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Crossing the Latest Line: The Evolution of Religious Thought as a Component of Human Sentience

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Abstract

Big History understands change in the Universe as a continual process, and complex, named epochs seem less useful lately. Nevertheless, higher levels of organizational complexity do emerge. One of the latest levels is sentience on the hominin evolutionary line. Psychologists, anthropologists, philosophers, and theologians explore the nature of human sentience, which includes consciousness, self-awareness, desire, will, ethics, personality, intelligence, and 'sensibility', or social sensitivity, empathy, sympathy, insight about others, and a special kind of ability we call 'Matrix Thinking'. Do religious and scientific thought have common roots and ongoing connections? Is scientific thinking enhanced by a capacity for religious and artistic thought? Within a Big History framework, we explore the emergence of religious thought as a major foundation of sentience. As an anthropologist and a Catholic priest, we explore religious thought as an evolutionary adaptation with cognitive, emotional, and perceptual features that were acted upon by natural selection. When and how did that happen?

Keywords: *religion, evolution, Big History, sentience, archaeology, Homo sapiens, Matrix Thinking, art, science, semiotics.*

Our paths to Big History, like those of so many researchers who meet at interdisciplinary boundaries, intersect in a common quest to understand an evolutionary development that requires various branches of science, divergent paradigms, and different concepts and methods. Our focus is on the emergence and the future of the amalgamation of traits called 'sentience', which sprang up on the Earth along the hominin line of our species' evolution. The research on sentience suggests that it lies at the foundation of science, religion, and art, which are together the principal capacities that make us human.

We emphasize that we use 'sentient' instead of 'sapient' because the archaeological evidence is mounting that sentience in our Three Advanced Do-

mains of Thought – science, religion, and art – began developing before we became who we are now, that is, before we became modern *Homo sapiens* (Cosmides *et al.* 2010; Henshilwood *et al.* 2002; Wynn and Coolidge 2011; Wayman 2012). Some archaeologists and cognitive psychologists are now pegging sentience to the emergence of the genus Homo*,* which includes ancient men who pre-date modern *Homo sapiens*. Signs of sentience surely go back to 200,000 years ago, and may go back to 500,000 years (Pollard 2013; Pringle 2013).

Where 'ancient men' stop and 'modern men' begin is becoming increasingly fuzzy, especially since it appears that we are continuing to evolve biologically, and apparently at an increased rate since the advent of agriculture around 10,000 years ago (Cochran and Harpending 2010). The so-called 'Human Revolution', so long understood as a watershed efflorescence of art and culture at 40,000–45,000 years ago in Europe, appears now less of a 'bright white line'. Archaeological remains that signify art, religion, and compound technologies are found repeatedly in East and South Africa (McBrearty and Brooks 2000; D'Errico *et al.* 2005; D'Errico 2003), signaling a shift of sentience back into the Middle Paleolithic in Africa, beginning around 300,000 years ago.

Because of these finds, a sentient species on the hominin line may not have been *Homo sapiens*. We were interested more broadly in the systems-change brought about by the evolution of full sentience, which has, according to all sources, happened only in the later stages of hominin evolution, whether understood as 40,000, or a half a million years ago. Both of these dates are but a moment in terms of the age of the Universe, lying as they do on the very edge of the lip of the accelerating expansion of the Universe since the Big Bang.

Our Problem: Big Questions for Big History

Our primary task as a priest and an anthropologist was to understand, together, how religious thought might have developed, and how and why it became so fixed within the human psyche that children adopt a notion of God with little or no prompting (Barrett 2012; Knight *et al*. 2004), and counter-intuitive beliefs of supernatural agents are virtually universal (Van Slyke 2011). Ours was essentially a philosophical task based on six disciplines:

- archaeology, including interpretations of finds from traditional 'stones and bones' excavations, as well as re-creations in cognitive archaeology;
- psychology, especially cognitive psychology and the study of perceptions, but also thought experiments and re-creations in the style of philosophy;
- biology, especially the study of evolution through natural selection, and the metamorphosis of 'proper [original] functions' to 'actual [today's] functions' (Fiddick and Barrett 2001) (Table 1);

- population genetics, especially how genes arise, spread, stabilize, and disappear in human populations (Pollard 2013; Cochran and Harpending 2010);
- anthropology and the ethnological study of present-day hunter-gatherers; and
- the cognitive science of religion, a cross-disciplinary field that draws in thinkers from the physical and social sciences, as well as philosophy and theology.

Other authors examine the cultural evolution of religion from animistic traditions, through tribal societies, and into recorded history with the Great World Religions – Christianity, Judaism, Islam, Buddhism, and Hinduism (Bellah 2011). That was not our focus. We were interested in the earliest stages of man's development, when, we are convinced, science, religion, and art – what we call the Advanced Domains of Thought – developed sequentially, and eventually, largely in tandem to support each other. There may be other such domains, such as sport or cuisine, but we focus on science, art, and especially, religion. We were in search of no less than the essence of humanness, and religion has always addressed human problems, incorporated human tendencies, and relied upon the natural life cycle of the human species to perpetuate a belief system.

We want to be clear that when we say 'religion', we do not mean the practice of religion, but the capacity of the species for religious thought. When we 'test' religion as an evolutionary adaptation, we do so in the context of evolutionary science, and we emphasize that this is not a test for the content of religion – or, for whether God exists – or any demonstration of how 'true' specific religious beliefs may be. Whether God or other beings and spirits are 'real' is a matter of faith. Using modern hunters and gatherers as a model, hominins probably existed for many thousands of years, perhaps millions, with animistic notions but without a concept of God as we know it today in some of the Great World Religions.

In summary, our problem was to investigate what is known about human sentience and to imagine how religion came to play a central role in both the origin and development of sentience. We also had a special interest in methods used by researchers in a variety of disciplines. Experimental psychologists use laboratory testing to understand the role of cognitive skills in the development of religion. Archaeologists use re-creations of ancient activities, as well as new excavation, dating, and interpretive methods. Anthropologists catalog, compare, and contrast the few hunters and gatherers who survived into the modern era. Theologians and philosophers use thought experiments to delve into the depths of how humans reason, feel, and understand the relationships among man, his world, and God.

Some scholars call mankind the 'believing primate' (Schloss and Murray 2010) and 'born believers' (Barrett 2012) to emphasize the great ease with which humans acquire religious thought during childhood and even later. At this point in our knowledge of the evolutionary emergence of religion, we do not completely understand why this is true. However, we do know without a shadow of a doubt that we are the 'lone survivors' (Stringer 2012) of complex, multiple lines of hominin evolution, especially in East and South Africa.

Russell M. Genet (2007) calls mankind 'the chimpanzees who were thrown to the lions' and there is much truth in this label. Our biological, cognitive, social, and cultural origins are all founded on a rugged lifeway that lasted for millennia while we scavenged with archaic hand axes the big game brought down by the big cats. Only later did we develop massive, coordinated hunts of great herd animals. Yet, whatever the hunting style, a premium was clearly placed on intelligence, foresight and planning, communications with symbolic language and signaling, the development of external storage devices, creativity as a cognitive capacity serving many abilities, quickness afoot, the sharpness of our stereoscopic and color vision, and the usefulness of nature's very best multipurpose tool – the human hand.

Out of the extraordinary biological diversity found in the many subtypes of archaic man, who faced the challenges of adversity in Africa and elsewhere, only our human species survived into the modern era. What role religion played in that survival we are only now beginning to comprehend, but religion – in spite of its disadvantageous excesses and temporarily brutal quality when it goes awry – must have had a selective advantage because it is so strong and we are, to date, so successful. The success of modern *Homo sapiens* and the retention of religion as an almost pan-human, internally integrated, complex and adaptive capacity must be connected to our survival.

Toward the end-stages of Big History, from the Big Bang to the emergence of hominin sentience as the latest, fuzzy line to be crossed, we find adaptive excellence in both body and mind. The lines of men and women who survived on the African savannah and went on to conquer the remainder of Earth's land masses, skies, and Moon – those hominins who are our forebears and neighbors – surely must have found at least some succor in religious thought, and, we think, much more.

Methodology: Toward a Confluence of Thinking about Thinking

We embraced a fully interdisciplinary approach as the only way to make sense of the components of human sentience that we identified in the various literatures. There is a wealth of research results, hypotheses, re-creations, and thought experiments on the type of cognition that characterized early man, and the rela-

tionships among very special faculties or what we call 'Advanced Domains of Thought' – science, religion, and art. We chose to focus on these three faculties because we sensed, as we continued to delve into the archaeological record and the cognitive science of religion, art, and science itself (called 'technology' in many studies), that students of sentience were *all grappling with the same questions*: What makes us different? What is it about our thinking that makes man stand out from all other living and non-living things on Earth and in our solar system? What is it that makes the evolution of sentience even *eligible* as a candidate for status as a major change in the course of Big History?

We found convergence as our research continued: pieces here, concepts there, new terms for old talents that emphasized cognitive evolution, and discussions that suggested a coherent adaptive strategy underpinning science, religion, and art. That convergence would have found little support even twenty years ago.

Most surprisingly, we discovered that science, religion, and art were more alike than we supposed at first. Components of sentience that emerged from the literature and were identified broadly among many, many writers underlie all three of our Advanced Domains of Thought (Fig. 1, left column). The domains are unexpectedly similar, not only because of their cognitive and intellectual nature, but because of the sociability required for their full and best functioning, and the emotionality that seems always to accompany leaps of creativity, both great and small, in all three domains. Science, religion, and art are all fundamentally cognitive accomplishments that take place within a cocoon of social activities and sensitivities, and they rely on both internal and external emotional reinforcement, both real and imagined.

The three Advanced Domains of Thought are also supported by components of sentience that characterize each one better than the others: science, religion and art have their own special components (Table 2). However, the sameness of the general components of sentience for science, religion, and art surprised us, and it seemed to signal a 'sea change', a coherent, organized complex of mental processes that came under enormous selective pressure and evolved together to give early man enormous advantages in his new 'socio-cognitive niche' (Whiten and Erdal 2012). Some writers attempt to pin this to a single gene, a single point in time, a single 'revolution'. We do not believe that the evidence is yet available to confirm or refute these notions or to characterize the rhythm of genetic and population changes beneath the emergence of sentience, in a detailed manner.

In spite of the same underlying qualities we found for science, religion, and art, we found no specific time at which all the various components of sentience suddenly and obviously emerged together. If indeed there was a 'Human Revolution', as some have written (Mellars and Stringer 1989), it was a long war.

Archaeological remains from the Middle Stone Age and even the Early Stone Age in Africa are yielding new information when approached with new digging and dating methods, and new interpretive frameworks. Sentience continued to poke through the fog of time, from farther and farther back.

Who could have dreamed that insecticidal plant materials from sleeping beds found beside an ancient lake dating to 77,000 years ago would indicate hominins' extensive knowledge of local plants and probable pharmacopoeias (Wadley *et al.* 2011)? Who could have guessed that carefully punctured snail shells found in stratigraphic layers dating to 75,000 years ago would indicate body adornment and an artistic sense, and who could have imagined that 195,000 years ago there was an external data storage system on a specially prepared surface of red ochre with carefully incised hatch marks that indicated premeditation and care (Henshilwood *et al*. 2002)? Clear suggestions of symbolism, art, religious belief, compound projectile technologies, long distance trade, and population growth peeked through the haze from more and more distant points in time.

It is surely possible according to the findings of population genetics, that sentience evolved relatively fast (Venditti and Pagel 2008), but new archaeological findings push sentience back well into the Middle Stone Age in Africa, which suggests (1) a more gradual development, or (2) the presence of an ability that rarely found expression (perhaps because of low population levels), or (3) simply a paucity of archaeological findings. In general, evolutionary biologists are connecting sentience to the rise of the genus Homo – not the species *Homo sapiens* – and it seems more and more reasonable to include archaic men. How fast or gradual this occurred must await further evidence that lies hidden in the ground.

Some students of religion may cry, 'Heresy'! Others might cry, 'Spandrel!' that is, in the context of evolutionary science, a phenotypic feature that is a by-product of the evolution and selection of another feature, and not a direct product of natural selection, as would be the case for a true adaptation. We do not hold to the spandrel theory of religion, which considers human religion as an assemblage of individual features that evolved separately and then came together and formed 'religion' only of late (Gould and Lewontin 1979; Kirkpatrick 2008). Instead, we find religion to be true adaptation, that is, a complex, coherent, integrated whole that was under enormous selection pressure and that survived to the present day as a favorable adaptation. We test religion as an adaptation in the next section, and while the advantages of religion may change in the coming millennia, religion still imparts reproductive fitness in modern man.

While we sampled the archaeology, psychology, cognitive science, biology, population genetics, evolutionary science, and theology literatures widely, we fastened upon five scholars who each provided a key to man's 'crossing

the latest threshold' and emerging as a sentient creature. These authors often worked in interdisciplinary teams in which they were forced to shift or broaden paradigms in order to arrive at a synthesis – like us, a priest/astronomer and a biologist/anthropologist. Together, they paint a picture of early man as a creature who is conscious, self-aware, emotionally informed, wonderfully creative and self-decorating, and a species who tosses symbols about very easily. Early man probably was, as we are, exquisitely sensitive to social signals and utterly dependent on the social group for both learning and love.

Because of our interest in religion, we began with biochemist and physician-turned-theologian Robinson and Southgate (2010), who published an oft-critiqued article for the journal *Zygon* on 'God and the World of Signs: Semiotics and Theology', based on C. S. Peirce's work in semiotics (1931–1935). In spite of the problems with this article, it contains a gem regarding human sentience. Robinson and Southgate give an example of what they call 'entering the semiotic matrix', which means multiple comparisons inside a matrix grid, of different types of signs. They write:

> The type of cognitive process we are referring to is that familiar to us in the use of diagrams and metaphors, both of which are kinds of icon that depend on symbolic representations and are in turn capable of generating new conceptual knowledge. Crossing this semiotic threshold – entering the semiotic matrix – opened up the possibility of art… and ritual… The important point is that these juxtapositions of signs would have consisted not merely of sequential combinations of signs but of a creative dialectic between different types of sign (Robinson and Southgate 2010: 702).

The approach of these authors was the systematic juxtaposition of different types of signs within a general framework of belief, in their case, Christianity. However, we realized that 'entering a semiotic matric' would work in a much more general way with signs and symbols for any system of belief or any corpus of elements in any tradition of science, religion, or art, not just Christianity. We found that it was not necessary for the categories or elements to exist along a continuum or fall into a series of ranked categories, but they often do, and this adds to the potential of this method to create new cultural knowledge.[1]

Next, we found anthropologist and psychologist Wynn and Coolidge (2011) – another interdisciplinary pair – who wrote a paper called 'The Implications of the Working Memory Model for the Evolution of Modern Cognition', in the *International Journal of Evolutionary Biology*. The concept of working memory, especially 'Enhanced Working Memory (EWM)' has also

[1] Corbally Ch. J., and Rappaport M. B. *Visible Supernovae in A.D. 1054, 2054, and 3054: Inspiration for the Religious and Artistic of the Past and Future.* INSAP VIII: The Eighth International Conference on the Inspiration of Astronomical Phenomena, Hayden Planetarium, American Museum of Natural History, New York, July 7–1, 2013.

had its legion of critics. Yet, we believe this notion, which probably evolved from computer jargon for random memory, is useful. To us it means 'the mental space in which to do work', which was critical for sentience in finding its earliest, and its eventual full expression.

Wynn notes elsewhere that working memory means, 'the ability to hold something in attention while you are being distracted', and he believes that humans do not use working memory very often because 'it requires a lot of effort' (quoted in Wayman 2012). Wynn and Coolidge give a full range of evidence for Enhanced Working Memory, but they do not define it very well, so we were left with a notion that seems, to us, consistent with Robinson and Southgate's 'entering a semiotic matrix'. It is the 'mental space' to do complicated comparisons and contrasts, to test out new meanings and analogies, and to create new cultural knowledge.[2]

Next, we found an article by Fiddick and Barrett, two evolutionary psychologists working at the Max Planck Institute. They provide a good framework for characteristics that have been acted upon by natural selection. They use the terms 'proper functions' (*i.e.*, the original functions in an early hominin environment) and 'actual functions' (existing today). We go further in Table 1, by expanding our list of the components of sentience, and identifying what we believe are the 'proper and actual functions' of each component both in an early environment and in today's Global Society. Fiddick and Barrett suggest many of our tests for religion as an adaptation, in the next section. However, they were of most importance to us because they thought seriously about cognitive components being subject to evolutionary pressure. We liked that, and very much agree with their viewpoint. Our model of hominin sentience considers religion as a coherent, integrated whole that was acted upon by natural selection. This fits the archaeological data and is consistent with researchers working in the fields of cognitive evolution, cognitive psychology, and cognitive archaeology. We began to ask what kind of selective pressures might have been involved in the evolution of religion as an adaptation.

Next, we found Whiten and Erdal (2012), two psychologists who, in their article on 'The Human Socio-cognitive Niche and Its Evolutionary Origins' try to identify components of what they call 'Deep Social Mind'. This reminded us of our attempt to identify components of sentience from the literature. Whiten and Erdal focused on the social nature of the human evolutionary niche and emphasized how learning and creativity among hominins is facilitated by and dependent upon social interaction. We liked this because we believe that not only

[2] Rappaport M. B., and Corbally, Ch. J. *Advanced Domains of Thought as a Wellspring of New Knowledge for Our Coming Global Society.* Keynote Address for 'Interdisciplinary Studies: The Next 25 Years'. Pasadena, California, August 1–4, 2013.

are social factors important, but emotional factors are, too. We identified cognitive, social, and emotional aspects for our components of sentience (Table 3). Often all three aspects exist at the same time in the highest expressions of sentience – science, religion, and art. Dean *et al.* (2012) illustrated this very well in their article entitled 'Identification of the Social and Cognitive Processes Underlying Human Cumulative Culture', in which they emphasized the notion of 'cultural ratcheting', where learning is seen as essentially a social phenomenon, and individual members of human groups are encouraged by each other to tinker, change, explore, and try new things. They 'ratcheted up' the process of creativity until a goal was reached or a synthesis created. For them, this was how culture grew and accumulated. We liked their approach, too.

Finally, we found Van Slyke and he was a joy to read because his book *The Cognitive Science of Religion* (2011) was conversant with the latest archaeological finds, and he had no tendency whatsoever to a reductionist viewpoint. He clearly espoused a notion that we agree with very much – that emotional and social factors were as important as cognitive factors in the evolution of religion, or, for us, sentience, in general, including science and art. We believe that each level in the hierarchy of the sciences involves different rules and processes that cannot be reduced to elements of more basic sciences. We, too, espouse a non-reductionist, holistic approach, but not all Big History advocates would agree.

After reviewing our five scholars, we arrived at a concept that we called 'Matrix Thinking', shared by all sentient humans and to some degree by earlier, archaic men who came before us and were beginning to think like us. We see Matrix Thinking as the 'creative driver' of human sentience, through which hominins create new cultural knowledge. Other living hominins, including the great apes, show rudiments of some of the features of Matrix Thinking,[3] sometimes but not always, and not in their fully expressed form, as in man.

We realized that the different literatures from which we drew our principal concepts had been growing in a parallel fashion within different disciplinary boundaries – although they were stretching those boundaries through collaboration in interdisciplinary teams. We shall attempt to take one step beyond all these authors and draw together analogous lines of research. We will propose a commonality to the origins of science, religion, and art for members of the genus Homo, and then we will test religion with twelve specific questions, and ask whether religion fits the definition of a true biological adaptation, that is,

[3] 'Matrix Thinking' is a term also used in management training by Roger La Salle, who contrasts it with 'linear thinking'. This is not the meaning we use, instead relying on a context of evolutionary biology, archaeology, and the cognitive sciences. David Noel has a book entitled *Matrix Thinking*, published by Cornucopia Press, 1997, which describes 'how real-life situations operate in human society at every level', but there is little additional information.

a complex, integrated whole that responded to selection pressure and provided greater reproductive fitness for hominins who bore the adaptation. Finally, we address how religion lines up with the other Advanced Domains of Thought in a proposed chronology of evolutionary emergence along the line leading to modern *Homo sapiens*.

Results: Matrix Thinking

There is a special kind of thinking that is characteristic of the sentient beings. At some level, we all realize this intuitively, and we sense in non-human hominins a deep affinity and commonality with, for example, the great apes' more modestly developed sentience. We see reflections of sentience in our own mirrors, in the species closest to us, in severely disabled children and adults who have some components of sentience but not all of them. We know when we fail to see it but feel that we should see it, as in the eyes of the sociopathic killer or our latest smartphone whose AI sounds right, but not exactly right. It is a fine distinction that we make many times over the course of our lives, easily, unselfconsciously, as if we were born to recognize sentience – which we surely were. For each of us, sentience provides a very basic form of mental fitness that could be acted upon by natural selection. We learn to judge it early in our lives, and it guides our choice of a mate. The same must have been true for archaic men.

We know when we perceive sentience because it provides for its own recognition. It is noteworthy that the 'latest line to be crossed' in the unfolding of Big History provides a reflexive quality, a knowledge of itself, a mirror on its own development so that Big History can look back upon itself.

Matrix Thinking, we believe, is the ultimate expression of sentience in our hominin line of development – to date, because we are still evolving. It is essentially a cognitive capacity, one that depends utterly on the sociability of sentient beings, and therefore has emotional aspects, too. The seeds of sentience and Matrix Thinking evolved originally among small bands of the genus Homo, who pursued a hunting-and-gathering way of life, so sentience and Matrix Thinking conformed to the functions required by that lifestyle through the processes of both biological and cultural evolution.

While sentience stabilized in the new socio-cognitive niche of different bands of the genus Homo, our three Advanced Domains of Thought (science, religion, and art) came to be used in a wide variety of biologically and culturally determined expressions that continue to change through the accumulation of genetic mutations and new cultural knowledge. Matrix Thinking is the most creative aspect of sentience, but is used less often than it might be, because it requires effort, discipline, concentration, introspection, and both structured logic and free association. Sentience and its creative driver, Matrix Thinking, were *the ultimate adaptations* according to researchers in cognitive evolution

and cognitive archaeology. Once they took hold, they could not be beat because, in part, they made culture infinitely flexible, changeable, and accommodating to new environments. Matrix Thinking has played a central role in the success of sentient human beings and was shared, to a degree, by archaic men who came before us and were beginning to think like us.

Let us review Matrix Thinking as we have come to see it, based on our survey of the literature.

First, Matrix Thinking requires a certain minimal brain capacity – both in size and complexity, including connections between parts of the brain that guide social and emotional functioning, and the more advanced prefrontal cortex used in reasoning and planning – the so-called 'executive functions' (Wynn and Coolidge 2011).

Second, Matrix Thinking involves systematically bringing together different kinds of symbols, not just signs, but all kinds of symbols, as well as processes laid bare through introspection and observations of natural phenomena.

Third, Matrix Thinking involves the juxtaposition of symbols in a mind that can hold different types of concepts in the consciousness and focus upon their differences, similarities, and connections for an extended time without distraction. It takes effort. Robinson and Southgate's 'semiotic matrices' were fine examples (2010: 698 and 701), but there are other graphic configurations that work just as well, for example, a diagram on the 'classes of social cognition in hunter-gatherer bands' and the relationships between them in Whiten and Erdal (2012: 2122), or the more compact language version of Matrix Thinking found in everyday metaphors.

Fourth, Matrix Thinking takes place within a world of social and emotional validation, and offers various satisfactions of an intellectual, social, and emotional type. In turn, social and emotional reinforcement provides additional motivation for Matrix Thinking.

Fifth, Matrix Thinking results in new models, new analogies, and new creations that have new characteristics, which are observed or manufactured, real or imaginary, naturally occurring or culturally invented.

Sixth, Matrix Thinking shares with its most common medium, human language, the virtually infinite *re-combinability of elements.* Matrix Thinking takes this basic feature of human language and extends it to every tradition of culture and belief. In Matrix Thinking we combine not just phonemes and morphemes. We combine and re-combine all symbols and signs.

Seventh, Matrix Thinking is a wellspring of new cultural knowledge for the coming Global Society,[4] while we continue to evolve culturally and biologically at an ever faster rate (Cochran and Harpending 2010).

[4] Rappaport M. B., and Corbally, Ch. J. *Advanced Domains of Thought as a Wellspring of New Knowledge for Our Coming Global Society.* Keynote Address for 'Interdisciplinary Studies: The Next 25 Years'. Pasadena, California, August 1–4, 2013.

Sentience is the latest line to be crossed in Big History, and much of sentience relies on Matrix Thinking, but not all of it. A sharper focus on religion will uncover features of sentience that lie outside of Matrix Thinking – human capacities such as awe, wonder, reverence, obedience, and ecstasy (Table 2). These features are always available to assist in making new cultural creations, for example: a new component of an old religious ritual; a new religious fable to teach children about acceptable behavior; a new cautionary tale to explain a cataclysm on Earth or a new star in the nighttime sky.

Results: Religion as an Adaptation

We claimed in the previous section that religion, as an Advanced Domain of Thought, is on a par with science and art, and all are adaptations. We do not see religion as a by-product of another hominin capacity, but as a complex, integrated set of traits that stands on its own as a response to evolutionary pressure. To support this claim, we examine twelve tests for the capacity of religion, or religious thought, as a bona fide biological adaptation that was shaped and molded through natural selection. Many tests were suggested by Fiddick and Barrett (2001).

Test 1. Is there an economy and efficiency of design in developmental mechanisms related to religion, as expected from an evolutionary view of cognition? Is it easily and naturally acquired by children?

Learning any religion during childhood is very easy. The type of religion depends on the child's social group. The notion of 'God' comes naturally for children, even when they are not prompted. While counter-intuitive, spirits are easy for children to believe in.

Test 2. Are developmental mechanisms for religion flexible and able to accommodate a wide range of novel inputs at the same time that they have 'functional specialization' or 'special design'? Does it develop in efficient, precise, and reliable ways?

Religion is learned and flourishes as a coherent whole, in spite the vagaries of childhood development, inconsistent teaching by adults, and often in the face of societal upheaval. Traditional religious stories can incorporate novel events in both childhood and adulthood without challenging the integration of the whole. Religion changes, but usually slowly. Its persistence, coherence, and consistency suggest the 'special design' of a true adaptation.

Test 3. Is the adaptive nature of religion still clear when its development goes awry? The absence of which components of sentience prevent full development of religion?

The Jonestown cult in Guyana, 1978, is an example of 'religion going awry' due to a lack of introspection, discernment, ethics, and wisdom. While it had some surface features of religion, it was not essentially prosocial. It is true

that religion can be co-opted for political goals (*e.g.*, Third Reich, 1930s–1940s), but their alliance never lasts unless it is ultimately life-giving and group-enhancing.

Test 4. Which components of sentience appear most important in the full and adequate development of religion? Why and how?

Components of sentience of a more social nature – especially insight into the self and others, social sensibility, and charity – are used to encourage group participation, as well as seemingly 'personal' devotion that always, we contend, takes place in a social context. While social components are extremely important for religion, the most complex and inclusive components for religion are ethics, wisdom, and symbolic inventiveness (Matrix Thinking).

Test 5. Does religion make use of the information structure of the environment, so that there is reason to believe natural selection would favor it in early hominin environments? Are there cognitive mechanisms that could aid a mobile species in accommodating to a heterogeneous and changing environment?

Through ritual, religion encourages group participation in hunting and gathering, and incorporates taboos to guard the wellbeing of group members. A mobile species makes certain locales 'sacred', with practical consequences, like avoiding dangerous environments or the contagion of dead bodies. Ritual cleansing symbolizes a purity of body, mind, and soul, and together, they confer physical and mental health, ideally.

Test 6. Are there cognitive mechanisms related to religion that impact reproductive success? Do they help hominins solve real problems in their environment, now and in the past?

Religious participation and ethical decision-making enhance an individual's appeal to other group members and aid, therefore, in the competition for sexual partners. Religion helps to drive and organize economic activity in all types of societies, from primitive to complex, and in all social levels of advanced societies.

Test 7. The structure of an evolved capacity like religion is explained most fully by its 'proper' (original) functions, so it is necessary to envision problems among early hominins that could be solved by cognitive mechanisms related to religion (Table 1). What were the 'proper' functions of religion – those which allowed it to be perpetuated over many generations and to organize internally in response to selection pressure?

Religion explains the origin of man and the cosmos, and reduces anxiety about poorly understood natural phenomena. It proscribes some behaviors and prescribes others. Beliefs in spirits help to explain motivation and personality in other hunter-gatherers, and ritual lends a sense of control. Religion provides symbols of group solidarity and rationalizes the group's actions. It encourages obedience to leaders and the elderly, and values their knowledge and wisdom.

Many studies show that religion has potentially beneficial effects on brain function, anxiety, depression, and health.

Test 8. Is there evidence that the human mind has domain-specific inference mechanisms for solving the sorts of problems that confronted our distant ancestors?

Yes, but a great deal more information on the cognitive, perceptual, and emotional components of religion (see Table 3) will follow from laboratory results in psychology and observation of hunter-gatherer cultures, as well, possibly, as genome comparisons of early and modern hominins, as techniques for re-creating ancient DNA improve.

Test 9. Do the cognitive mechanisms related to religion continue to assist the human species today? How? Are there 'actual functions' related to this capacity, or are traits better interpreted as either by-products or random?

Religion continues to support group solidarity and individual humans in times of calm and crisis. It gives meaning to human existence and reduces anxiety. It controls, organizes, and gives vent to fluctuations in genetically based features of temperament in still-evolving modern populations (Cochran and Harpending 2010). It explains them, channels them, and provides succor when they spin out of control. With its clear functional specificity, religion is not a 'spandrel' composed of independent features that evolved separately, but a complex integrated whole, whose central features are neither by-products nor random.

Test 10. The hallmark of an adaptation is functional specialization. Is religion 'functionally specialized'?

Religion is effective in regulating human behavior within a flexible code that allows variation and explains deviation. Religion is remarkably persistent among all human cultures. It organizes activities according to a sacred calendar, and so makes the seasons, sources of food, and human behavior seem more predictable.

Test 11. Is there evidence of 'special design'? Are cognitive mechanisms related to this capacity functionally complex and designed to solve specific problems?

The ubiquity of religion argues for its status as an adaptation with 'special design'. It provides answers to pan-human questions, explaining the inexplicable, and organizing specialized components of sentience (awe, wonder, adoration, reverence, and sometimes ecstasy), to soothe humans in conflict and crisis, often with ritual (*e.g.*, chanting and the rosary). Religion helps to organize and rationalize costly economic behavior and war.

Test 12. Does the role of religion gain stature as an 'adaptation' due to its incorporation of a large number of the 'components of sentience' that appear in humans, but no other species on Earth?

Yes, sentient hominins have all the components simultaneously and they are all potentially related to religion. Our closest relatives, the great apes, have a few rudimentary components, but evidence is very weak and fragmentary for sentience, or for cultural 'ratcheting' and cumulative culture (Dean 2012).

While our perspective on religion will not satisfy some people, we believe our responses to these standard tests for a biologically based adaptation through natural selection are consistent with the findings from archaeology, psychology, ethnology, and biology, and that they will be confirmed as the evidence accumulates even further.

Results: A Timeline for the Emergence of Religious Thought

Our analysis of religion as a bona fide adaptation suggests a sequence for the emergence of our three Advanced Domains of Thought in the genus Homo. Fig. 1 illustrates the sequential development of Science, Religion, and Art, and their overlap.

Science evolved first to aid a lifestyle of hunting-and-gathering on the African savannah. Then, we propose that religious thought evolved second to support group solidarity and explain the cosmos. From a certain perspective, the archaeological evidence for religion is the leanest, but that is true only if you interpret each find as an individual object. Grave offerings are clearly indicative of a belief in an afterlife, and therefore a belief in the supernatural. However, what about carefully punctured shells of the same size that were clearly used for adornment, and pigment processing as evidenced in red ochre and the materials to grind it? These kinds of findings suggest ornamentation of the self with objects of value, and religious beliefs help to define what is valuable. That kind of leap cannot be too far-fetched if we look at our own behavior in the modern era, else why process pigment and carefully puncture like-size shells, at all? Then, it appears to be an easy step to suggest that ornamentation, because of its sign of 'specialness', might well be involved in religious (for early man, perhaps animistic) thought and ritual. For any present-day or archaic members of the genus Homo, this does not appear unreasonable. As we view the archaeological evidence from our own vantage point in time, we might well wonder why art, ornamentation, religious belief, and religious ritual *might not be joined*. They certainly are for all known cultures. The record of 'stones and bones' is now being very creatively augmented through re-creations in the relatively new field of cognitive archaeology (De Beaune, Coolidge, and Wynn 2009).

Finally, we propose that art developed last, and for most of the evolutionary history of the genus Homo, art remained entwined with science and religion, and served to support them. For archaic men, tools were painted and incised as surely were cave walls. Strung shells and teeth adorned the body, along

with red pigment, and were probably used in some kinds of ritual. It was not until the modern age that art more fully disengaged from the practical concerns of life and developed traditions of its own that were unconnected to economic pursuits and religious ceremonies. Yet, in some ways art remains firmly attached to them through patronage for the arts, support for 'politically correct' forms of art and non-support for the more radical forms of art that have not yet wormed their way into the mainstream of society.

Conclusion: Crossing Big History's Latest Line

In conclusion we will summarize the primary connections between our work on human sentience – especially Matrix Thinking – and Big History.

Big History approaches the past by describing it not simply from a human perspective, but in the context of the evolution of the entire cosmos. Big History has only become possible with the advent of modern science, and yet the term was appropriately coined by a professor of history, David Christian (2004), who developed a cross-disciplinary course at Macquarie University, Sydney, Australia, in the 1980s. It has three distinctive features (Christian 2009).

First, it includes the whole of the past, from the Big Bang to the present day. It tells an all-encompassing epic story in which individuals, communities, and indeed everything in the universe, can find its place. Second, it is a scientific story. It stands or falls on the best data and chronometry available from all the sciences, and the most-testable interpretations and theories conceived. Finally, it is global, galaxy-wide, and cosmic. It does not rely on a particular cultural tradition for its proof, but should be acceptable in Rome or Moscow, Tucson, Paris, or the Polynesian Islands, and even in the Andromeda galaxy.

Big History ushered in a revolution in the understanding of our humanity, including projections of our future. When it proposes future scenarios, they must remain scientifically based. It assumes that current data and their trends will guide these projections. Since these data and projections will be global, they have the potential of uniting humanity.

Within this Big History framework, we have explored the emergence of religious thought as a component of sentience and focused upon its most unique form of thought, Matrix Thinking, which unites science, religion, and art, just as they are united in the archaeological record. Now, our goal is to use Matrix Thinking self-consciously, going forward, for the benefit of us all.

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Appendix

Table 1. 'Proper functions' and 'actual functions' of general components of sentience (definitions 'proper functions' and 'actual functions' are from Fiddick and Barett 2001)

Components Of Sentience	**Proper Function in an Early Hominid Environment**	**Actual Function in Today's Global Society**
Consciousness	To enhance sexual selection	**The Self in the Group** Patriotism Ethnic group and nationalistic identification Mass movements Cults
Awareness Self-awareness	To enhance group solidarity	
Desire Will	To enhance scavenging (early hunting)	**Economic and Political Strategizing** Participation in and leadership of voluntary organizations Political participation, leadership, and campaigning Competition among ideologies Social media presence Growth in democratic process Homogenization of middle class values worldwide International commercial competition Multi-national corporations The United Nations and its commissions International crime syndicates Campaigns to improve the status of women, life expectancy, child health and nutrition Some environmental planning and change
Personality Prudence	To enhance gathering food and materials	
Introspection	To enhance defense	
Concentration without easy distraction	To enhance aggressive actions, when necessary	**Intellectual and Moral Life** Participation in multi-state and worldwide religious organizations Growth of educational and intellectual opportunities. Learning how to learn. Becoming well informed with internet media. Expansion of civic responsibility. Archiving human intellectual accomplishments. World Heritage sites. Search for Earth-like planets; SETI program. Big History. Informing Science with the Arts.
Symbolic thinking Intelligence	To enhance sexual selection	
Ability to anticipate the intentions of others Insight Sympathy Empathy	To enhance group solidarity	
Social sensibility Charity Capacity to fall in love	To enhance scavenging (early hunting)	**Social Life** Participating fully in family life, learning how to read social signals, and care for others physically and emotionally Being charitable in word, deed, and feeling Expanding identification to include all humans, not just the immediate "in-group"; some expand this to other living things, and to "the Earth" Valuing social knowledge accumulation in sub-cultures, lifestyles, and local, internet, and cross-national communities of all types Nurturing love of all types, and appreciating the importance of love in interpersonal relationships Reconciling opposing social values, and incorporating them into a larger synthesis Allowing emotional, social, and spiritual factors to weigh against strictly rational, expedient, and utilitarian factors Joining communities of faith
Ethics Wisdom Matrix Thinking	To enhance gathering food and materials	
	To enhance defense	
	To enhance aggressive actions	

[a]Fiddick and Barrett 2001.

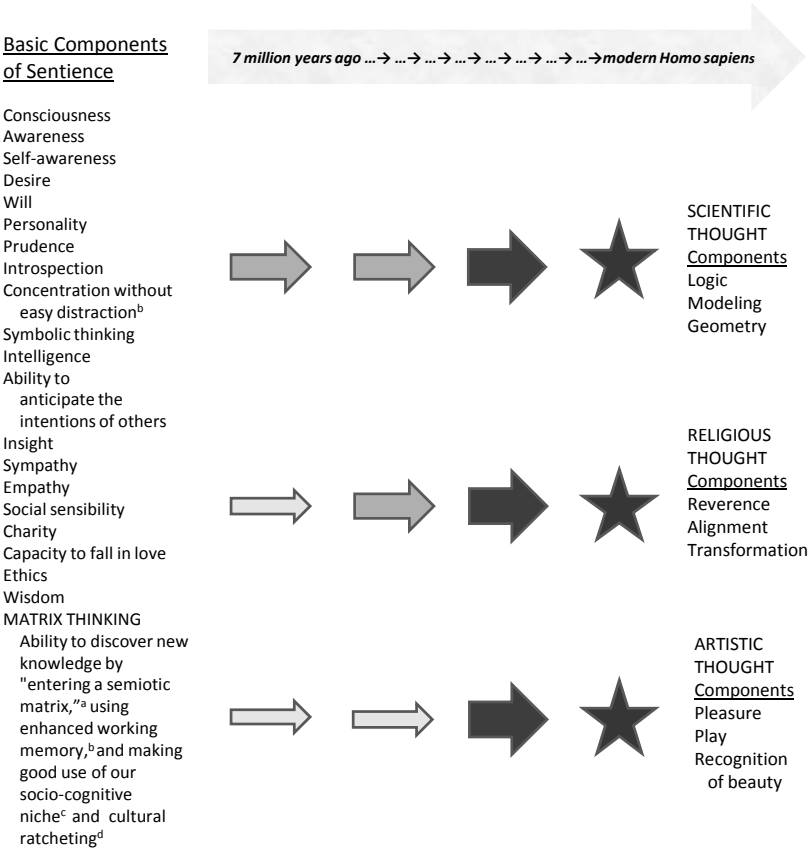

Fig. 1. Evolution of advanced domains of thought in genus Homo ([a] Robinson and Southgate 2010, [b] Wynn and Coolidge 2011, [c] Whiten and Erdel 2012, [d] Dean *et al.* 2012)

Table 2. Components of sentience for three advanced domains of thought

Components of Sentience: Scientific Thought

- Logic and the recognition of cause and effect
- Manipulation of symbols
- Conceiving a timeline
- Recognition of empirical data (even if fallacious) and assigning meaning to it
- Recognition of imperfectly similar events or objects (through comparison) and extrapolation to new cases
- Ability to form explanations
- Skepticism
- Numeric ability
- Geometric ability
- Multidimensional imaging
- Modeling and manipulating formulas
- Matrix Thinking

Components of Sentience: Religious Thought

- Awe and wonder
- Belief in supernatural spirits or beings
- Adoration
- Reverence
- Obedience
- Endowing ritual with symbolic meaning
- Alignment, or continual comparison with a moral code; planning one's life according to that code
- Introspection, concentration, and meditation
- The habit of prayer
- Religious transformation, or achieving a deep selflessness and being filled with a supernatural presence
- Achieving an ecstatic state (an altered state of consciousness) to interact with the supernatural
- Matrix Thinking

Components of Sentience: Artistic Thought

- Pleasure
- Play
- Recognition of beauty (and genetic quality) in symmetry
- Recognition of beauty (and health) in color
- Recognition of beauty (and sexual receptivity) in form
- Recognition of beauty in sound patterns
- Recognition of beauty in composition
- Recognition of beauty in asymmetry
- Self-correction, continual editing
- Purposeful synesthesia
- Symbolically attaching features of Art to Science and Religion
- Matrix Thinking

Table 3. Cognitive, perceptual, and emotional features of sentience components (sentience components include: Δ cognitive dimensions, ρ perceptual dimensions, ∞ emotional dimensions)

Component of Sentience	**Definition in an Ancestral Hominid Environment**
Consciousness	Δ ρ Perceiving the self as distinct
Awareness	Δ ρ Perceiving the self as a group member
Self-awareness	Δ ρ Perceiving the self as distinct group member
Desire	ρ ∞ Perceiving something as attractive and holding its attainment in mind for a period of time
Will	Δ ∞ Setting a goal and holding it in mind in the face of opposition
Personality	Δ ρ ∞ Extraversion, openness, agreeableness, and conscientiousness Example: Planning and leading a hunt
Prudence	Δ ρ ∞ Balancing risk vs. gain, and tolerating "holding back" Example: Planning strategy for a hunt
Introspection	ρ ∞ Prudence directed inward, self-correcting of will and desire
Concentration without easy distraction	Δ Staying focused Example: Tracking game or moving in a pattern for a gathering foray
Symbolic thinking	Δ ρ ∞ Substituting mental constructs for larger ideas, and manipulating them in the Advanced Domains of Thought (Art, Science, and Religion)
Intelligence (intellectual, social, and emotional)	Δ ρ ∞ Analyzing, weighing, and judging social and environmental factors rapidly with specific goals in mind
Ability to anticipate the intentions of others	Δ ρ ∞ Perceiving, evaluating, and making conclusions about other hominid intentions -- group and extra-group
Insight	Δ ρ ∞ Discerning covert and underlying relationships among people and environmental factors, and weighing them
Sympathy	∞ Understanding the problems others experience
Empathy	∞ Identifying deeply with others and the problems they experience
Social sensibility	Δ ρ ∞ Using emotional intelligence for group goals, and allowing emotion to inform intellect and rational processes
Charity, or values-based altruism	Δ ρ ∞ Example: valuing and protecting aging group members for their knowledge
Capacity to fall in love	Δ ρ ∞ Bonding with awe, wonder, and adoration with a mate
Ethics	Δ ρ Balancing different values
Wisdom	Δ ρ ∞ Balancing values with insight about social and emotional utility
Matrix Thinking: The ability to develop new cultural knowledge	Cultural Creativity Example: Incorporating a new supernova (eg, "Crab") in an existing pantheon of spirits. Example: Changing kinship and marriage rules to adopt an extra-group member. Example: Tracking a newly encountered type of game, or, in a new environment.