The Evolutionary Emergence of Costly Rituals

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ABSTRACT

This paper reviews four archaeological indicators of ritual behavior guided by two broad hypotheses: (1) that evidence of costly ritual behavior will emerge at around 150,000 ybp as a result of increasing ecological and social stress, and, (2) this evidence will be more pronounced among *H. sapiens* than Neanderthals consistent with the proposition that *H. sapiens* used ritual more frequently and successfully in creating greater social complexity than Neanderthals. General support for both hypotheses was found. Additionally, there was evidence that *H. sapiens* adopted costly ritual behavior earlier than Neanderthals and intensified it to higher levels. Two factors are discussed in accounting for these findings: (1) inter-group interactions and competition, often resulting from migrations in pursuit of scarce resources, and (2) the need for reliable pair-bonding as described in the Female Cosmetics Coalition model.

INTRODUCTION

Elaborate burials such as those found at Sungir, Dolní Věstonice, Paviland, and Saint-Germain-la-Rivière are widely cited examples of ritual among Upper Paleolithic *Homo sapiens* (or Anatomically Modern Humans, AMH). A key indicator of ritual at these sites is behavioral cost—the fact that considerable time, effort, and resources were expended in the interment of the bodies, far beyond what can be explained in utilitarian terms. For example, the body adornments and grave goods associated with the Sungir burials are estimated to have required nearly 10,000 hours of labor (White 1993: 296). Rituals do not always involve such costs. The largest Blombos ochre-engraved plaque (M1–6) probably had ritual significance, but at less than 10cm in size, the labor required for the engraving was likely measured in minutes not hours (Henshilwood et al. 2009). The distinction between "cheap" and costly ritual is not trivial. Where inter-individual or inter-group interests easily align, rituals can be "low cost" (Kuhn 2014). However, where intra- or inter-group cooperation is risky because the temptation to cheat or exploit others for short-term gain is present, rituals grow more costly. Costly rituals provide credible displays of commitment. To willingly bear the burdens imposed by costly rituals, one must be truly committed to the group and its values (Henrich 2009; Irons 2001; Sosis and Alcorta 2003).

The emergence of ritual in hominin evolution provides important information about cognition—"modern" cognition is often indexed by the presence of ritual (Henshilwood et al. 2009; Henshilwood and Marean 2003). While *costly* rituals may not necessarily indicate an important cognitive change, they can be informative socially or ecologically. For example, recently Kuhn (2014) argued that archaeological evidence of intensified ritual behavior is most likely attributable to social factors—the challenges of coordinating larger, more differentiated social groups. Furthermore, among traditional societies, extreme rituals are more likely where conditions of resource stress or inter-group conflict prevail (Hayden 2003: 104–105; Sosis et al. 2007). These rituals help to ensure intra- or inter-group trust in the sharing of scarce resources or intra-group cohesion in the face of hostile competitors.

The earliest evidence of ritual is often taken to be the collection of red ochre beginning sometime prior to 300,000 ybp (Barham 2002; Watts 2009). There are reasons to suspect, however, that the last 150,000 years (roughly) were particularly stressful for hominins along the two dimensions known to affect ritual intensity—resource scarcity and inter-group conflict.

This period was marked by dramatic and often abrupt climatic swings producing resource depletions across Africa and Europe (Alley 2000: 118–126; Kim et al. 2014; Muller et al. 2011; Svensson et al. 2008). For example, an analysis of Lake Malawi sediment cores (Scholz et al. 2007) indicates mega-drought conditions in East Africa between 135–127 kya and again between 78–74 kya (although a later analysis suggests that these dates may be pushed backed about 10,000 years, see Lane et al. 2013). The geographic range of the mega-drought affected region has been estimated to encompass Northern South Africa to the Red Sea coast of Sudan (Blome et al. 2012).[1] Climate shifts have been shown to correlate with major human migratory events across Africa

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beginning about 120,000 ybp, including the "out of Africa" migration of *H. sapiens* (around 60,000 ybp) into West Asia and Europe (Rito et al. 2013). Presently, it appears that migratory movements were more frequent across Africa than Europe, suggesting greater inter-group contacts among AMH than Neanderthals (Kim et al. 2014).

Beginning about 120,000 ybp there is also evidence for severe population bottlenecks in Africa. Kim et al. (2014) estimated that the ancestors of the African Khoisan population declined about 26% from their peak, while declines in populations ancestral to non-Khoisan Africans and non-Africans suffered much steeper declines ranging from 69–92%. Similarly, Neanderthals in Western Europe experienced an extreme bottleneck sometime around 50,000 ybp (Dalen et al. 2012).

The importance of climatic fluctuations, resources depletions, and population bottlenecks is that they often lead to migratory movements as groups seek refuge and/or scarce resources, or as they (re-)colonize newly open territories (post-bottleneck). These movements can bring previously isolated groups into cooperative or competitive contact with one another, which would be expected to intensify ritual behavior. Delan et al. (2012), for example, argue that a re-occupation of Western Europe commenced shortly after 50,000 ybp as both surviving Western Neanderthals expanded out from refugia and Eastern Neanderthals moved in.

Genetic and fossil evidence can reveal potential migrations and inter-group contacts as in the (likely) inter-breeding of *H. sapiens* and Neanderthals in the Levant (Hershkovitz et al. 2015; Sankararaman et al. 2012). Archaeological remains can also be informative. For example, beginning about 130,000 years ago, the density of lithic assemblages and faunal remains point to increased population concentrations in Mediterranean areas of the Levant (Hovers and Belfer-Cohen 2013b: S346). Emerging at around the same time in these areas is the first evidence of ritual activity in the form of beads, ochre, and burials.

Social and ecological stressors were compounded by a biological one in African *Homo sapiens*, in whom a substantial increase in brain size occurred around 200,000 ybp (Watts 2014: Table 1). A similar increase in Neanderthal brain size also occurred, but not until about 70,000 ybp. Encephalization would have put even greater stress on hominin mothers' ability to secure adequate resources for their highly altricial offspring. Thus, around the same time that climatic changes were prompting greater migratory movement in pursuit of scarce and scattered resources, increased pressure also was placed on cooperative breeding and pair-bonding. In broad terms then, the later MP (MSA)/early UP (LSA) represents a turbulent period where at particular times and places we would expect ritual to intensify into costly ritual.

Though both Neanderthals and AMH were subject to high stress conditions to which they may have responded with costly rituals, it is possible that AMH used ritual more successfully in constructing greater social complexity, especially as they moved out of Africa into Europe. A number of lines of evidence indicate greater social sophistication in AMH compared to Neanderthals. First, AMH appear to have had significantly higher population densities than Neanderthals and more extensive trade networks (Adler et al. 2006; Hayden 2012; Féblot-Augustins 1993; 2009; Mellars and French 2011). Smaller group sizes, more constricted territories and less frequent interactions with others meant a generally more simplified and insular Neanderthal social world compared to AMH (Caspari and Lee 2004; Gamble 1999; Kuhn and Stiner 2006).

Second, these social differences appear to have left both neurological and genetic traces. Pearce et al. (2013) compared AMH and Neanderthal brain organization using roughly contemporaneous crania (between 27,000–75,000 ybp) and found relative enlargement in areas of the AMH brain relevant to social reasoning. Furthermore, recent analyses of the Neanderthal genome revealed significantly less diversity compared to AMH as well as higher levels of inbreeding and reduced efficiency of purifying selection—all indicators of low population density and smaller, more isolated groups (Briggs et al. 2009; Castellano et al. 2014; Sanchez-Quinto and Lalueza-Fox 2015).

Thus, while evidence of cognitive differences (e.g., symbolism, language, planning, and innovation) between AMH and Neanderthals has waned (d'Errico et al. 1998; Villa and Roebroeks 2014; Zilhao 2012), important social differences persist—AMH social groups were larger, more complex and interconnected than those of Neanderthals. One explanation for these social differences is that AMH employed costly rituals more frequently and successfully thus enabling them to construct and maintain a more complex, inter-connected social world. Importantly, these social differences emerge well after the first evidence of ritual (in the form of ochre and beads) appears in the archaeological records of both species (Hayden 2012; Villa and Roebroeks 2014.). This supports that notion that it was ritual that drove social complexity more so than vice-versa.

From the preceding discussion then, two broad hypotheses can be proposed: (1) Evidence of increasing ritual cost should be present in hominin archaeological remains beginning at about 150,000 ybp; and, (2) this evidence will more frequently be associated with *Homo sapiens* than Neanderthals.

ORGANIZATION OF THE PAPER

In the first part of the paper, I define ritual and distinguish between costly and cheap rituals showing that costly rituals are more effective for creating group solidarity. This discussion also demonstrates that costly ritualized behaviors are present across the animal kingdom and frequently observed among human traditional societies.

The second part of the paper tests the two proposed hypotheses using four types of archaeological remains relevant to ritual behavior: (1) the procurement and processing of mineral pigments, especially red ochre; (2) the procurement and creation of beads and body ornaments; (3) the use of caves as ritual venues; and, (4) burials.

PART 1:
RITUALLY REGULATING SOCIAL LIFE

The use of ritualized behaviors as a means of regulating social life is widespread across the animal kingdom. For example, male elk (and other large male ungulates) use a "low stretch ritual" to gain access to an estrous female without frightening her (Guthrie 2005: 68). The stretch position emulates that of a calf wanting to nurse and puts the female at ease while allowing the male to better detect estrus odors. Similarly, among many waterfowl, ritualized mating dances are used both for selecting mates and building social bonds between them (Kraaijeveld and Mulder 2002). Finally, many dog owners are familiar with the "play bow ritual" often seen at the opening of a rough-house play session. The dog lowers its head to the ground between its front paws with its hind end raised and tail wagging. The bow conveys the important message that seemingly aggressive acts (growling, chasing, biting, etc.) are not to be misconstrued as real aggression—they are for play.

As highly social creatures our primate cousins have an array of ritualized behaviors for regulating their social lives. For example, when chimpanzee, bonobo, and spider monkey foraging parties reunite, they engage in ritualized acts of welcoming and social re-affirmation including mutual embracing, kissing, group pant-hooting, and grooming (Goodall 1986). Gelada baboons use rhythmic back-and-forth approach vocalizations to signal benign intent during close-quarter feeding sessions. These vocalizations allow two baboons to peaceful feed near one another without threat (Richman 1987). Finally among chimpanzees, reconciliation between combatants is signaled by submissive bows, plaintiff vocalizations, and the hand-out begging gesture (on the part of the loser) followed by embraces and kisses (from the winner, de Waal 1990). Given their primate heritage, our ancestors were pre-adapted with a rich repertoire of ritualized behaviors for regulating social life.

WHAT IS RITUAL?

In this context, ritualized behavior refers to stylized, (often) repetitive, attention-getting, invariantly-sequenced (informally "rule-governed") gestures or vocalizations designed to send social signals (for a more in-depth discussion see Rossano 2012). For example, male baboons wishing to signal friendship will often engage in the "scrotum grasp ritual" (Smuts and Watanabe 1990; Whitham and Maestripieri 2003). This act is especially effective given that grabbing and ripping at the genitals is common when primates fight. Thus, the scrotum-grasp can be understood as a ritualized version of this fighting action. However, the scrotum-grasp is a stylized or more restricted form of the action (i.e., a momentary grasp rather than aggressive grabbing and ripping). The act itself is undoubtedly attention-getting (it is hard to ignore someone handling your genitals); and it follows a fairly strict sequence. While making affiliative gestures such as lip-smacking and flattening of the ears, one baboon strides up to another using a rapid, straight-legged gait. The other responds in like fashion, and then after a quick hug each presents his hind-quarters to the other.

Though the terms ritual and ritualized behavior are often used interchangeably, there is an important distinction. Ritualized behavior refers specifically to a stylized, attention-getting, invariantly-sequenced, often repetitious social signal. Rituals are larger than this. They take ritualized behaviors and surround them with ceremonial, traditional, and symbolic elements, heightening their emotional impact and memorability (Bell 1997). Mosque worship, for example, contains ritualized behaviors such as bowing repeatedly, holding the palms upward, and touching the head to the ground. These behaviors, however, are embedded within larger ceremonial and symbolic elements such as those found in the design of the mosque, the dress of the worshipers, and the requirement of facing toward Mecca. While ritualized behaviors are widespread throughout the animal kingdom, true rituals are uniquely human.

CHEAP AND COSTLY RITUALS

The definition of costly ritual used in this paper is derived from costly signaling theory (Sosis and Alcorta 2003; Zahavi and Zahavi 1997). In this approach, any social signal, including a ritualized signal, is primarily aimed at manipulating another's behavior by influencing his or her affective state (Owren et al. 2003). For example, by lowering its head and putting its hand out in the begging gesture, a chimpanzee signaler adopts a submissive, vulnerable posture which serves to relax the receiver who then might be more apt to share food, provide aid, or stop aggression (Pollick and de Waal 2007). A second, though less frequent, use of a ritualized behavior is to signal honest commitment. This type of signal is essential for building enduring cooperative relationships. To be effective, ritualized signals of commitment must be costly; otherwise they are prone to deceptive use and therefore unreliable as a basis for relationship-building.

The begging gesture and scrotum grasp exemplify these different purposes. The begging gesture is low cost, can be used deceptively and is therefore relatively ineffective as a sign of relational commitment. The baboon scrotum grasp, however, has been shown to be a reliable signal of commitment and thus effective for relationship-building (Whitham and Maestripieri 2003). So what is the difference? The answer is found in the inherent costs associated with the gestures. It is far riskier to let someone grab your genitals than to simply beg. By literally placing one's reproductive success in another's hands, this gesture becomes an effective way of signaling trust, and trust builds strong relations.

Using cost as a means of assuring honest commitment in social communication can be found in many species. Indeed, for reliable signals to evolve those signals must be hard to fake otherwise recipients will ignore them (Sosis and Alcorta 2003; Zahavi and Zahavi 1997). For example, a male frog wishing to signal his robustness to local females might do so using a loud long croak. However, if loud long croaks can be easily produced by weakling males, then there is no reason why females should evolve to accept such a signal as informative of the male's health status.

As it turns out though, a loud long croak is metabolically expensive for such a small bodied creature and weakling males generally cannot produce croaks with the same intensity as healthy males. Thus, loud long croaks effectively serve as reliable signals of robustness specifically because they are costly to produce (Welch et al. 1998).

Similarly, Thompson's gazelles will often jump high into the air or "stot" as a predator approaches the herd. Stotting is both attention-getting and energetically expensive and as such seems odd in the presence of a predator—why expend so much energy trying to attract the attention of someone who wants to eat you? The answer is that by obviously demonstrating its strength and agility, the stotting gazelle sends an honest message about its physical fitness. A slower, weaker gazelle cannot afford such a display and thus becomes a more desirable victim in the eyes of the approaching predator (Zahavi and Zahavi 1997).

What makes a ritualized behavior more costly is usually quantitative in nature. It is the increased duration and amplitude of a frog's croak or the increased height of a gazelle's stot that make these signals costly and therefore effective social signals. Among male baboons, it is the increased frequency of scrotum-grasp greetings that predicts stronger social bonds (Whitham and Maestripiari 2003).

COSTLY RITUALS AMONG TRADITIONAL SOCIETIES

Costly rituals are common among traditional societies. For example, over 70% of traditional societies have some form of adolescent initiation, many of which require the initiate to endure isolation, deprivation, genital cutting, tooth removal, exposure to harsh elements, exhaustive dancing, and other forms of psycho/physical stress (Alcorta 2006; Catlin 1867; Glucklich 2001; Knight et al. 1995; Lutkehaus and Roscoe 1995; McCauley 2001; Power 1998: 122–5; Whitehouse 1996).

Costly rituals demanding great self-control are commonly used for settling disputes and making peace. For example, feuds and disagreements among the Ammassalik of Greenland are often addressed using a traditional "drum match," where the aggrieved parties stand face-to-face drumming and singing about the other's personal and familial flaws (Mirsky 1937). Tradition dictates that no matter how insulting or abusive the drummer becomes, the other party must remain indifferent to the taunts and accusations. Similarly, the truce-making ritual of the Yanomamo requires that warriors silently endure repeated threats and provocations from their enemies (Chagnon 1968).

"Ordeal" rituals are also fairly common across traditional societies for dispute resolution (Freeman 1981; Lewis and Dowsey-Magog 1993). In these, someone accused of wrongdoing can demonstrate their innocence and erase their personal or familial shame by successfully completing a painful ordeal, often by fire or boiling water. For example, in the Bisha ritual of many Bedouin tribes, the accused person is required to place his/her tongue on the handle of a red-hot ladle (Al-Krenawi and Graham 1999). The results of the ordeal are almost always taken to be final and the dispute thereby settled.

Even celebratory rituals have demanding aspects. Singing, dancing, and chanting together are nearly universal among traditional societies. Complex female polyphonic choral singing is nearly always part of this activity (Knight and Lewis 2014). This singing is "costly" in that it is challenging to learn, requires great vocal and articulatory control, and is often performed energetically and continuously for long periods of time. For example, Mbendjele women are known to engage in night-long sessions of polyphonic chorusing when camping out in the deep bush in order to ward off predators.

Costly, group coordinated singing and dancing probably has deep evolutionary roots. Genetic analyses indicate that three traditional societies—the !Kung San of Southern Africa, the Andaman Islanders of Southeast Asia, and the Australian Aborigines—very likely represent humanity's most ancient populations with the latter two possibly tracing back to the earliest "out of Africa" migration (Endicott et al. 2003; Hudjashov et al. 2007; Thangaraj et al. 2003; Wade 2009: 99–102). Common to all three are religious rituals involving highly emotive night-long sessions of vigorous singing and dancing (Wade 2009: 118). This suggests that our ancestors' earliest religious rituals may have been similar in both content (singing, dancing, chanting) and cost (vigorous sessions lasting all night).

COSTLY RITUALS AND RELIGION

To outsiders, some religious rituals can seem peculiar and onerous. Having to stop everything five times a day to pray, as devout Muslims do, or praying in the hot sun wearing a heavy dark coat and hat, as Orthodox Jews do, hardly seem worth the bother. Moreover, some religious rituals, such as the snake handling practices of Appalachian Pentecostals, are downright dangerous. However, the evolutionary success of religion may (in part at least) be explainable by its employment of costly rituals such as these.

Recent empirical work has shown that costly, high ordeal rituals are effective in building strong cooperative communities. Xygalatas et al. (2013) found that both participants in and witnesses to high ordeal rituals (such as those involving body piercing with needles, hooks, and skewers) contributed significantly more to a public fund and showed stronger emotional attachment to their national identity than low ordeal ritual participants. Furthermore, rituals that incorporate greater degrees of synchronous movement, such as chanting, praying, or dancing together, have been found to instill a greater sense of shared sacred values among participants leading to significant increases in intragroup generosity (Fischer et al. 2013). The social cohesion engendered by costly rituals accounts for the greater longevity of religious communes relative to secular ones (Sosis and Alcorta 2003; Sosis and Bressler 2003).

PART II:

COSTLY RITUALS IN HUMAN EVOLUTION

Given their primate heritage, our hominin ancestors had a range of ritualized behaviors for regulating social life.

However, two important changes occurred over the course of hominin evolution. First, true rituals emerged out of primate ritualized behaviors. While it is not entirely clear when or why this happened, some theorists have focused on the necessity of reliable pair-bonding in the context of multi-male/multi-female groups as the critical selection pressure (Deacon 1997; Knight et al. 1995; Power 2009).

One theory, the Female Cosmetics Coalition (FCC) model of Knight et al. (1995), is highly relevant because it directly addresses the presence of red ochre in the hominin archaeological record. This model argues that increased encephalization beginning about 700,000 ybp put greater pressure on hominin mothers' ability to secure necessary resources for their increasingly dependent offspring. A second (and last) major encephalization event occurred around the time of the emergence of AMH (roughly 200,000 ybp) which made reliable pair-bonding essential for offspring survival. Female coalitional rituals involving red ochre (which are ubiquitous among traditional societies in southern Africa) arose in response to the need for cooperative breeding and reliable pair-bonding. Initially, these rituals were sporadic; but with the last enchepalization event, they became frequent and served the specific function of unifying females against male philandering.

What is significant about these rituals, it is claimed, is that they would have involved performances that referred to abstract cultural *fictions*, thus making them more than just indexical signals. By painting themselves with red ochre, non-fertile females feigned fertility with the full knowledge that males were not actually fooled by the display. Instead, what was understood by both parties (the signaling female coalition and the male observers) was a culturally constructed (not actual) reality—the sexual inaccessibility of any female member of the coalition in the absence of reliable male investment. This then marks the critical transition from the indexical ritualized behaviors of nonhuman primates, to true symbolic human rituals. A similar transition probably also occurred with Neanderthals, but somewhat later (associated with a 70,000 ybp brain expansion).

The second important change was that the frequency of costly rituals appears to have substantially increased. While primates have some ritualized behaviors that serve as costly signals, these are nowhere near as prevalent as the costly rituals present among human traditional societies or contemporary religious groups. Thus, over the course of hominin evolution, not only did true rituals emerge from ritualized behaviors, but the frequency with which high cost was associated with these rituals increased as well.

Section Two tests two hypotheses relevant to this increase: (1) costly rituals largely emerged in the last 150,000 years as a result of challenging ecological and social conditions; and, (2) costly rituals are more often associated with AMH than Neanderthals.

IDENTIFYING COSTLY RITUAL IN ARCHAEOLOGICAL REMAINS

Identifying ritual in archaeological remains is challenging. In facing this challenge, archaeologists and anthropologists have established criteria for inferring ritual. The remains should indicate behavior that is invariant, repetitious, rule-governed (e.g., confined to a particular time and place or rigidly sequenced), stylized (either highly restricted or elaborated in form), and/or designed to send a canonical message (Rappaport 1999; Chase and Dibble 1987; Ross and Davidson 2006; Sosis and Alcorta 2003; Watts 2009). Furthermore, ritual sometimes involves transformations—redefining an ordinary object by using it in an extra-ordinary context (Liénard and Sørensen 2014).

For example, Ross and Davidson (2006) applied the above criteria in assessing ritual in Australian rock art. Consider a rock art image depicting a simplified human form. Ritual use might be inferred from its highly simplified form (stylized criterion). However, if the image is a singular artifact, then the case is weak. It could simply be a one-off doodle. However, if similar simplified images are consistently found in particular contexts (such as exclusively in sheltered outcroppings facing the rising sun), made from the same materials (etched in red ochre) then the ritual case is much stronger. Not only is the stylized criterion fulfilled but also repetition (the same image reproduced multiple times), rule-governed (always found in the same physical context), invariance (always made with the same materials), and possibly canonical message (the invariant, rule-governed nature of the image strongly suggests it carried some important cultural message to others).

Once archaeological remains exhibit the characteristics of ritual, cost can be assessed by measures of the time, energy, effort, or risk involved in creating the remains (Coulson et al. 2011). Often increased cost is captured in the criteria of repetition (a hundred beads are more costly than ten), rule-governance (an image that must be created in a dangerous-to-access deep cave site is more costly than the same image created in an easy-to-access rock shelter), or invariance (consistently using red ochre when other more accessible materials are available would constitute greater cost).

A potential weakness of assessing cost solely on the physical remains is that we can never be sure what other activities might have been associated with the remains. For example, a week of dancing, fasting, and painful physical ordeals might have accompanied the rock shelter image (as opposed to the deep cave image). However, speculations such as this can be made endlessly for nearly any remains. On what basis can we assume the week of dancing, fasting, and physical ordeals was necessarily associated with the rock shelter image and not the deep cave image? Possible related activities are forever lost to us. The evidence available to us is the archaeological record itself and therefore the present paper will restrict all cost assessments exclusively to that evidence.

RED OCHRE

Claims for the ritual use of ochre have been made at numerous sites (e.g., Barham 2002; Henshilwood et al. 2001; Hovers et al. 2003; Knight 1999; Watts 2009). These claims are based on a number of factors: (1) the excessive amounts present at many sites (repetition); (2) the selectivity for particular types and hues (invariance); (3) distances traveled and effort expended in securing particular types of ochre when other types were more readily accessible (rule-governed); and, (4) the presence of intentional engravings with consistent geometric patterns on multiple ochre pieces in different contexts (stylized and canonical message, Henshilwood et al. 2009: 45).

Even so, there has been considerable debate about the extent to which practical from ritual use of ochre can be distinguished. For example, Wadley (2005) has found that red ochre mixed with resin could be an effective hafting adhesive. Thus, large amounts of red ochre could have a purely utilitarian explanation. On the other hand, Watts (2009) cites evidence indicating that different colors of ochre are equally effective for hafting and equally *ineffective* for tanning hides; thus, the excessive collection of exclusively bright, saturated red ochre (at the deliberate exclusion of other colors) indicates ritual use.

Another observation supports the ritual argument. Wadley's studies of ochre use at Sibudu (South Africa) show that coarse-grained ochre is essential for successful hafting. At Sibudu, however, coarse-grained ochre is the least common type throughout the entire period of occupation (Hodgkiss 2012: 107). Thus, at no time were the residents of Sibudu preferentially selecting the coarsest grain ochre over others, as might be expected if hafting was its main use (Hodgkiss 2012: 112–113). Similar preferences for fine-grained ochre are also documented at Blombos, Pinnacle Point, Diepkloof, Qafzeh, and Skhul (Dayet et al. 2013; d'Errico et al. 2010: 3103; Henshilwood et al. 2001: 431; Hovers et al. 2003: 502; Marean et al. 2007: 906; Watts 2010: 409). Thus at numerous sites, hominins were intentionally procuring a form of ochre that was not ideally suited for practical ends.

Table 1 presents 20 AMH (or Archaic *Hs*) sites bearing red ochre. There are far more sites claiming to have ochre than have been analyzed and published. For example, Watts (1999) lists 74 MSA sites in Southern Africa where ochre is claimed to have been found. Table 1 includes published sites that are reasonably well-documented (quantities, weights, percentages worked, and procurement distances generally reported) and contemporaneous with the Neanderthal occupation of Europe and the Near East.

The data from Table 1 are presented graphically in Figure 1. Ochre pieces, rather than weights, are represented. Since transforming ochre into pigment requires grinding, ochre pieces more closely index potential pigment use than weight. Wadley (2005) has shown that ochre pieces ("crayons") are likely waste products from processing. Thus, many small pieces would suggest greater ochre processing, while large weights would indicate what was left unprocessed.

Consistent with hypothesis 1, Table 1 shows that only the first three sites listed have dates entirely preceding 150,000 ybp. This can also be seen graphically in Figure 1, where the number of sites and amounts increase substantially at around 150,000 ybp. Also consistent with hypothesis 1 are three intra-site comparisons over time. For example, as can be seen in Table 1, the Twin Rivers ochre occurs mainly in two blocks—A, dated to 400–266 kya, and F, dated to 200–140 kya. Hypothesis 1 would predict more ochre in block F, which is (by far) the case (see Figure 1 as well). Two other sites show the same pattern. At Blombos, 80% of the ochre occurs at levels dated from 140–100 kya (Henshilwood et al 2009: 29-30). At Mumbwa, two-thirds of the ochre occurs between 130–107 kya (Avery, 2003: 65; Barham, Pinto and Andrews 2000: 83). Sai Island might represent a counter-instance, however, the total amount here is quite small.

Table 1 also reveals a cluster of six sites (Rose Cottage Cave, Apollo 11, Hollow Rock Shelter, Olieboompoort, Diepkloof Rock Shelter, Klasies River) whose initial dates are around 120,000 ybp (note: most of the Blombos and Mumbwa ochre are also dated to around this time). A second cluster of four sites emerges at around 70,000 ybp (Porc Epic Cave, Sibudu, Boomplaas Cave, and Klein Kliphuis). These are both periods of time when drought-related migrational movements are likely to have been occurring (Rito et al 2013; Scholz 2007). However, for more meaningful predictions to be formulated and tested, greater precision in supposed movement patterns and dating will be required.

Table 2 presents reasonably well-documented Neanderthal sites. Again, not all sites claiming to have ochre (or other mineral pigments) could be included for lack of analyses.[2] For example, in their recent review of Châtelperronian pigment sites, Dayet et al. (2014) identified 14 sites (1/8 of all Châtelperronian sites) claiming to have possible evidence of pigments (see their Table 1: 181). Of these, however, only six have evidence the authors deemed "reliable" and have quantities reported. All six are included in Table 2. Additionally, in his review of European MP pigment sites, Watts (2009: Table 4.2, 75) lists only five sites, all of which are included in Table 2 (or in one case, discussed in the text). Figure 2 presents these sites graphically.

From Table 2 it is clear that most documented Neanderthal mineral pigment use occurs in Western Europe between 50–40,000 ybp (note: most is red ochre but two sites, Pech de l'Azé and Abri Peyrony, are manganese). This would be expected if the pigment use resulted from post-bottleneck territorial competition between resident Western Neanderthals and invading Eastern Neanderthals (for earlier sites, 50–45,000 ybp) or competition with incoming Cro-Magnons (for later sites, 45–40,000 ybp). One possible way of distinguishing this might be if the later-dated pigment can be more closely associated with patterns found among *H. sapiens*, either in the type of pigment used or in how it was processes or utilized. Figure 3 provides a direct graphic comparison of *Homo sapiens* and Neanderthal pigment sites.

Two points can clearly be observed from this comparison. One, there are many more *Homo sapiens'* sites with substantial amounts of pigment compared to Neanderthals. Only two Neanderthal sites have amounts numbering over 100 pieces (14%), compared to 16 (80%) for *Homo sapiens,* 7 of which (30%) have over a thousand. The differences seen

TABLE 1. AMH (or Archaic *Hs*) PIGMENT SITES.

Site	Hominin	Dated to:	Amount[1]	Transport distance	Evidence of Use	Source
1. Twin Rivers A, Zambia	Archaic *Hs*	400–266 kya	1530 pieces 11.9kg est.	up to 22km	est. 3.5% worked	Barham 2002
2. GnJh-15 Kapthurin Formation, Kenya	Archaic *Hs*	>285 kya	>70 pieces about 5kg		ochre stains maybe from power	Deino and McBrearty 2002
3. Sai Island, Sudan	Archaic *Hs*/AMH	223–152 kya from oldest layers	59 pieces; yellow & red ochre	local sources	very little signs of use	Van Peer and Vroomans 2004
4. Border Cave, SA	Archaic *Hs*/AMH	230–145 kya	111 ochre pieces, <.5kg	120km for hematite	8% worked	Watts 2002
5. Twin Rivers F, Zambia	AMH	200–140 kya	29,792 pieces 56.7kg est.	up to 22km	3.5% worked	Barham 2002
6. Mumbwa, Zambia	AMH	170–23 kya	439 pieces 2/3 130–107 kya	1–18km	about 5% worked	Barham et al. 2000
7. Pinnacle Point, South Africa	AMH	164–91 kya	1032 pieces, nearly 2kg (1kg considered "pigment")	up to 60km	42 worked	Marean 2010; Watts 2010
8. Blombos, South Africa	AMH	143–70 kya	>8,000 pieces 5.8kg (80% in oldest layers 140–100 kya)	5–40km	about 1500 worked[1]	Henshilwood et al., 2001; 2009
9. Rose Cottage Cave, South Africa	AMH	130–60 kya	407 pieces 1.5kg		ochre on lithics	Clark 1997; Wadley and Harper 1989
10. Apollo 11, Namibia	AMH	126–60 kya	105 pieces, >1kg		nearly 30% worked	Watts 2002
11. Hollow Rock Shelter, South Africa	AMH	126–100 kya	1123 pieces 1.3kg		8.4% worked; 45% by weight	Evans 1994
12. Olieboompoort, South Africa	AMH	120–100 kya	304 pieces nearly 12kg	local sources	13.2% worked	Watts 2002
13. Diepkloof Rock Shelter, South Africa	AMH	110–52 kya	558 pieces	>20km for some	16% worked no evidence of use as adhesives	Dayet et al. 2013
14. Klasies River, South Africa	AMH	110–60 kya	217 pieces, mostly red 3kg			Singer and Wymer 1982
15. Skhul (Levant)	AMH	100 kya	71 fragments	80km	not reported	d'Errico et al 2010; Salomon et al 2012a
16. Umhlatuzana, South Africa	AMH	>90 kya	1675 pieces, 3.4kg		8.5% worked ochre on lithics	Kaplan 1990
17. Qafzeh (Levant)	AMH	90 kya	at least 84 pieces 1.1kg	within 8km of site	about 5 worked	Hovers et al. 2003
18. Porc Epic Cave, Ethiopia	AMH	77–61 kya	214 small pieces		16% worked	Clark et al. 1984
19. Sibudu, South Africa	AMH	77–50 kya; most at about 60 kya	over 5,000 15.4kg; ochre on lithics	local	about 700 worked	Wadley and Jacobs 2006; Hodgskiss 2012
20. Boomplaas Cave, South Africa	AMH	70–40 kya	133 pieces 1.3kg		about 19% worked	Watts 2002
21. Klein Kliphuis, South Africa	AMH	≈65 kya	nearly 4000 pieces 2.5kg	local within 6km	175 worked, 1 piece engraved	Mackay 2010

[1] Of red ochre, unless otherwise indicated in the table.

[2] Henshilwood et al. (2009: 30) states that only 307 pieces were "definitely" modified. In Henshilwood et al. (2001: 432), all studied pieces (which at that time were 1448) were claimed to have been either "probably" or "definitely" modified.

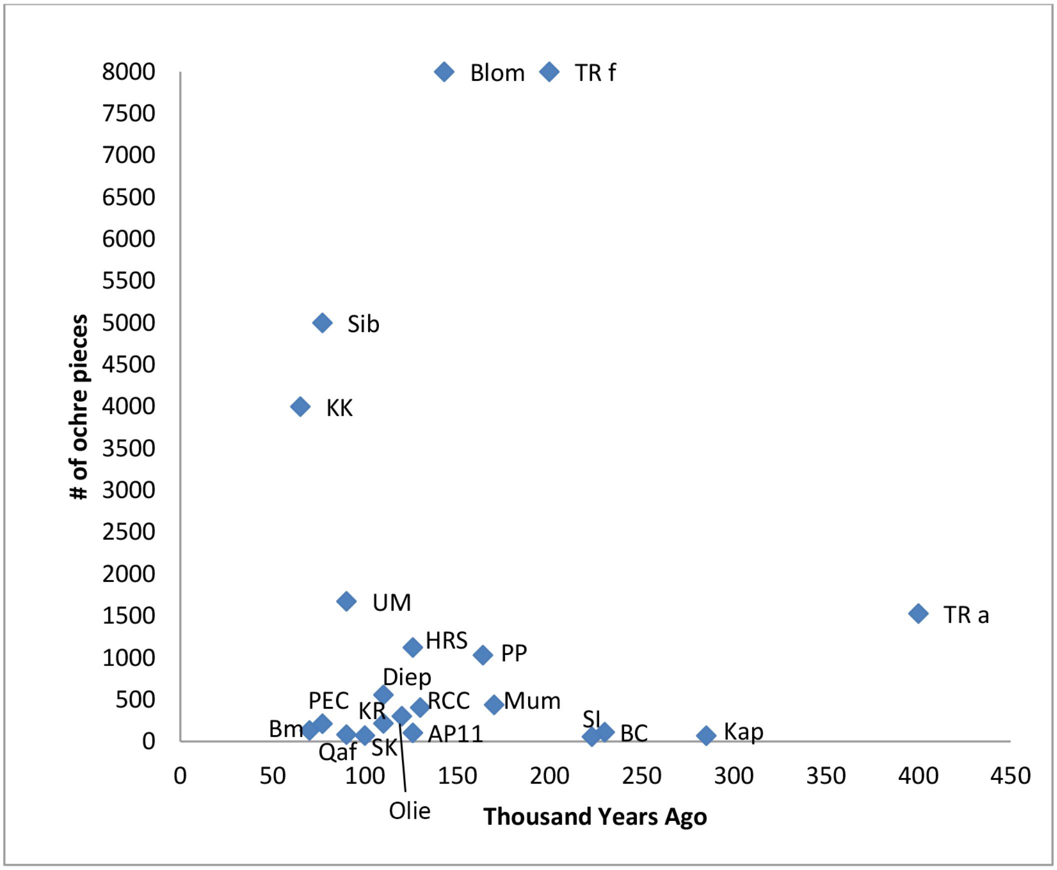

Figure 1. AMH (or Archaic Hs*) ochre sites, amounts depicted over time using older dates in a date range (e.g., Sibudu dates from 77–50 kya, 77 is used for plotting).Twin Rivers F block site is capped at 8000 pieces. Actual estimated amount is over 29,000.* ***Legend****: AP 11=Apollo 11, BC=Border Cave, Blom=Blombos Cave, Bm=Boomplaas Cave, Diep=Diepkloof Rock Shelter, HRS=Hollow Rock Shelter, Kap=GnJh 15 Kapthurin, KK=Klein Kliphuis, KR=Klasies River, Mum=Mumbwa, Olie=Olieboompoort, PEC=Porc Epic Cave, PP=Pinnacle Point, Qaf=Qafzeh, RCC=Rose Cottage Cave, SI=Sai Island, Sib=Sibudu Cave, SK=Skhul Cave, TR a=Twin Rivers A block, TR f=Twin Rivers F block, UM=Umhlatuzana.*

in Figure 3 confirm Watt's (2009: 80) conclusion that the pigment records of AMH and Neanderthals are simply not comparable. Second, Neanderthal pigment use is largely later-occurring compared to *Homo sapiens*. Eleven of the 14 Neanderthal sites, including all the ones with amounts exceeding one piece, occur at 50 kya or later. Whereas numerous *Homo sapiens* sites with amounts in the hundreds emerge 50–100,000 years prior to this.

From Figure 3 it is clear that Grotte du Renne is the only Neanderthal site where amounts approach the "extremes" of some AMH sites. Assuming remains here are genuinely Neanderthal, it raises the intriguing possibility of a sudden increase in Neanderthal ritual activity in their waning days. Under increasing social pressure, Neanderthals may have engaged in more frequent and costly ritual behavior in an attempt to solidify their disintegrating communities.

One site which has not been included in this analysis is Terra Amata. Over 70 pieces of ochre were found here (Wreschner 1985) making it one of the larger European Lower/Middle Paleolithic mineral pigment collections. The site was initially dated to around 300,000 ybp, (Lumley 1969) thus making it more likely to be a *H. heidelbergensis* site rather than Neanderthal. Re-examinations of the site, however, by both Wreschner (1985) and Villa (1982) have called into question many of the original conclusions. Natural processes could not be ruled out for both the presence of the ochre and the possible modifications to the ochre pieces. In addition, the date of the site may younger than previously thought.

Why the differences in ochre use between *Homo sapiens* and Neanderthals? The FCC model predicts that among Neanderthals, pair-bond instability was far more problematic during warming periods, leading to intermittent spikes in coalitionary rituals involving red ochre (for details behind this see Power et al. 2013). By contrast, pair-bond instability was more constant for African *Homo sapiens*, becoming especially intense around 200,000 ybp (when the last increase in brain size occurred), leading to more continuous ritual activity.

This model provides an explanation for the greater abundance of red ochre in the African archeological record compared to that of Neanderthals from about 300,000 to 60,000 ybp. However, one clear anomaly suggests that on its own this explanation may not be a complete one for ei-

TABLE 2. NEANDERTHAL PIGMENT SITES.

Site	Hominin	Dated to:	Amount[1]	Transport Distance	Evidence of Use	Source
1. Maastricht-Belvedere, Netherlands	N (likely)	285 kya	red stains in soil	maybe 40km	liquid from processing?	Roebroeks et al. 2012
2. Achenheim, France	N	250 kya	1 piece	not reported	rubbed	Thevenin 1976: from Barham 2002
3. Becov, Czech Republic	N or *H. erectus*?	250 kya	1 piece 3.3cm	not reported	scraped	Marshack 1981
4. Pech de l'Azé I & IV, France	N	45–50 kya	up to 500 manganese <1kg	not reported	nearly 300 worked	Soressi et al. 2008
5. Cueva de los Aviones, Spain	N	50 kya	ochre on shell	3–7km	na	Zilhão et al. 2010
6. Les Bossats, France	N	45-50 kya	82 fragments <3cm each	local 1km	all worked	Bodu et al. 2013
7. Roc-de-Combe, France	N	45–42 kya	36 "lumps" red and black	7km	0.3–0.5% worked	Dayet et al. 2014
8. Bidart, France	N	45–42 kya	1 piece	unclear	"scant" evidence of modifications	Dayet et al. 2014
9. Le Baste, France	N	45–42 kya	3 pieces	local sources; 25km possibly for one	"scant" evidence of modifications	Dayet et al. 2014
10. Les Tambourets, France	N	45–42 kya	2 pieces	not reported	"facetted"	Dayet et al. 2014
11. Labeko Koba, Spain	N	45–42 kya	15 pieces	not reported	"knapped and scraped?"	Dayet et al. 2014
12. Abri Peyrony, France	N	about 40 kya	32 pieces manganese	not reported	18 worked	McPherron et al. 2012
13. Cueva Antón, Spain	N	38 kya	ochre on shell	5km	na	Zilhão et al. 2010
14. Grotte du Renne, France	N?	34–45 kya[2] 21–49 kya[3]	>1500 pieces mostly red ochre >18kg	up to 30km	many show evidence of being worked	Caron et al. 2011; Salomon et al. 2012b

[1] Of red ochre, unless otherwise indicated in the table.
[2] Reported in d'Errico et al. (1998).
[3] Reported in Highham et al. (2010).

ther AMH or Neanderthal pigment use. Inconsistent with the FCC model is the substantial increase in Neanderthal ochre use beginning about 50,000 ybp, including the copious amounts reported from Grotte du Renne (Power et al. 2013: 50; also see Watts 2014: 224). This period was marked by a general cooling associated with Heinrich event 4 (d'Errico and Goni 2003). As mentioned earlier though, both AMH and Neanderthals show increases in ochre use at times when out-group encounters are likely (120,000 and 70,000 ybp for AMH and 50,000 ybp for Neanderthals).

BEADS AND BODY ORNAMENTS

Table 3 summarizes the findings from well-documented (number of beads, origin, secure dates all reported), roughly contemporaneous AMH and Neanderthal sites where beads and other body ornaments have been found. Not all the sites claiming to have beads are included in Table 3. This is because at many sites analyses of the beads are incomplete or as yet unpublished.[3] For example, d'Errico and Vanhaeren (2009: 29–30) list nine southern and eastern African MSA or early LSA sites where beads or stone rings have been reported. However, they acknowledge that most of these sites lack secure dates.

Table 3 makes two important assumptions regarding authorship of beads and body ornaments: (1) Though disagreements on the interpretation of remains at many Châtelperronian sites abound (Caron et al. 2011; d'Errico et al. 1998; Higham et al. 2010; Mellars 2010), Table 3 assumes Neanderthal priority at Châtelperronian sites. (2) While the authorship of transitional industries is still subject to debate, it is tentatively assumed that AMH are the more likely authors. Two lines of evidence support this assumption. First, evidence mounts for both an earlier and more rapid dispersal of AMH across Eurasia and an earlier demise (by about 45,000 ybp in Iberia) of Neanderthals than previously thought (Douka et al 2013; Galvan et al. 2014; Hershkovitz et al. 2015; Higham et al. 2011; 2014; Wood et al. 2014; however, see Banks et al. 2013 for a contrary view).

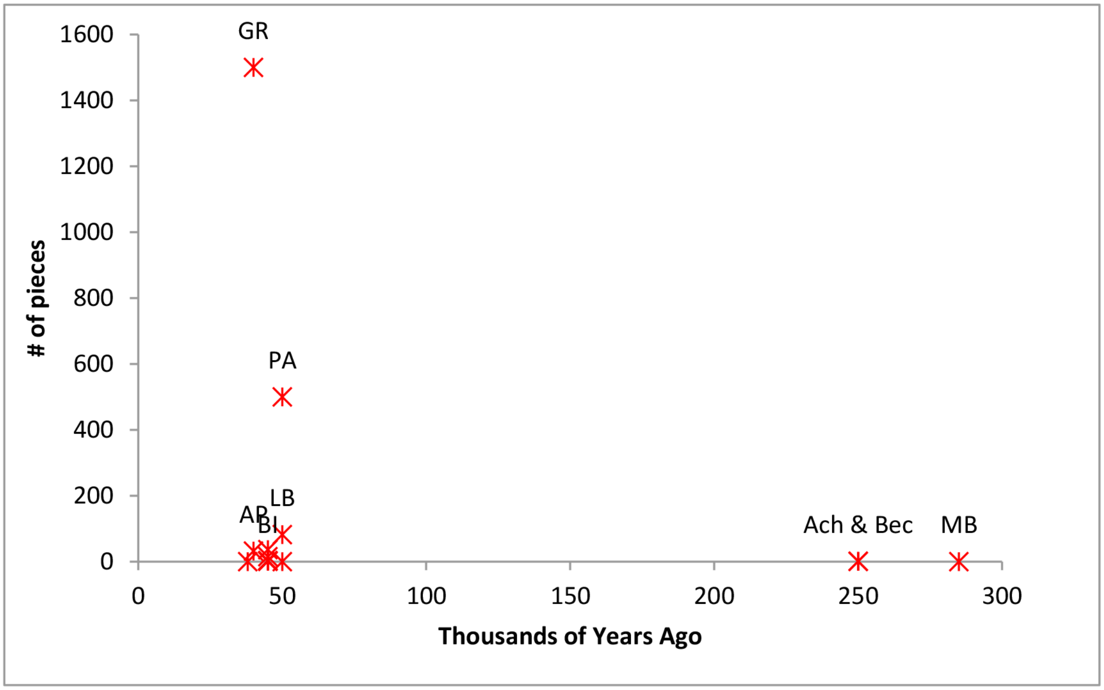

Figure 2. Neanderthal pigment sites, amounts depicted over time. ***Legend****: Ach=Achenheim, AP=Abri Peyrony, BEC=Becov, BI=Bidart, CA=Cueva de los Aviones, CAN=Cueva Anton, GR=Grotte du Renne, LB=Les Bossats, LeB=Le Baste, LK=Labeko Koba, LT=Les Tambourets, MB=Maastricht-Belvedere, PA=Pech de l'Azé I, IV, RDC=Roc de Combe. Note: labels are only included where space allows.*

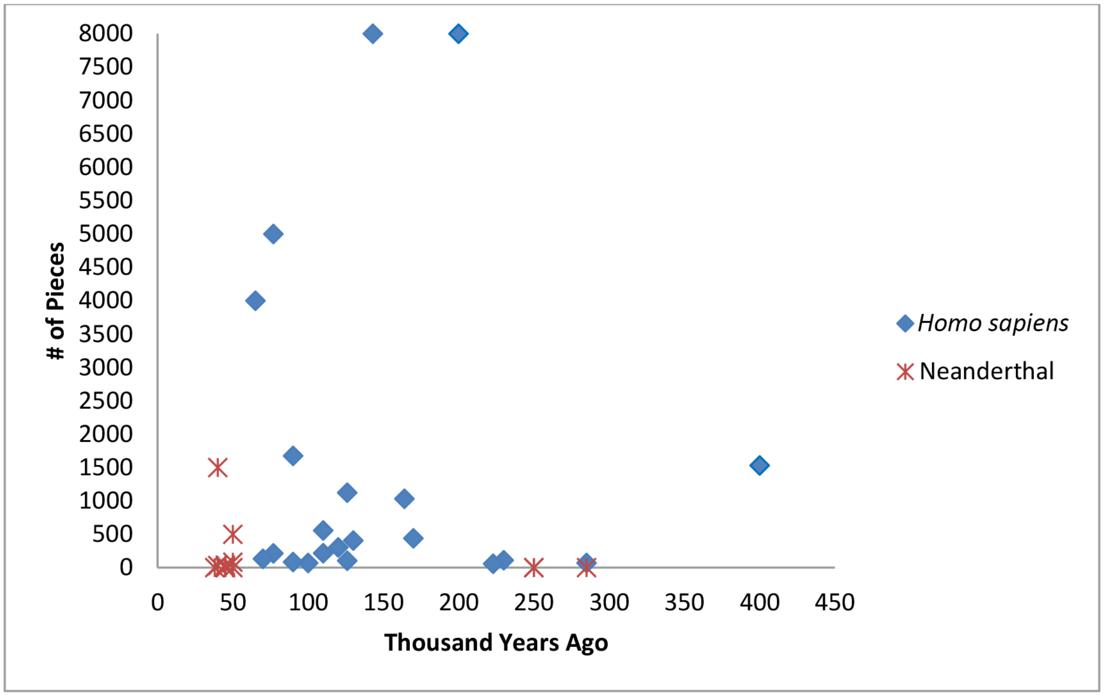

Figure 3. Homo sapiens *vs. Neanderthal pigment sites over time. Older dates are used for plotting where a date range is given for a site.*

TABLE 3. COMPARISON OF BEADS: NEANDERTHAL (N) and AMH.

Site	Hominin	Dated to:	Number	Transport Distance	Perforations	Source
Skhul (Levant)	AMH	at least 100 kya	2	3–20km	natural	Vanhaeren et al. 2006
Oued Djebbana, Algeria	AMH	100 kya (likely)	1	190km	natural	Vanhaeren et al. 2006
Qafzeh (Levant)	AMH	at least 90 kya	10	20–40km	natural	Bar-Yosef Mayer et al. 2009
Grotte des Pigeons, Morroco	AMH	80 kya	38	40–60km	natural	d'Errico et al. 2009
Blombos, South Africa	AMH	75 kya	71	20km	41 anthropogenic	Henshilwood et al. 2004
Bacho Kiro, Bulgaria	AMH?	43 kya	3 (2 in fragments)	not reported	bone and teeth pendants	d'Errico and Vanhaeren 2009; Zilhão 2012
Ksar 'Akil (Levant)	AMH?	40–42 kya	814	6–10km	anthropogenic	Kuhn et al. 2001; Douka et al. 2013
Üçağızli, west Turkey	AMH?	40–42 kya	1098	local shore	anthropogenic	Kuhn et al. 2001; Douka et al. 2013
Fumane, Italy	AMH	40–42 kya (Proto-Aurignacian and Aurignacian)	nearly 900	not reported	anthropogenic[1]	Peresani et al. 2013
Krems-Hundssteig, Austria	AMH	Early Aurignacian (likely)	128	not reported	not reported	Nigst 2006
Riparo Mochi, Italy	AMH	36 kya (oldest)	>500	local shore	anthropogenic (many)	Stiner 2003
Cueva de los Aviones, Spain	N	50 kya	3	1.5–7km	natural	Zilhão et al. 2010
Fumane, Italy	N	45–48 kya	1	at least 100km	not perforated	Peresani et al. 2013
Cueva Antón, Spain	N	38 kya	1	60km	natural	Zilhão et al. 2010
Grotte du Renne, France	N	34–45 kya[2] 21–49 kya[3]	36	not reported	teeth pendants	d'Errico et al. 1998
Quinçay, France	N	Chatelperronian	6	not reported	teeth pendants	Granger and Leveque 1997
Ilsenhöhle, Germany	N	Chatelperronian	1 ivory disc	not reported	centrally located hole	Zilhão 2012
Trou Magrite, Belgium	N	Chatelperronian	1 ivory ring	not reported	not reported	Zilhão 2012

[1] Described as "pierced" (Peresani et al. 2013: 3) which I interpret to mean deliberately perforated; also described as "shell beads" (Peresani et al. 2013: 9), since the term "bead" is used I assume there is evidence of human agency involved in determining their use.

[2] Reported in d'Errico et al. (1998).

[3] Reported in Highham et al. (2010).

Second, two AMH teeth have been linked to the Uluzzian in Italy (Benazzi et al. 2011; however see Zilhão et al. 2015 for doubts about the stratigraphic integrity of the site). Thus, while recognizing that future evidence could force re-assessments, Table 3 tentatively assumes AMH priority at Initial UP sites such as Ksar 'Akil and Üçağızli.

Ritual use of beads is supported by the fulfillment of many of the requisite criteria. First, selection of the beads was rule-governed. Specific, often rare species (e.g., *Cyclope* at Riparo Mochi, *Nassarius* at Oued Djebbana, Grotte des Pigeons and Blombos) were deliberately selected, and/or rare sizes or particular naturally-occurring perforations (e.g., Qafzeh, Cueva de los Aviones, Riparo Mochi) were targeted. Second, invariance is also present in that beads were worked in a constant manner—perforated so as to be worn and colored with red ochre (Cueva de los Aviones, Blombos, Qafzeh). Finally, repetition is often present in that multiple beads are found at many sites (Blombos, Ksar 'Akil, Üçağızli, Fumane, Krems-Hundssteig, and Riparo Mochi).

There are two notable patterns in Table 3. First, there are no reports of beads for Neanderthals older than 50 kya. Bead production for AMH, however, traces back to around 100 kya at a number of African and Levantine sites (Skhul, Oued Djebbana, Qafzeh, and Grotte des Pigeons). Second, at all of these sites (both Neanderthal and older AMH), the number of beads is relatively small (always less than 40 and often less than 10). Blombos is somewhat exceptional at 71. As has been noted by others (e.g., d'Errico et al. 2009) there is a hiatus in bead production between 70–40 kya. After that, as can be seen in Table 3, bead numbers spike dramatically with orders of magnitude increases at sites such as Ksar 'Akil, Üçağızli, Fumane, Krems-Hundssteig, and Riparo Mochi, all of which date to between (roughly)

42–36,000 ybp. This would be the time period corresponding to the migration of AMH into West Asia and Europe (Hershkovitz et al. 2015).

It has been argued that beads represent a form of intergroup social signaling (Kuhn and Stiner 2007). Deteriorating climatic conditions associated with MIS 4 (73–60,000 ybp) may have severely reduced and isolated hominin populations, limiting inter-group interactions, producing losses of cultural knowledge including bead-making traditions (d'Errico et al 2009; Hovers and Belfer-Cohen 2006). Subsequent population expansions and migrations may have served as the catalyst for the re-emergence of bead making traditions at around 40,000 ybp. Notably, at many sites this re-emergence was at a much higher cost level, which is what would be expected if social conditions were particularly unstable and competitive.

Tentatively, it appears that *Homo sapiens* were the creators of the large amounts of beads found at the transitional sites of Ksar 'Akil, Üçağızli, and Fumane. This would be consistent with the large amounts of beads found at other clearly AMH sites such as Krems-Hundssteig and Riparo Mochi, and it would offer strong support for hypothesis 2. If it turns out that Neanderthals were responsible for beads at any or all of these transitional sites, it would indicate that they utilized beads in a similar way as AMH in response to apparent social stress.

It may be noteworthy that Neanderthals had independent traditions of using teeth, feathers, and eagle talons as body ornaments (Morin and Laroulandie 2012; Finlayson et al. 2012; Radovčić et al. 2015). Presently, there is no evidence that these were created in high quantities similar to beads. If Neanderthals were responsible for the large numbers of beads at transitional sites, it is curious that this increased ritual cost involved beads and not these other, indigenous body ornaments. It suggests that Neanderthals were signaling more to AMH than to other Neanderthals.

USING CAVES AS RITUAL VENUES

Penetrating into deep cave recesses for artistic, religious, or other potentially ritual purposes has been well-documented for *Homo sapiens* during the Upper Paleolithic (40–10,000 ybp). Accessing deep cave sites was often risky and dangerous. For example, reaching the painted chambers at Montespan Cave required trekking through frigid waters for more than a kilometer. To access Nerja Cave in Spain, AMH had to negotiate a steep climb up a sheer rock face. The painted shaft at Lascaux required a 16 meter rope-descent into pitch-darkness; while the Salon Noir chamber at Niaux Cave was accessible only after traversing a 450 meter passage and making a 200 meter climb. Compounding the danger was the fact that while making these ventures, AMH were carrying torches, artistic supplies, ladders, and often had children in tow (see White 2003 for summary). In addition, *Homo sapiens* often expended considerable time, energy, and resources in the deep cave chambers creating paintings or constructing ritual venues, such as the elaborate El Juyo "sanctuary" in northern Spain (Arias 2009; Freeman and Gonzalez Echegaray 1981). Thus, there is little question that Paleolithic spelunking was often a costly endeavor.

The costs incurred in deep cave ventures suggest that important, possibly sacred, "rules" were being followed. The rule-governed nature of the behavior supports a ritual interpretation. Furthermore, the behavior was repetitious—numerous caves were visited, multiple times. The behavior was often invariant—art with recurrent themes and images were created in similar contexts (deep cave recesses). Often the images were stylized with repetitive geometric forms, negative and positive hand stencils, and three dimensional animal forms created using outcroppings and recesses. All of this supports a ritual interpretation.

Rhino Cave

Although the most well-known and arguably the most impressive ritual use of caves occurred during the later UP (Altamira, Lascaux, El Juyo, etc.), *Homo sapiens* started penetrating deep into caves at the very outset of the Upper Paleolithic. Cave paintings at Chauvet date to before 30,000 ybp (Chauvet et al. 1996, but see Pettitt and Bahn 2014) and recent finds at El Castillo Cave in Spain push the earliest cave art back to around 40,000 ybp (Pike et al. 2012). While the authorship of the El Castillo art is unclear, recent evidence points to a Cro-Magnon origin (Galvan et al. 2014; Wood et al. 2014). This adds further credence to the notion that this form of costly ritual behavior was part of the *Homo sapiens'* repertoire prior to their exodus from Africa, and indeed other evidence confirms this.

At Rhino Cave in Botswana (Southern Africa) evidence has been found for some of the earliest cave rituals, dating to the late African MSA (280–30,000 ybp; Coulson et al. 2011). Rhino Cave is located in the Tsodilo Hills of Botswana, situated high on the northernmost ridge of what is called Female Hill. Its prominent location (the Hills are the only major outcropping for over 100kms in any direction) prompted Coulson et al. (2011) to argue that it was a likely assembly site for hominin communities in the region. Though visually prominent, gaining access to the cave is not easy—one must climb over or squeeze between large boulders, crawl through a narrow passage, and then navigate down a steep drop leading to the cave floor. Though the cave is not deep, the surrounding boulders and high walls effectively block out any direct sunlight.

Inside the cave, there is a natural snake-like outcropping. The outcropping was intentionally modified to enhance its serpentine qualities, and by flickering torch-light it conveys the illusion of movement. While it is impossible to know how this outcropping was interpreted by MSA people, similar contexts from more recent sites have been interpreted religiously—as signifying entry points to the spirit world (Lewis-Williams 2002).

The snake-rock is not the only unusual aspect of Rhino Cave. There are also an unusually large number of burnt and broken tools in the cave produced from carefully selected ("one-offs," Coulson et al. 2011: 30) colorful, non-local ("exotic") raw materials. These raw materials were transported to the cave from distances ranging from fifty to several hundred kilometers. At the cave, the raw materials were "delicately worked" (p. 48) into tools (points) and then intentionally destroyed and burned. From a practical standpoint, this behavior is odd and costly. Time, energy, and valuable material resources were exhausted for no clear utilitarian gain. But, as Coulson et al. (2011) point out, these are precisely the hallmarks of human ritual.

The modifications to the "serpent" outcropping have been dated broadly to the Middle Stone Age (Coulson et al. 2011: 39). The burnt, broken points at Rhino Cave have been indirectly dated (using similar finds in the region) to around 70,000 years ago. While tentative, this date situates the Rhino Cave rituals roughly within or just after the second mega-drought at the southern end of the drought-affected region. This could plausibly be a key time and place for increased inter-group interactions.

Neanderthal Cave Rituals

The recent finding of an abstract geometric engraving about 100m deep in Gorham's cave (dated to older than 39,000 ybp) supports the notion that Neanderthals did, occasionally, venture deep into caves (Rodriguez-Vida et al. 2014). Relative to AMH, however, evidence of Neanderthals' use of deep cave sites is quite rare.[4] Beside Gorham's cave, only two other instances are reasonably well-documented, both from Western Europe at roughly the same time (around 50,000 ybp). The first instance is the Neanderthal habitation site at Galérie Schoepflin at Arcy-sur-Cure in France. About 30m into the cave, a litter of bones, tools, and weapons was found and some have argued that the bones (especially) might carry symbolic importance (Hayden 2003: 102).

The second instance, Bruniquel Cave in southwestern France, is more impressive. About 200m deep in the cave, after a very tight crawl through a narrow passage, there is a small (approximately 14m^2) enclosed floor space that appears to be a ritual site (Hayden 2003: 100–102, 2012). Stalagmites and stalactites have been broken off and formed into two circles on the cave floor. Evidence of a fire is present in the larger of the two circles. The scene has been dated to around 50,000 ybp, before AMH were present in the region, but at a time when Eastern and Western Neanderthals may have contesting for the territory. Brian Hayden has argued that Bruniquel was a likely venue for ritual activity involving four or five Neanderthal participants.

Two points emerge from this examination of early cave rituals. (1) For both Neanderthals and AMH, the emergence of cave rituals occurs in temporal and geographic contexts where out-group encounters are plausible. For Neanderthals, it is southern France at around 50,000 ybp. For AMH, it is south/central Africa around 70,000 ybp. This falls generally into line with hypothesis 1. (2) As predicted by hypothesis 2, the evidence of costly behavior is more compelling for AMH.

In terms of behavioral cost, Rhino Cave exceeds Bruniquel in a number of ways: (1) very particular (colorful) raw materials were transported to Rhino Cave from tens and possibly hundreds of kilometers away, while the materials at Bruniquel were found in the cave (stalactites and stalagmites). (2) At Rhino Cave, both the materials brought to the cave and materials found in the cave (the natural outcropping) were worked at the site, whereas no materials were worked at Bruniquel. (3) Once worked, a considerable amount of raw material was destroyed at Rhino Cave, whereas nothing comparable occurred at Bruniquel. If rituals were conducted at Rhino and Bruinquel Caves, both may have involved important religious and/or symbolic content for the participants and in that sense were qualitatively equivalent. However, in terms of behavioral cost, Rhino Cave exacted more from its participants than Bruniquel.

BURIALS

All skeletal remains are buried. Thus, archaeological criteria such as degree of articulation, stratigraphic integrity, and body position are critical for identifying when the remains might indicate intentional mortuary behavior (Hovers and Belfer-Cohen 2013a). Mortuary behavior represents another potential form of ritual. The behavior is typically rule-governed—specific places were set aside as locations for the dead. For example, at Shanidar and Sima de los Huesos, bodies were deposited (either buried or simply cached, see ensuing discussion) repeatedly over centuries (Pettitt 2002). Furthermore, bodies were often positioned in very deliberate ways such as oriented east-west or with the long axis of the cave (Defluer 1993: 236; Pettitt 2011: 168). Secondly, the practice of inhumation (as opposed to abandonment or caching) involves an invariant sequence of actions: (1) digging or somehow demarcating the grave, (2) placing the body in the marked area, (3) covering the body with sediment. Finally, repetition is also found at sites with multiple bodies and where the same grave goods (tools, lithics, animal bones, and beads) are found in great numbers.

In his recent analysis of the evolution of mortuary behavior, Pettitt (2011: 57) identifies 120,000 ybp as an important transition point when hominins began the practice of inhumation—the deliberate placement of a body into a prepared grave. Prior to this, bodies were simply abandoned, disposed, or in some cases cached in unmodified natural locations (Pettitt 2002). Examples of caching would include the approximately 30 bodies (likely *H. heidelbergensis* but possibly Neanderthal) from the Sima de los Huesos site in the Atapuerca Mountains in north-central Spain (dated to 400–500,000 ybp; Andrews and Fernandez Jalvo 1997; Arsuaga et al. 1997; Bischoff et al. 2007; Fernandez Jalvo and Andrews 2003; Pettitt 2011: 49–54) and the five to possibly 15 Neanderthals found at Pontnewydd Cave, Wales (approx. 225,000 ybp).

Inhumation involves more effort than caching in that a grave site is prepared for reception of the body either by digging a pit or marking a space with blocks. The body is then placed in the excavated feature and covered with sediment (Pettitt 2011: 9). Sometimes simple grave goods also are included with the body. At minimum, true burial requires inhumation.

Thus, the earliest true burials among AMH are found at Skhul and Qafzeh Caves in Israel, dated to sometime between 120–90,000 ybp. While there is general agreement that either six or seven burials are present at Qafzeh (8, 9, 10, 11, 15, and maybe 3, 13, or 25; Belfer-Cohen and Hovers 1992: Table 2; Pettitt 2011: 59, 68; Riel-Salvatore and Clark 2001: Table 1), there is less agreement on the number at Skhul. In his original analysis, McCown (1937 as cited in Belfer-Cohen and Hovers 1992: 467) claimed that only seven bodies showed evidence of natural articulation, and of these a strong case for intentional burial could only be made for four (I, IV, V, and VII). Riel-Salvatore and Clark (2001: Table 1) claim six burials at Skhul (with the same four as McCown deemed "certain") as do Belfer-Cohen and Hovers (1992: Table 2). Pettit (2011: 59, 68) argues for ten at Skhul.

Whatever the actual number, it is clear that most of the burials are simple, involving little more than a body being placed in an excavated grave. A few, however, go beyond this. A boar mandible was deliberately laid along with the body for Skhul 5. Ochre was included for at least two of the Qafzeh burials (8, 11; Hovers et al. 2003; Riel-Salvatore and Clark 2001). Qafzeh 11 is the most elaborate burial with four large blocks (40cm max dimension) used to line the grave area and a block placed on top of the body. A large antler and frontal bone of a red deer were also placed with the body, along with (the already mentioned) red ochre.

It has been suggested that burial expresses a tribal connection to the land (Gilead 1989). This connection is likely to become more intense when different groups contest with one another over territory. It may be significant then, that these earliest burials appear to coincide with a period of increased population concentration in the Levant (Hovers and Belfer-Cohen 2013b: S346).

Evidence of inhumation is also present in Southern Africa by 76,000 ybp. At Border Cave in South Africa, the partial skeleton of a four-to-six month old infant (BC3) was found placed into a deliberately cut grave, 24cm deep, 38cm x 30cm in size (Cooke et al. 1945; Rightmire 1979). It may also be noteworthy that this burial is dated to the time of the second mega-drought, in a region (northeast South Africa near the border of Swaziland) that would have been just outside of the drought-affected area. That migrating populations may have been involved is a distinct possibility.

The emergence of inhumation can also be seen among Neanderthals. While some have questioned the reality of Neanderthal burial (Gargett 1989; 1999), most researchers accept that some Neanderthals were buried (Pettitt 2002; Riel-Salvatore and Clark 2001). There is some indication, however, that *H. sapiens* practiced burial more frequently than Neanderthals. Burials of both species are found in the Levant; but when adjusted for time, more *H. sapiens'* burials are present there (Hovers and Belfer-Cohen 2013b: S340). Furthermore, it appears that Neanderthals began the practice later than *H. sapiens*. With the possible exception of Tabun Cave and some burials at La Ferrassie, nearly all Neanderthal burials date to 70,000 ybp or later, with most occurring between 60–50,000 ybp (Pettitt 2011: 81). Using those accepted as true burials (i.e., inhumation is present) by Pettitt (2011: 105–130) and judged as "certain" burials by Riel-Salvatore and Clark (2001), the list of Neanderthal burials includes:

1. Tabun C1 (120,000 ybp, Grun and Stringer 2000, but there is debate over dating see Pettit 2002: 2 and footnote 1).
2. Le Regourdou (60–70,000 ybp, Hayden 2003: 114)
3. La Ferrassie (70,000 ybp, although this is unsettled see Pettitt 2002, footnote 2)
4. Kebara 2 (and possibly 1; 48–60,000, Valladas et al. 1987).
5. Amud (50–80,000 ybp, Pettit 2002)
6. Shanidar (40–55,000 ybp, see discussion in Pettitt 2011: 123–124).
7. Dederiyeh Cave (50,000 ybp, Pettit 2011: 107).
8. La Chapelle-aux-Saints (50,000 ybp, Rendu et al. 2013).
9. Spy in Belgium (35,000 ybp, Pettit 2011: 115)

(note: though the infant burial at Roc de Marsal fulfils the criteria, it has been excluded given the doubts raised by Sandgathe et al. 2011a).

What is interesting about this list is that with the exceptions of Regourdou and La Ferrassie, all of these are at times and places where Neanderthals could plausibly have encountered *H. sapiens* as they: (1) made their initial foray into the Levant (Tabun), (2) moved out of Africa around 60,000 ybp into West Asia (Kebara, Amud, Dederiyeh, Shanidar) or (3) moved into Western Europe (Spy). Furthermore, the burial at La Chapelle-aux-saints is at a time when resident Western Neanderthals may have been confronting invading Eastern Neanderthals. It does not seem unreasonable to suspect that inter-group encounters prompted a heightened sense of territoriality among Neanderthals leading to increased burial activity.

Similar to AMH, Neanderthals sometimes left grave goods with the burials. Indeed, their frequency of doing so was greater than that of early AMH. Using the burials deemed "certain" in Riel-Salvatore and Clark's (2001) review, 16 of 23 (nearly 70%) Neanderthal burials have grave goods while only four of ten (40%) early AMH burials do. In both cases, the grave goods are almost entirely made up of materials frequently found at the grave site such as lithics, bones, and rocks. The only possible exceptions are the Shanidar "flower" grave (Neanderthal), which has largely been discredited (Sommer 1999), and the ochre found at Qafzeh 8 and 11 (AMH).

Highly elaborate burials with copious, ceremonial grave goods not readily found near the grave site such as Sungir, La Madeleine, Dolní Věstonice, Saint-Germain-la-Rivière, or the famous "Red Lady" burial at Paviland do not emerge until after 30,000 ybp among AMH. This clearly involves another increase in ritual cost and is unique to *Homo sapiens*. Whether Neanderthals, had they survived, would have taken this next step is an open question.

DISCUSSION

This review was guided by two broad hypotheses: (1) Evidence of increased ritual cost should be present in hominin archaeological remains beginning at about 150,000 ybp and (2) this evidence will more frequently be associated with *Homo sapiens* than Neanderthals. General support was found for both. In addition, two patterns emerged in the data that provide a potential framework for understanding why these hypotheses were supported. First, remains indicative of increased ritual cost consistently occurred in geographical and temporal contexts where inter-group interactions were plausible. Specifically:

- **Pigments**: In Africa, most high-quantity sites occur after 200,000 ybp with clusters occurring around 120,000 and 70,000 ybp, both periods when drought-related migrations are probable. In Europe, most pigment sites are dated to 50–40,000 ybp, a time when both Eastern Neanderthals and (later) Cro-Magons were encroaching on the West.
- **Beads**: Sites with the largest quantities of beads are in geographical and temporal contexts (Levant, West Asia, Italian coast, all at around 40,000 ybp) where migrating *H. sapiens* may have encountered resident Neanderthals (or possibly other resident *H. sapiens*).
- **Caves**: Both Rhino Cave and Bruniquel Cave are in geographical and temporal contexts where inter-group competition over scarce resources are probable. Rhino Cave is in northern Botswana (southern end of the drought belt), tentatively dated to 70,000 (just after the second mega-drought). Bruniquel is in southern France, dated to around 50,000 ybp, at a time when Western Europe was being re-colonized after depopulation.
- **Burials**: The first true burials (inhumations) arise in the Levant around 100,000 ybp, a time when both *H. sapiens* and Neanderthals were moving in and out of the region. Furthermore, most Neanderthal burials are around 50,000 ybp, a time when repopulation of the West was occurring.

Second, there is a tendency for *Homo sapiens* to both adopt ritual behavior first and to intensify its use to higher levels compared to Neanderthals. Specifically:

- **Pigments**: first emerge by the hundreds among African archaic *Homo sapiens* more than 300,000 ybp. From that time on, numerous *Homo sapiens'* sites can be found with pieces numbering from tens to thousands. For Neanderthals, the first evidence occurs at about 285–250,000 ybp in the form of stains on the ground (at one site) or a single piece (at another). It is not until 50,000 ybp that more than one piece of ochre is found at a Neanderthal site. After that, only two sites have numbers over 100.
- **Beads**: first emerge among AMH about 100,000 ybp at Skhul, Qafzeh, and Oued Djebbana. Bead numbers increase dramatically (70–1000+) at later AMH sites such as Blombos, Fumane, and Riparo Mochi. Beads first appear among Neanderthals at about 50,000 ybp at Cueva de los Aviones. With one exception, beads at Neanderthal sites always number less than 10.
- **Caves**: The first evidence of ritual use of caves dates tentatively to about 70,000 ybp among AMH and about 50,000 ybp among Neanderthals. Furthermore, from the outset, AMH's use of caves was more resource intensive compared to Neanderthals, and in time reached a point of frequency and risk never approached by Neanderthals.
- **Burials**: The emergence of inhumation occurs at around 100,000 ybp for AMH. It may also have occurred around this time for Neanderthals if the Tabun date holds. However, presently inhumation is more clearly established for Neanderthals at around 70,000 ybp. Moreover, only among AMH does burial reach ritual elaboration (as defined by Pettitt 2002).

While these patterns are very general, they are also quite consistent across all four types of remains. With geographic and temporal refinement, they can provide a basis for future tests.

So what factors are driving these patterns? This paper has focused on two: inter-group encounters (often spurred by migrations in search of scare resources) and the necessity of reliable pair-bonding arising from encephalization as described in the FCC model (more specifically focused on red ochre use).

The FCC model offers a two-pronged explanation for why *H. sapiens* began using ochre before Neanderthals and did so more consistently and intensely over time—brain size increased earlier in *H. sapiens* and biological and climatic differences between AMH in Africa and Neanderthals in Europe made *H. sapiens*' pair-bonds inherently less stable. Thus, the need for red ochre-involved rituals emerged sooner and, in time, required more frequent practice among African *H. sapiens* than Neanderthals. Tests of the FCC model have yielded some supportive evidence (see Power et al. 2013; Watts 2014) and this model may uniquely explain the earliest African red ochre sites such as Twin Rivers, Kapthurin, Sai Island, and Border Cave, and Neanderthal pigment use prior to 60,000 ybp. But there are reasons to suspect that later pigment use may require a combination of the FCC model and other factors.

Most Neanderthal pigment use occurs between 50–40,000 ybp, which is inconsistent with the FCC model, but not with one based on inter-group competition. Additionally, the FCC model specifically focuses on red ochre. Other ritual activities involving body ornaments, caves, and burials are not addressed. As described earlier, inter-group encounters resulting from migrating groups pursuing scarce resources show promise as a means of accounting for the intensification of ritual activity associated with these remains.

Genetic studies in combination with fossil evidence can be used to formulate predictions about where and when inter-group encounters may have occurred. For example, Sankararaman et al. (2012) used genetic evidence to estimate the probable time frame for inter-breeding between *H. sapiens* and Neanderthal as being 47–65 kya. This would make the most likely place for the encounter somewhere in West Asia. Hershkovitz et al. (2015) recently found fossil evidence of *H. sapiens* at Manot Cave in northern Israel dated to around 55 kya. From this, one could predict evidence of increased ritual behavior in the Levant at around this time—and indeed evidence of burials from Amud, Kebara, Shanidar, and Dederiyeh, as well as the large collections of beads at Ksar 'Akil and Üçağızli are consistent with this. Formulating predictions such as these can help to tease apart when increased ritual activity was more likely due to group competition versus pair-bond instability.

Why are *Homo sapiens* the only remaining hominins on earth? The data reviewed in this paper add yet another factor to those that have been proposed over the years—costly rituals. Over the past 150,000 years, a greater frequency of climate-related migrations, inter-group encounters, and ritually-reinforced pair-bonding may have conspired to produce a stronger tradition of costly rituals among some African *H. sapiens* compared to other hominins including Neanderthals. Both resident African *H. sapiens* and those who migrated from Africa beginning about 60,000 ybp, employed that tradition to create a decisive social advantage over other *H. sapiens* groups, Neanderthals, and other hominins as they spread globally.

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ENDNOTES

1. Blome et al. (2012: 25) estimated the southeastern border of the mega-drought belt to have been at approximately 22 degrees South Latitude (range 19–25 degrees) and approximately 25 degrees East Longitude (range 23–27 degrees). The northern border was estimated to have been at approximately 18 degrees North Latitude and 37 degrees East Longitude. This zone would run roughly from central Botswana to the Red Sea coast of Sudan south of Port Sudan to the Eritrean border. However, they also report the northern boundary of Southern Africa shows evidence of a mega-drought signal.
2. Dayet et al. (2014: 185) searched published and "gray" literature and found 14 possible Châtelperronian pigment sites. They also state (p. 184) that only the Grotte du Renne pigments have been subject to extensive study. Watts (2009: 74, 79) summarizes Neanderthal pigment findings thusly: "For Middle Pleistocene Europe, there are at most five occurrences, three of which are questionable. All are thought to predate 220 ky, … I know of only two cases … between 128 ky and 75 ky [Combe Grenal and Tata]. The great majority of the 40 or so European Mousterian sites with pigment date to the Last Glacial … most post-date 60 ky, and manganese predominates over red ochre. Forty is a small proportion of excavated Mousterian sites. It is not until the arrival of modern humans … that pigment use in Europe becomes ubiquitous, when it overwhelmingly takes the form of red ochre. … (Châtelperronean) Neanderthals … also start using much larger quantities of red ochre." Wreschner (1980: 632) claims there are 15 Mousterian sites with evidence of ochre, including burials and sites where tools and other artifacts have been found with ochre stains. By that same criterion, he cites 123 UP ochre-bearing sites, 25 of which are burials.
3. A number of Neanderthal sites have made claims for the presence of personal ornaments. D'Errico et al. (1998: S13) state that personal ornaments have been found at seven Châtelperronian sites apart from Grotte du Renne. However, in their table summarizing these sites (Table 4: S12), they list only one other site as having shells (Cauna de Belvis) and four other sites as having teeth (Châtelperron, Roc-de-Combe, Roche-au-Loup, and Roche de Quinçay). Roche-au-Loup is also listed as possibly having ivory rings. No discussion of the quantity of these possible ornaments is provided and no references are provided (two possible references for Roche-au-Loup are both in French). On p. S11, mention is made of perforated shells found in Uluzzian layers at Cavallo and bi-valve fragments at Castelcivita (both original references are in Italian). With the exception of Quinçay, my own attempts to track down more information on these sites have proven fruitless. However, most of the attention on Châtelperrionian remains has focused on Grotte du Renne and Mellars (2010: 20148) has referred to this site as the "single most impressive…pillar of evidence for [Neanderthal]…symbolic behavior." Thus, it appears that none of the other sites mentioned by d'Errico et al (1998) are nearly as impressive as Grotte du Renne. Indeed, contrary to d'Errico et al. (1998), Mellars claims that no other Châtelperonnian sites has personal ornaments other than Quinçay (p. 20147).

   In his recent review of Neanderthal ornaments, Zilhão (2012) concurs that Quinçay represents a second Châtelperonnian site yielding personal ornaments (although contra Mellars, he sees no controversy over the dating and priority of the finds). Zilhão includes a number of other sites where he believes Neanderthal personal ornaments have been found: (1) a single ivory disc with a central hole from Ilsenhohle, Germany, (2) an ivory ring from Trou Magrite in Belgium, and (3) a single bone pendent and fragments of two pierced teeth pendants (species unknown) from Bacho Kiro Cave in Bulgaria. He also mentions large numbers of beads from Klisoura I in Greece and Fumane Cave in Italy but these are attributed to the initial Upper Paleolithic of those regions (p. 41–42). The important point of all this is that it reaffirms the notion that outside of Grotte du Renne and Quinçay (which are both included in Table 1), the Châteperonnian sites with beads and other body ornaments are generally yielding finds in the single digits.
4. In their discussion of Neanderthal use of fire, Sandgathe et al. (2011b: 219) state: "Neanderthal cave occupations are almost universally situated at or very near the cave mouth."

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