The Development of Human Creativity: Cognitive Substrates of the Upper Paleolithic Archaeological Record

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Abstract: The Middle-Upper Paleolithic transition (*ca*. 40,000 years BP) and the following Upper Paleolithic period witnessed a major leap in human creativity. In this period we see far more *objets d'art*, more complex tool-kits, and evidence for an increase in human capacity for ritual and belief compared to previous stages in human evolution. In correlation with the aforementioned progress perhaps the most significant development in biological history of humankind is the prevalence of a new species of Homo, i.e., *Homo sapiens sapiens*, aka Behaviorally Modern Human. In this paper it has been attempted to discuss the underlying cognitive abilities for the development of creativity in *Homo sapiens sapiens* by using archaeological finds left behind from latter change as well as finds indirectly pertaining to developments such as ritual and burial rites, artistic exprssions, abstract reasoning, and ultimately an apparently coherent and structured language, As conclusion, we will explore the ramifications of these novelties in what it means to be human.

Keywords: *Homo sapiens sapiens*, Behaviorally Modern Human, The Middle-Upper Paleolithic transition, human cognition, human creativity

Introduction

In this paper our goal is to explore the increase in human creativity that began with the Middle-Upper Paleolithic transition and continued throughout the Upper Paleolithic period and beyond. We will investigate the emergence and development of human creativity throughout the Upper Paleolithic period by using the discovered archaeological material. We will also try to discuss the underlying cognitive abilities for the development of creativity in our species, *Homo sapiens sapiens.*

What Happened in Middle-Upper Paleolithic Transition?

In conjunction with the aforementioned progress in human creativity in the Middle-Upper Paleolithic transition, perhaps the most significant development in human history is the prevalence of a new species of *Homo*, i.e., *Homo sapiens sapiens*. Referred to in this paper also as Behaviorally Modern Human (BMH), *Homo sapiens sapiens* is the last and only surviving species of the genus *Homo*. In this paper, the two terms- *Homo sapiens sapiens* and Behaviorally Modern Human- will be used interchangeably. BMH is known by an expansion in material culture that characterized the Middle-Upper Paleolithic transition (Mithen 1998). This transition took place approximately 40,000 years ago, and was due to a surge of human creativity in a relatively short span of time (Bar-Yosef 2007). In the Upper Paleolithic period we see far more *objets d'art*, more complex tool-kits, and evidence for an increase in the capacity for ritual and belief compared to previous stages in human evolution (Klein & Edger 2002).

What is Creativity?

BMH differed with earlier members of the genus *Homo* by capacity for creativity, both in quantity and quality. Creativity is based upon novelty and innovation, particularly the ability to synthesize and utilize new concepts (Hodder 1998). These new concepts are seen in new types of behavior that are not just reapplications of previously established schemas or modes of action, though they may logically follow them (Carruthers 2002). BMHs are capable of having goals that do not immediately come from their physical environment, but stem from the representation of the abstract, something outside of reality (Amati & Shallice 2007). As discussed by Hodder (1998), ritual in particular can shed much light on the nature of

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BMH creativity. Ritual itself is a creative endeavor, relying on an ability to think about and represent the abstract in concrete actions. It is also a means of perpetuating creativity through new creative developments. It creates a realm in the mind's periphery where worldly rules do not apply, and allows for the exploration and evaluation of new and different possibilities. Though it is still uncertain how much ritual factored into the lives of BMHs in the Upper Paleolithic period, it is evident by their remaining material culture that the capacity for such abstract thought and imagining of possibilities was indeed present and fairly abundant.

No discussion of BMHs is complete without a discussion of language (Lieberman 2007). Processing language is intertwined with general cognitive function; thus as general cognitive ability increased, linguistic ability increased as well (Savage-Rumbaugh & Rumbaugh 1993). Although the development of full language preceded the first archaeological evidence for creativity by about 60,000 years, it logically follows that through their link with general cognition, language and creativity are interconnected. According to Carruthers (2002), language, though not sufficient for its advent, was perhaps necessary for the development of creativity in BMHs. Human language is both recursive and generative, allowing a general framework to be used repeatedly to form a near infinite amount of new utterances (Savage-Rumbaugh & Rumbaugh 1993). Language is a means of representing concrete ideas and objects in abstract terms through the use of symbols (Carruthers 2002). Creativity can be defined in much the same way. Language provided human mind with the capacity for abstract thought and allowed for conceptualization of the world through arbitrary symbols, two important prerequisites for creativity (Boden 1998). Although language and creativity use many of the same cognitive pathways and are considered to be closely related, they are not identical and can thus be conceptualized separately. Language laid the path for human creativity to develop throughout the Upper Paleolithic.

Evidence for Creativity in *Homo sapiens sapiens*

The archaeological record of the Upper Paleolithic period is rife with evidence for BMH creativity. In this section we will discuss the archaeological evidence for creativity, including tools and *object d'art* within the context of the changing cultural scene of the Upper Paleolithic. In this section we will also discuss ritual paintings and burial sites as further evidence for increasing capacity for creativity throughout the Upper Paleolithic.

Upper Paleolithic Cultures

BMHs in the Upper Paleolithic are characterized by tool-making, artistic expressions and the development of rituals and beliefs. Generally, Upper Paleolithic tool-making industries consisted of long blades made from prepared cores, burins or chisel-ended tools, and tools made of materials such as bone, ivory, and antler. Upper Paleolithic "art" generally consisted of beads and pendants; bone, ivory, or antler carvings; and paintings (Bar-Yosef 2007). Innovations in art often accompanied innovations in tool-making industries, and these innovations can be identified as being part of different cultures. The most well-known cultures in the Upper Paleolithic of Europe include the Aurignacian, Gravettian, Solutrean, and Magdalenian cultures (Gamble 1999). Although many more cultures existed in the Upper Paleolithic, together these four cultures span the length of the Upper Paleolithic and serve to give a general idea of the progression of tool-making industries from the Middle-Upper Paleolithic shift to the end of the Upper Paleolithic (for more information regarding the ambiguities and definitions of Upper Paleolithic cultures, see Gamble 1999 and Bar-Yosef 2007). BMH rituals developed over the course of the Upper Paleolithic. Their development is characterized by an increased reliance on shamans, ritual art and symbols, and burial rituals. Such strides in rituals, art, and tool-making indicate the development of creativity in BMHs throughout the Upper Paleolithic.

Aurignacian Culture

The Aurignacian culture was one of the first cultures to appear in the Upper Paleolithic. It lasted around 8,000 years, from about 37,000 until 29,000 years ago, and ranged from Spain to Bulgaria (Klein & Edgar 2002). The Aurignacian tool-making industry can be identified by a composition of a few, but very specific tool types. These types included nosed scrapers, carinated scrapers, and prismatic blade technology, along with bone, ivory, and antler split base points. During the early Aurignacian, raw material for stone tools was found within a radius of a few miles from an area of habitation. Additionally, the edges of stone tools were often reworked and retouched repeatedly. The later Aurignacian, however, saw an increase in stone tools made from raw materials from distant sources. The edges of these later stone tools do not show as much retouching, but exhibit an increase in the overall yield of individual tools from a single core (Blades 1999). During the Aurignacian, the production of bone, ivory, and antler tools increased from their level of production in the Middle Paleolithic, as they became a more common tool-kit component (Bar-Yosef 2007). Tools also became more complex than those of the Middle Paleolithic Mousterian tool-kit, demonstrating a more artistic and unique appearance rather than one that was simply utilitarian (White 1992).

Art in the Aurignacian culture consisted of beads, pendants, and carved objects made by modifying teeth, ivory, or bone. Beads and pendants were made by piercing

a hole through animal teeth, and served as a form of personal ornamentation. Carved objects consisted of objects claimed to be flutes (but see Morley 2006) made from bone, and figures carved from ivory that were zoomorphic figures, consisting of horse and bird figurines of the types that existed in the region, and therianthropic figures, which combined human and animal characteristics (Conard 2003). The advent of personal ornamentation, and carvings of abstract figures are also material evidence that signals the BMH capacity for creativity.

Gravettian Culture

The Gravettian culture appeared about 28,000 years ago, lasting for 7,000 years until 21,000 years ago, and ranged from Portugal to western Russia (Klein & Edgar 2002). The Gravettian tool-making industry added and improved upon the previous industry by expanding its tool-kit to include beveled spear points, barbed points, atlatl or spearthrowers (in some areas), and even such items as ivory boomerangs. These new types of tools suggest further cultural adaptation to the increasingly cooler European climate, with an increase in implements made for big game hunting. The Gravettian also saw the development of weaving as a means of making nets for fishing, as evidenced by bone and ivory weaving implements and textile impressions found on pieces clay (Hoffecker 2005; Soffer, Adovasio & Hyland 2000).

During the Gravettian phase, art became increasingly expressive and more detailed (Poikalainen 2001). Evidence for woven textiles, basketry, ceramics, and sculpture in the Gravettian phase has been found at a number of sites throughout Europe (Hoffecker 2005). Of particular interest in the Gravettian are the so-called Venus figurines found in most Gravettian sites, made from ivory, bone, or terra-cotta. These figurines depict nude or nearly nude female figures with exaggerated body parts, including breasts, belly, vulva, and buttocks. There has been much speculation over the purpose of these figurines, from being symbolic fertility idols to simply being actual representations of contemporary female anatomy (Soffer, Adovasio & Hyland 2000). There has also been much debate over the nature of the figurines, whether their exaggerated proportions depict a woman who is pregnant, or a woman who is obese (Cheng 2006; Shewan 2006). Nonetheless, the sculpting of such figurines along with the production of woven textiles and baskets demonstrate increasing capacity for creative thought among BMHs.

Solutrean Culture

The Solutrean culture appeared approximately 21,000 years ago and lasted for 4,500 years until 16,500 years ago, and existed throughout France and Spain (Klein & Edgar 2002). Stone tool innovations from the Solutrean consisted of biface laurel leaf points, microblades used in bone and antler spears, and a more widespread use of spearthrowers (Aubry, Almeida, Neves & Walter 2003; Hoffecker 2005). Though these innovations are important, perhaps the most telling innovations took place in other tool types. The Solutrean saw the development of harpoons made with barbed antler points, fishhooks, and the widespread use of eyed needles. These innovations suggest further adaptation to the increasingly cooler climate through more efficient hunting, increased diversity in the type of meat consumed, and the ability to produce better types of clothing (Hoffecker 2005).

The art of the Solutrean culture consisted of many of the same forms as previous cultures, with the addition of sewn tailored clothing and rock carvings. The evidence for an increase in the complexity of tailored clothing lies in the more widespread use of the eyed needle, which during the Solutrean was found throughout all of Europe (Hoffecker 2005). Rock carvings rose in abundance in the Solutrean phase, particularly in France and the Iberian Peninsula. During the early Solutrean, rock carvings consisted of mainly zoomorphic drawings. Carvings from the late Solutrean still consisted of zoomorphic drawings, but also contained other, geometric shapes such as dots, circles, rectangles, and organized lines. Many carvings included a few animals surrounded by many of these other forms, known as signs. The purpose of these signs included in rock carvings hint at an increasing capacity for expressing thoughts symbolically (Bicho *et al*. 2007).

Magdalenian Culture

The Magdalenian culture was one of the last cultures of the Upper Paleolithic, and lasted for 5,500 years, appearing about 16,500 years ago and lasting until 11,000 years ago, ranging from southern Britain to Germany (Klein & Edgar 2002). Tool technology in the Magdalenian phase expanded to include a more widespread use of the harpoon throughout Europe, and an increased usage of bone and antler tools (Bar-Yosef 2007). New forms of bone and antler tools consisted of the bow and arrow and throwing darts (Hoffecker 2005). There is also evidence of the introduction of a whalebone tool industry in the Magdalenian period, showing an expanse from using land resources to using marine resources as well (Pétillon 2008).

During the Magdalenian phase, cave paintings, perhaps the most apparent aspect of Magdalenian art, became more prevalent and complex. Though cave painting in some form had been present since the Early Upper Paleolithic, Magdalenian cave paintings, such as those found at Lascaux in France and Altamira in Spain, built upon previous rock art by continuing to use signs to express both abstract ideas and concrete objects (Curtis 2006). In the Magdalenian phase, these signs increased in number and complexity (Wildgen 2004). Anthropomorphic figures

were included in cave paintings, as were complex hunting scenes. These scenes were often depicted in signs or codes that may have required special knowledge to create and understand (Chalmin, Menu & Vignaud 2003). Such complex signs and codes suggest the existence of rituals or beliefs, especially the existence of shamans (Wildgen 2004; Chalmin, Menu & Vignaud 2003). These codes also lay the framework for the development of written language, and demonstrate the ever-increasing cognitive capabilities of BMHs in the Upper Paleolithic.

Rituals

Rituals are often considered to be the foundation for the formation of religion. Rituals are not the product of religious beliefs, but rather what serves to develop them (Fogelin 2007). Rituals in the Upper Paleolithic can be characterized by an intricate system of shamanism and burial rites. These intricate systems reflect the ability for BMHs to think creatively and perceive the world in an abstract manner. It also shows an ability to create concrete objects, portrayals, or rituals based on these abstract perceptions. The advent of ritual and belief among BMHs marks an increase in capacity for creative thought and action.

Shamans

The entire Upper Paleolithic period witnessed an increase in presence of shamans. Evidence for rising amount of shamanistic activity is found in the increasing complexity and prevalence of cave art, as much of the cave art found throughout the Upper Paleolithic is considered to be the product of shamans (Bar-Yosef 2007). The cave art itself holds evidence as to the nature of shamanistic rituals and beliefs during the Upper Paleolithic. Cave art, specifically that of the later Upper Paleolithic, suggests that BMHs had the notion of both animal and therianthropic spirits (Hayden 2003). In the Magdalenian site of Lascaux, some of the animals included in the paintings are entirely mythical. The notions of spirits suggested by such mythical creatures are nearly universal concepts in shamanistic religions. The codes surrounding the cave art, as discussed in the previous section, have been thought to be an important aspect of early rituals and beliefs. They closely resemble the visual experiences that occur during periods of high stress or sensory deprivation, two important aspects of trance experiences. Such trance experiences are commonly associated with shamanistic rituals (Rossano 2005).

Burial Rites

Graves and burial sites from the Upper Paleolithic period suggest the development of burial rituals by BMHs. Evidence for the development of burial rituals can be seen in the items and body ornaments placed on and around the grave, along with the use of ochre to adorn the deceased and the layout of the graves themselves. Additionally, because of the specific items found with each individual, it is evident that each burial and thus each deceased person were treated in a unique manner (Giacobini 2007). Burial rituals can be observed through a number of Upper Paleolithic sites. The burial of the Sunghir children in Russia gives particular insight into the burial rituals of the Upper Paleolithic. The burial of the Sunghir children is a double burial of a boy and a girl placed head to head in a narrow and shallow grave. Their bodies were covered with ochre and adorned with elaborate personal ornaments, including pendants, mammoth tusk spears, pierced animal teeth, and ivory beads that have been estimated to each take over an hour to make (Formicola 2007).

Barma Grande, a part of the Grimaldi caves in Italy, yielded a triple burial consisting of an adult male and two adolescents thought to be females. The adult male was placed on his back and the two adolescents were laid to rest on their left sides. Much like the Sunghir children, these three individuals were covered with ochre and powdered oglist, and were adorned with ornaments and surrounded by goods. Some of the items found among the deceased were made of ivory, a relatively rare material in the area (Giacobini 2007). In both burials, the placement of the bodies along with their rich adornment demonstrates reverence and admiration for the deceased. The inclusion of such intricate artifacts with the bodies and the red ochre covering them also implies a belief system concerning the dead, perhaps even the belief in the existence of an afterlife.

The Cognition of Creativity

The capacity for such creativity seen in the Upper Paleolithic archaeological record is entirely dependent on the cognitive abilities, or cognition, of BMHs (Gibson & Ingold 1993). Cognition refers to the acquisition, storage, transformation, and application of information in the mind. Human cognition is generally comprised of a number of mental processes including but not limited to memory, imagery, recursion, learning, planning, reasoning, and decision-making (Sternberg 1999). This section will highlight three main cognitive abilities necessary for BMHs make the immense strides in tool-making, art, and ritual seen in the Upper Paleolithic: abstract reasoning, learning, and recursion.

Abstract Reasoning

As a mental process, reasoning is the ability to define, understand, and form judgments about the world (Davidson and Noble 1989) reason as a whole is important for understanding creativity in BMHs, abstract reasoning is perhaps the most critical form of reasoning for the

development of creativity, and can be most readily seen in the archaeological record. Abstract reasoning is the ability to use thought to manipulate events, objects, or concepts that are not immediately present or available in one's environment. It also allows for the transformation of abstract concepts into concrete representations or expressions (Amati & Shallice 2007). Evidence for abstract reasoning can be seen best in the art and rituals from throughout the Upper Paleolithic.

Abstract Reasoning in Art

Art is a craft that is highly dependent on the capacity for abstract reasoning (Abdi 2012). Art itself is concerned with concepts and their manipulation into concrete representations. Abstract reasoning in art from the Upper Paleolithic can perhaps be seen best in the cave paintings from the Magdalenian phase (Laursen 1993). The paintings of Lascaux show a number of scenes depicting grazing herds or animals being hunted (Curtis 2006). The artist viewed a herd or hunting party at one point in time and decided at a later date to turn his memory of the event into a painting. The memory of the event becomes a concept since it does not presently exist in the real world, only in the artist's mind. These paintings demonstrate the ability to take something existing only in the mind and turn it into a concrete representation in the present.

From Lascaux, further evidence for abstract reasoning can be seen in the signs painted on the cave walls. The signs in the caves consist of organized lines and geometric shapes surrounding the animal paintings. Although their exact meaning is not yet known, these signs likely served as a sort of symbolism, possibly even a form of written language for BMHs (Bicho *et al*. 2007). Symbolism calls for the use of concrete symbols to represent abstract concepts and ideas (Alocorta & Sosis 2005). As a form of symbolism, the signs portrayed in the cave paintings required the ability to take abstractions, concepts existing mainly in the mind, and transform them into physical representations.

Abstract reasoning in ritual

The development of rituals among BMHs, including both shamans and burial rites, indicate that BMHs had the capacity for abstract reasoning. The existence of shamans generally necessitates the existence of spiritual beliefs (Hayden 2003). Spiritual beliefs in the Upper Paleolithic likely consisted of ancestor- and animal- worship (Rossano 2005; Hoffecker 2007). Ancestor worship requires the ability to conceive of entities that do not exist in the material world and attribute actions and abilities to them. Animal worship requires the ability to conceive of already existing beings and ascribe new, often supernatural qualities to them. These supernatural qualities themselves require the ability to, in a way, make free form associations on already existing phenomena and conceive of them in an immaterial manner (Alcorta & Sosis 2005).

Burial rites in the Upper Paleolithic also suggest spiritual beliefs (Fogelin 2007). Burial sites from the Upper Paleolithic include ochre and artifacts that are on or associated with the bodies (Giacobini 2007). The manner in which ochre was applied to the bodies hints that it was used to anoint the bodies, perhaps during a funerary rite. The artifacts found with the bodies suggest that there was a special connection between the deceased and these objects, and that they were meant to accompany this person beyond their lifetime. Both anointing the deceased and inclusion of personal artifacts point to BMH belief in an afterlife (Formicola 2007). The belief in an afterlife means that death is viewed as more than a natural phenomenon, as a transition into another state of existence. This view would require abstract reasoning in that it calls for the invention of a new state of being that is intangible and outside of the physical world (Alcorta & Sosis 2005).

Learning

Learning is a form of cognition defined as the acquisition of knowledge for subsequent use and application. Learning can be conceived of as the process of forming rules and schemas and change in behavior and thinking produced by the formation of these rules and schemas (Ingold 1993). In the Upper Paleolithic, the capacity for learning allowed for many of the technological and cultural practices of BMHs (Amati & Shallice 2007). This is especially apparent in the archaeological record through the tool-making industries and rituals of the Upper Paleolithic.

Learning in tool-making

In the Upper Paleolithic period, the tool-making industry can be characterized as a rapidly changing and highly adaptive industry. A number of different tool-making industries appeared in a relatively short span of time, each making additions and innovations to the last. The rapid progression of tool-making was due to the ability of BMHs to learn. The condition of the environment and, perhaps most importantly, prior experience needed to be taken into account when designing, making, and using tools. When new information was gained by way of experience, this information was assessed, and if judged to be beneficial, was used to modify an existing schema (Toth & Schick 1993). Learning was also necessary for the propagation of previously learned knowledge. If a certain group or individual created a schema for tool-making that was beneficial for the population, other groups or individuals would need the ability to assimilate this new schema into their own scope of knowledge for it to become most beneficial.

An example of this can be seen in the changes projectile tools underwent in the Upper Paleolithic period. One progression of projectile tools can be conceived of as follows: spear, to spear with spear-thrower, to bow and arrow. These three projectile tool types appear sequentially in the archaeological record, with spears appearing in the Aurignacian phase, spear-throwers reaching common use during the Solutrean phase, and bows and arrows appearing in the Magdalenian phase. Such a progression of projectile tools can be seen as an adaptation to an environment in which the main source of food was big game (Hoffecker 2005). Spear-throwers allowed a spear to go farther than when thrown only by hand. This idea was conceived because of BMHs surveying the hunting situation and learning what type of distance and force was needed to kill big animals, and ultimately resulted in the modification of the tool industry. This way of making tools was perpetuated through the assimilation of this new system of knowledge by BMH populations. The bow and arrow was likely invented in the same manner. The environment and game called for a more efficient means of hunting, and using a bow and arrow allowed for a more compact and controlled shot than a spear and spearthrower. Once again, this tool was propagated throughout BMHs populations by assimilation of knowledge by other groups, or learning (Hoffecker 2005; Toth & Schick 1993).

Learning in ritual

The capacity for learning allowed the propagation of rituals and beliefs during the Upper Paleolithic. There is much evidence suggesting the existence of shamans during the Upper Paleolithic (Chalmin *et al*. 2003). The evidence for these shamans spans thousands of years, showing that shamanistic rites and beliefs were passed down from generation to generation. Shamanistic rites and beliefs are commonly passed from one generation to the next via a master/apprentice relationship. To become a shaman himself, the apprentice must listen to and observe the master performing the rites associated with the position (Hayden 2003). Evidently, this type of relationship relies heavily on the ability of one individual to receive knowledge and new modes of thinking from another individual through observation and instruction. For shamanism to have been perpetuated, the apprentice must have exercised and enhanced his capacity to learn.

The nature of rituals is such that his/her knowledge pertaining to them must be passed on and adopted by others for them to truly become ingrained in a culture (Geertz 1993; Ingold 1993). Burial sites provide evidence for learning in the Upper Paleolithic (Mussi 1986). A number of different burial sites throughout Europe and the Middle East show similar types of burial sites, even though these sites are separated by thousands of years (Giacobini 2007). Though the sites show some amount of variation, they all share basic, common elements, such as the inclusion of artifacts around the grave, and personal ornaments and ritual coloring on the deceased (Formicola 2007). The widespread use of these particular elements suggests they were absorbed and passed on by each generation. Even the variation suggests a sort of learning in that the burials were at times modified according to soil type, age of the deceased, or number of bodies. This variation demonstrates the affect of knowledge acquired in the past on current behaviors (Giacobini 2007).

Recursion

Recursion was first identified as a part of human cognition in the study of language, specifically in the theory of generative grammar (Chomsky 1956). The cognitive definition of recursion stems from this linguistic model, and is considered to be an important aspect of cognition (Noble & Davidson 1999; Corballis 2003). Recursion can be defined as a structure having embedded parts that can create an infinite number of new combinations by simply rearranging these parts within the same structure. Thus, recursion can be seen as providing a cognitive framework within which thoughts and actions occur (Hoffecker 2007). Recursion is a key cognition for many creative activities of BMHs, especially tool-making and art.

Recursion in tool-making

Tool-making in the Upper Paleolithic relied on increasingly complex methods of production as time passed. These methods however, all relied on the single underlying concept of percussion. Percussion is generally defined as one object coming into contact with another object by some force, either at a perpendicular or an oblique angle. Tool-making contains two main types of percussion, thrusting and resting. Thrusting percussion is characterized as actively striking one object against another, such as the cracking of materials, stone knapping, and pounding. Resting percussion is characterized as moving one object against another, such as grinding, polishing, or smoothing material (de Beaune 2004).

Different types of percussion form a progression in the archaeological record. A progression is seen in the development of stone tools, from cracking, to knapping, to pounding. There was also a progression from direct to indirect thrusting, where instead of one object striking the other directly, another implement would be placed in between. A final progression of percussion exists in the archaeological record, from thrusting percussion to resting percussion, where striking objects together gave way to other means of modifying objects (de Beaune 2004). Another interesting progression in tool-making occurred in

the change from predominantly stone tools to tools made of other materials such as antler, bone, and ivory (Bar-Yosef 2007).

Changes in percussion types and materials used in tool-making resulted from the transference of a general framework to other situations (Hoffecker 2007). The percussive striking action involved in cracking were applied to a different context and brought about stone-knapping, and this same concept was applied to yet another condition and brought about pounding. The concept of striking one object against another was expanded to include another third object as an intermediary to lessen the shock and create more intricate, smaller strikes. Likewise, the progression from thrusting to resting percussion involved the reinterpretation of an existing framework of striking an object against another as moving one object against another. The same general concept of using one object to modify another still applied, though its nature was slightly different. In the case of the progression of stone tools to tools made of other materials, the same framework of modifying an object to act as a tool was expanded to include materials other than stone, like bone, antler, or ivory. These various progressions in tool-making were all products of the capacity for recursive cognition (Hoffecker 2007).

Recursion in art

Throughout the Upper Paleolithic, art showed a high level of recursion. Art is recursive by nature, and is characterized as fitting different components into a general model. In the case of Upper Paleolithic art, the general model is a form or figure and the components are body parts and colors. As seen in the archaeological record, art during the Upper Paleolithic showed an increase in the diversity of these varying components.

In Upper Paleolithic art, the animal form in particular was the most common general form (Hayden 2003). This animal form, however, often went through a variety of modifications (Hoffecker 2007). An example of such recursion can be seen in the therianthropic sculptures from the Aurignacian phase. These sculptures consist of a number of features, some human, and some animal. One figure in particular shows a feline head placed on a standing human body (Conard 2004). The artist used the general model of a standing human and changed certain specific component, in this case the type of head, in order to produce a new type of figure.

Another instance of recursion can be seen in some of the cave paintings from the Magdalenian phase. At Lascaux, cave paintings include animals that were based solely on the artist's imagination. These painted animals were a combination of traits of other animals found in the surrounding environment. One in particular appeared to have the body of an ox, the coloring of a horse, and the head and horns of an oryx (Rossano 2005). These varying components from different species were all placed into the general form of an animal to produce the likeness of an animal that existed solely in the artist's mind, and not in reality, thus demonstrating the capacity of the BMH for recursion.

Evidence for creativity in earlier hominids

There is evidence that other hominids had the capacity for tool-making, and, by extension, the capacity for some of the cognitive functions associated with tool-making. Hominids such as *Homo erectus*, *Homo heidelbergensis* and *Homo neandertalensis* (Neandertals) are known to be stone tool users. Although their tool types were not as complex or numerous, the archaeological record does show evidence for innovation and adaptation through tool modifications (Toth & Schick 1993). It has been theorized that *Australopithicus* may have used implements made of wood to look for termites and other sources of food, as chimpanzees have been observed doing. Although these tools were not made of stone, they still demonstrate a certain capacity for passing on and receiving of new information (McGrew 1993). As previously discussed, the capacity for tool use in those species suggests elements of recursion and learning as part of their cognitive abilities.

The interesting case of *Homo neandertalensis*

Of all the hominid species, *H. neandertalensis* may have had other, more surprising cognitive capabilities in common with BMHs, such as those involved in art and ritual (Abdi 2012). Mithen (2005) argues that there is much archaeological evidence linking Neandertals to abilities such as art, music and language, and systems of belief. Artifacts such as flutes carved from bone suggest a Neandertal capacity for music. Music is highly related to language and shares many of the same cognitive components (Brown, Martinez & Parsons 2006). The possibility of Neandertals having the ability to make music suggests they may have had the cognitive capacity for language as well.

Some Neandertals have also been associated with seemingly Upper Paleolithic, BMH artifacts. Personal ornaments were found at a Neandertal site in Arcy-sur-Cure in France. The distribution of these ornaments suggests the Neandertals had an industry of making such items (Hublin *et al*. 1996). The existence of such Neandertal artifacts could mean that Neandertals had the same capacity for abstract reasoning as BMHs necessary to produce such objects independently, or that they shared the BMH capacity for learning and adaptation and assimilated these art forms from BMHs.

Finally, Neandertals had a system of burial that suggest

some ability to form beliefs and perhaps ritual. Though Neandertal burials were generally devoid of grave goods and artifacts present in BMH burials. Neandertals, however, were the only other hominid beside BMH that consistently buried their dead. Burials imply the knowledge of a difference between life and death, and suggest Neandertals may have in some way marked this difference through a ritualized act (Giacobini 2007; d'Errico 2007). The existence of ritual in Neandertals would denote a similar capacity to BMHs for abstract reasoning and learning. The question of Neandertal cognition, however, is still hotly debated, and no definitive conclusion on their cognitive abilities has been reached as of yet.

Discussion

Though the three types of cognition discussed in this paper are only three of many types of cognition necessary for creativity, they make up a very important combination. The three cognitions, abstract reasoning, learning, and recursion, are all interdependent. Learning gives a framework from which to reason abstractly. Learning also creates the structures used in the process of recursion, while abstract reasoning allows for recursion by supporting the unique application of existing frameworks to other situations.

Evidence from earlier hominids, especially Neandertals, shows that the cognitive substrates of creativity, particularly abstract reasoning, learning, and recursion, did not originate in BMHs. The manner in which they are utilized, however, is unique to BMHs (Wynn & Coolidge 2004). The archaeological record, particularly that concerning tool-making, suggests that most other hominids show the capacity for one or two of those capabilities (McGrew 1993). The lack of one of these interconnected cognitions would undoubtedly hinder the creative ability of a particular species in comparison to BMHs. There is evidence that Neandertals may have had all three of these cognitions. This evidence, however, is very scarce and often appears after contact with BMHs in the early Upper Paleolithic (Hublin *et al*. 1996; Mellars 2004). This suggests that Neandertals may not have had a full capacity for innovation, as they merely emulated BMHs. Though this emulation in itself requires the aforementioned cognitive capabilities, it hints that Neandertals may not have integrated these cognitions as BMHs had.

Examples of hypercreativity from the field of cognitive neuroscience provide unique insight into how BMHs might have developed creativity. Hypercreativity is present in mental illnesses such as schizophrenia and bipolar disorder (Folley & Park 2008; Ivleva *et al*. 2008). It is a contributing factor to hallucinations, delusions of grandeur, manic episodes, and other such imaginative symptoms (Folley & Park 2008). Schizophrenia and the mania associated with bipolar disorder are the result of frontal lobe dysfunction (Burch *et al*. 2006). The frontal lobe plays an important part in cognitive control and inhibition (Miller & Cohen 2001). When this inhibition and control is suspended, as in the case of these particular mental illnesses, creativity becomes overly expressed and negatively affects cognitive functioning (Folley & Park 2008). These instances of hypercreativity suggest that it is not the mere existence of cognitions that gave rise to creativity, but their control. Thus it may have been the ability to alternately inhibit and suspend the use of this control function that allowed creativity to develop as a functional aspect of BMH cognition.

Conclusion

Creativity in *Homo sapiens sapiens* developed in a relatively short amount of time during the Middle-Upper Paleolithic shift, and continued to develop throughout the Upper Paleolithic. Rapid innovations in tool-making industries, new types of art, and the advent of ritual beliefs signaled that mental processes such as abstract reasoning, learning, and recursion had become staples of higher cognition. During the Upper Paleolithic, a new type of hominid began to spread across the globe, one with an integrated system of cognition and a sophisticated method of cognitive control that enabled and enhanced creativity. Creativity continues to spark more innovations and new ideas in the same manner that took us from stone tools and cave art in the Upper Paleolithic to computers and cell phones in the modern age.

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