychology* 2022, 1-19.

Nougier, L.-R. 1963. *La Préhistoire: Essai de Paleo-Sociologie Religieuse*. Paris: Bloud et Gay.

Overmann, K.A. 2014. "Finger-counting in the Upper Palaeolithic." *Rock Art Research* 31 (1), 63-80.

Owens, D'A., and B. Hayden. 1997. "Prehistoric rites of passage: a comparative study of transegalitarian hunter-gatherers." *Journal of Anthropological Archaeology* 16 (2), 121-161.

Pappas, S. 2018. "Were paleo artists also self-mutilators?" *Live Science* December 4, 2018. https://www.livescience.com/64228-paleo-artists-cut-off-fingers.html.

Patte, E. 1960. *Les Hommes Préhistoriques et la Religion*. Paris: Picard.

Pfeiffer, J.E. 1982. *The Creative Explosion: An Inquiry into the Origins of Art and Religion*. New York: Harper and Row.

Pigeaud, R., J. Rodet, T. Devièse, C. Dufayet, E. Trelohan-Chauve, J.-P. Betton, and P. Bonic. 2006. "Palaeolithic cave art in West France: an exceptional discovery: the Margot cave (Mayenne)." *Antiquity* 80, 81-92.

Raffield, B., C. Greenlow, N. Price, and M. Collard. 2016. "Ingroup identification, identity fusion and the formation of Viking war bands." *World Archaeology* 48, 35-50.

Ross, M. 2001. "Emerging trends in rock-art research: hunter-gather culture, land and landscape." *Antiquity* 75 (289), 543-8.

Rouillon, A. 2006. "Au Gravettien, dans la grotte Cosquer (Marseille, Bouches-du-Rhône), l'Homme a-t-il compté sur ses doigts?" *Anthropologie* 110, 500-509.

Sahly, A. 1966. *Les Mains Mutilées dans l'Art Préhistorique*. Toulouse: Ministère des Affaires Culturelles.

Sansoni, U. 1994. *Le Più Antiche Pitture del Sahara: L'Arte delle Teste Rotonde*. Milan: Jaca Book.

Sax, B. 1994. "Animals in religion." *Society & Animals* 2, 167-174.

Segal, K., J. Jong, and J. Halberstadt. 2018. "The fusing power of natural disasters: an experimental study." *Self and Identity* 17 (5), 574-586.

Sheikh, H., Á. Gómez, and S. Atran. 2016. "Empirical evidence for the devoted actor model." *Current Anthropology* 57 (S13), 204-209.

Snow, D.R. 2006. "Sexual dimorphism in Upper Palaeolithic hand stencils." *Antiquity* 80, 390-404.

Stelle, L.J. 2012. "The rock art of the blood of the ancestors' grotto (11SA557): the archaeology of religious theater". *Illinois Archaeology* 24, 1-70.

Swann Jr., W.B., M. D. Buhrmester, Á. Gómez, J. Jetten, B. Bastian, A. Vázquez, A. Ariyanto, T. Besta, O. Christ, L. Cui, G. Finchilescu, R. González, N. Goto, M. Hornsey, S. Sharma, H. Susianto, and A. Zhang. 2014a. "What makes a group worth dying for? Identity fusion fosters perception of familial ties, promoting self-sacrifice." *Journal of Personality and Social Psychology* 106 (6), 912-926.

Swann Jr, W.B., Á. Gómez, J.F. Dovidio, S. Hart, and J. Jetten. 2010. "Dying and killing for one's group: Identity fusion moderates' responses to intergroup versions of the trolley problem." *Psychological Scienc*e 21 (8), 1176-1183.

Swann Jr., W.B., Á. Gómez, D.C. Seyle, J.F. Morales, and C. Huici. 2009. "Identity fusion: the interplay of personal and social identities in extreme group behavior." *Journal of Personality and Social Psychology* 96 (5), 995-1011.

Swann Jr., W.B., Á. Gómez, M.D. Buhrmester, L. López-Rodríguez, J. Jiménez, and A. Vázquez. 2014b. "Contemplating the ultimate sacrifice: Identity fusion channels pro-group affect, cognition, and moral decision making." *Journal of Personality and Social Psychology* 106 (5), 713-727.

Swann Jr., W.B., J. Jetten, Á. Gómez, H. Whitehouse, and B. Brock. 2012. "When group membership gets personal: a theory of identity fusion." *Psychological Review* 119 (3), 441-456.

Utrilla, P., V. Baldellou, M. Bea, and R. Viñas. 2013. "La cueva de la Fuente del Trucho (Asque-Colungo, Huesca). Una cueva mayor del arte gravetiense." In *Pensando el Gravetiense: Nuevos Datos Para la Región Cantábrica en su Contexto Peninsular y Pirenaico*, edited by C. de las Heras, J.A. Lasheras, Á. Arrizabalaga, and M. De la Rasilla, 526-537. Madrid: Monografías del Museo Nacional y Centro de Investigación de Altamira.

Valde-Nowak, P. 2003. "Obłazowa Cave: Nouvel éclairage pour les mains de Gargas?" *International Newsletter on Rock Art* 35, 4-6.

Valde-Nowak, P. 2009. "Obłazowa and Hłomcza: two Paleolithic sites in the north Carpathians province of southern Poland." *Lithic materials and Paleolithic Societies*, edited by B. Adams and B. S. Blades, 196-207. Hoboken: Wiley-Blackwell.

Valde-Nowak, P., A. Nadachowski, and M. Wolsan. 1987. "Upper Palaeolithic boomerang made of a mammoth tusk in south Poland." *Nature* 329, 436-438.

Van den Broeck, A.J.P. 1950. *De Dageraad der Mensheid*. Utrecht: Ossthoek's Uitg.

Vanhaeren, M., and F. d'Errico. 2006. "Aurignacian ethno-linguistic geography of Europe revealed by personal ornaments." *Journal of Archaeological Science* 33 (8), 1105-1128.

Vázquez, A., L. López-Rodríguez, M. Martínez, S. Atran, and Á. Gómez. 2020. "Threat enhances aggressive inclinations among devoted actors via increase in their relative physical formidability." *Personality and Social Psychology Bulletin* 46 (10), 1461-1475.

Wade, V., L.A. Wallis, and Woolgar Valley Aboriginal Corporation. 2011. "Style, space and social interaction: an archaeological investigation of rock art in inland north Queensland, Australia." *Australian Archaeology* 72, 23-34.

Wellmann, K.F. 1972. "New Mexico's mutilated hand: finger mutilation and polydactylism in North American Indian rock art." *JAMA* 219 (12), 1609-1610.

Whitehouse, H. 1992. "Memorable religions: transmission, codification and change in divergent Melanesian contexts." *Man* 27 (4), 777-797.

Whitehouse, H. 1995. *Inside the Cult: Religious Innovation and Transmission in Papua New Guinea*. Oxford: Oxford University Press.

Whitehouse, H. 2018. "Dying for the group: towards a general theory of extreme self-sacrifice." *Brain and Behavioral Sciences* 41, E192.

Whitehouse, H., and J.A. Lanman. 2014. "The ties that bind us: ritual, fusion, and identification." *Current Anthropology* 55 (6), 674-695.

Whitehouse, H., B. McQuinn, M. Buhrmester, and W.B. Swann Jr. 2014. "Brothers in arms: Libyan revolutionaries bond like family." *Proceedings of the National Academy of Sciences* 111 (50), 17783-17785.

Winkelman, M. 2002. "Shamanism and cognitive evolution (with comments)." *Cambridge Archaeological Journal* 12 (1), 71-101.

Xygalatas, D., P. Mitkidis, R. Fischer, P. Reddish, J. Skewes, A.W. Geertz, A. Roepstorff, and J. Bulbulia. 2013a. "Extreme rituals promote prosociality." *Psychological Science* 24 (8), 1602-1605.

Xygalatas, D., U. Schjoedt, J. Bulbulia, I. Konvalinka, E.-M. Jegindø, P. Reddish, A.W. Geertz, and A. Roepstoff. 2013b. "Autobiographical memory in a fire-walking ritual." *Journal of Cognition and Culture* 13 (1-2), 1-16.

Zboray, A. 2013. "Wadi Sura in the context of regional rock art." In *Wadi Sura – The Cave of Beasts: A Rock Art Site in the Gilf Kebir* (*SW-Egypt*), edited by R. Kuper, 18-23. Cologne: Heinrich-Barth-Institut.

Zboray, A. 2018. ""Korossom Fantastic" and the Karnasahi pastoralists, the principal rock art styles of the Eastern Tibesti." In *What Ever Happened to the People? Humans and Anthropomorphs in the Rock Art of Northern Africa*, edited by D. Huyge and F. Van Noten, 25-34. Brussels: Royal Academy for Overseas Sciences.