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An Evolutionary Model of Early Theology When Moral and Religious Capacities Converge

--Manuscript Draft--

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To: **Dr. Ernest Thomas Lawson, Editor-in-Chief**
Journal of Cognition and Culture

Dear Dr. Lawson,

It is our pleasure to submit to you today a manuscript entitled, **"An Evolutionary Model of Early Theology When Moral and Religious Capacities Converge"**. This work represents an extension of a line of theoretical work published in *The Emergence of Religion in Human Evolution* (Routledge 2020).

We were drawn to your journal by a publication we found on ResearchGate: "Evolution of the Parietal Lobe in the Formation of an Enhanced "Sense of Self": The Neuropsychological Foundations of Socialization, Prosocial Behaviors, and Religion" by Cohen and Johnstone, volume 24(1-2):91-120. The discussion is similar in many ways to that in our book, *The Emergence of Religion in Human Evolution* (2020, Routledge).

We we also drawn by the due consideration of data from cognitive science, neuroscience, paleoneurology, and evolutionary theory in discussions of religion, morality, and the self.

The present submission is an extension of our theoretical work in the Routledge book. We analyze the emergence of "theological thinking" using the same types of data from a wide variety of modern sciences, including paleoneurology. There are five tables embedded in the double-spaced submission.

We are happy to address questions from your reviewers, and make revisions.

Thank you for considering our work. Potential reviewers are listed below. They come from a volume on cognitive archaeology. Of course, others may serve just as well.

Yours truly,

Margaret Boone Rappaport PhD (corresponding, first author)

Christopher J. Corbally, SJ, PhD (second author)

Potential reviewers are listed here. They are specialists in religion, cognition, and evolution. We do not personally know any of them, but their work appears in *Cognitive Archaeology and Human Evolution*, Cambridge University Press, 2009.

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Hypothesis

An Evolutionary Model of Early Theology When Moral and Religious Capacities Converge

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ABSTRACT

This analysis summarizes conclusions on an evolutionary model for the origin of moral and religious capacities in the genus Homo. The authors' published model (2020, Routledge) is now extended to the emergence of nascent theological thinking, augmenting the previous line of theory based on genomics, cognitive science, neuroscience, paleoneurology, cognitive archaeology, ethnography, and modern social science. This analysis concludes that findings support the earliest theological thinking in *Homo sapiens*, but not in an earlier species, *Homo erectus,* and clarifies why and when it likely began. Types of anatomy, behavior, neurology, and cognition are presented that support tendencies to frame a structure of religious principles and a set of supernatural figures that early humans would consider right, just, exemplary, and even sacred. Stages of emergent physical, behavioral, and cognitive features are presented in tables. While based on published research results in the sciences, the model is presented here with anticipation of future testing.

KEY WORDS

theology, neuroscience, paleoneurology, cognitive archaeology, theological creativity, counter-factual thinking, prayer, preaching, art, music, precuneus

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> The change from one stable equilibrium to the other may take place as the result of the isolation of a small unrepresentative group of the population, a temporary change in the environment which alters the relative viability of different types, or in several other ways...
>
> J.B.S. Haldane (1932, 56) Ch. IV, *The Causes of Evolution*

1. Introduction

Species in the genus Homo did not always have theological thinking, i.e., a capacity to formulate theories about the relationships between humans and the supernatural, and to use those theories in determining rules of human behavior, including ethics, and in practicing related symbolic rituals. Definitions of "theological thinking" and "theology" have varied through history and by culture and level of socioeconomic development. For example, Saint Anselm of Canterbury (1033-1109) was known as the "Father of Scholasticism". He could easily be seen as an early philosopher who pre-dated today's scholars in "systematic theology". His definition of theology might be stated as "faith seeking understanding". Indeed, definitions of theology vary widely between "the faithful" and those outside a specific faith.

In this analysis, there was a need to view theology as broadly as possible, so as to include all human groups in all cultures, at all time periods, beyond a traditional Judeo-Christian framework, and one that encompasses non-modern, tribal, and prehistoric human beings. Because of these requirements, we settled upon a very broad definition of "theories about the relationships between humans and the supernatural". All cultures develop these "theories" about the "way things work" among human beings and spirits, gods, or beings who are outside, beyond, or above the natural environment. Belief systems about these realms and beings are codified orally or in writing as theologies, and they are passed down from generation to generation, and their histories are often used as teaching examples. Theologies are changeable, but appear to change slowly, theoretically imparting a sense of stability to social groups of humans. This definition reflects the needs of today's sociologists, anthropologists, and

psychologists, and even—as we shall we—today's new cognitive archaeologists (e.g., Coolidge and Wynn 2009; de Beaune, Coolidge, and Wynn 2009).

In this analysis, it is assumed that there were precursors in the long course of physical, cognitive, and cultural evolution of humans, before the capacity of theological thinking arose. Two models are summarized upon which theological thinking rests: (1) a model for the emergence of moral capacity in *Homo erectus* (ancestor to *Homo sapiens*) and (2) a model for the evolution of religious capacity only in *Homo sapiens,* which relies upon specific archaeological and paleoneurological findings. These models set the stage for the eventual emergence of theology—complex theories about humans and their relationships with the supernatural, and involvement of the supernatural with the natural and social worlds. It is likely that *Homo erectus* already had some emergent features that would give rise to modern humans' religious and theological repertoires. Models for the emergence of moral thinking here suggest that *Homo erectus* might have enjoyed storytelling, ritual, chanting, and percussion. The species likely had features supporting the capacity of moral reasoning and moral adjudication of their fellows' behavior. However, *Homo erectus* probably did not engage in theological thinking. The neuroscience that supports this contention is explored in the following discussion, along with differences between a member of the genus Homo who displays theological thinking, and one who does not.

1.1 Hypothesized Physical Markers of Religious Capacity

The emergence of theologies could begin in a rudimentary way only with *Homo sapiens*' expanded and globular skull shape, which appeared more than 300,000 years ago (Hublin et al. 2017), and stabilized around 150,000 years ago, although others have recently suggested later

dates (Neubauer, Hublin, and Gunz 2018). Emiliano Bruner and colleagues (2013; 2016; 2017) demonstrate clearly, with contemporary research methods, that our globular skull shape is primarily the result of the enlargement of the precuneus, part of the parietal lobes. The theological model presented here relies on the hypothesis that theological thinking arose due to an expansion of the parietals, especially the precuneus, which manage important aspects of theological thinking, including the human capacities to conceive and experience supernatural beings with all the characteristics common to God in the Judeo-Christian traditions, or other divine beings in Eastern and tribal societies. Members of different cultures evidence theological capacity in different ways. For example, transcendence is perceived as an aspect of the self and of Buddha in Buddhism, but usually as an aspect only of God in Christianity. Irrespective of these differences, the characteristics of a theology remain remarkably uniform from culture to culture, in ways both fundamental and pervasive, for example: (1) an oral or written history of supernatural beings, spirits, gods, and humans with quasi-supernatural origins, as well as stories about their exploits, and instructional lessons; (2) oral and text documentation of these stories, persons assigned to storing and retaining them for their social group, and methods for passing them from generation to generation; and (3) structures of principles, rules, and ethical reasoning that individuals can study, learn, and use in their own lives. This equivalence of theologies alone goes far in supporting a common evolutionary origin for theological thinking, in the manner that Christiansen and Müller (2014) illustrate so well for human languages, through the process of cultural neural reuse, i.e., the fixation of neural pathways to serve specific purposes, through repeated use during development and eventual fixation in the adult. The process relies on a high level of plasticity in modern humans (Gómez-Robles and Sherwood 2016).

1.2 Religious Capacity as a Species Trait

It is important to remember that the cognitive science, neuroscience, and human genomics of religious capacity have only barely begun to be identified. Our general thrust has been to suggest that religious capacity is a phenotypically variable, but reliably produced trait—which satisfies important criteria introduced by Fiddick and Barrett (2001). Religious capacity is a cognitive trait that is exceptionally elaborate, drawing upon many identified, and as-yet-unidentified neurological capacities. The multiplicity of the brain's many capacities (possibly numbering in the "thousands") receives highly credible corroboration from neuroscientist Michael Gazzaniga (1999). Here, it is proposed that not all humans have religious thinking, the trait, and some of those who have the trait, choose not to express it or to engage it behaviorally. Religious capacity is optional, like the use of mathematics, or reading.

1.3 Religious Capacity as a Possible Adaptation: It Depends on the Environment

There has been much discussion as to whether religion is a "true adaptation" (Fiddick and Barrett 2001, for guidelines on defining an "adaptation"). Ours is a somewhat contrarian viewpoint that understands moral capacity, religious capacity, and the resulting theological capacity as biologically based traits of modern *Homo sapiens*, irrespective of their adaptive nature. In other words, throughout the literature there is an implication that religious capacity had to be useful to the survival of the species. We do not agree that it necessarily was, especially at first, but it also could not be lethal. It is proposed here that it became useful to the social group eventually, and remains so, but at first, it may have appeared aberrant, odd, and perhaps not useful at all.

In one environment, a trait is "somewhat adaptive", and in another environment it is "highly adaptive". In yet a third environment, it is "neutral". In the higher Primates, the evolution of some types of traits involves complex cognitive feedback loops that make populations on the human line actors in their own evolution (i.e., neural reuse theory). A variety of researchers are coming, tentatively, to see the domain of human cognition as an area in which traits can be encouraged by use and reuse of a faculty irrespective of its adaptive nature either then, or now, or in the future. Nature does not "foresee" the usefulness of cognitive skills that might emerge for random reasons, or no reason. Adaptation can be a random process especially in small groups where there is considerable inbreeding. Early humans and their immediate ancestors lived in small, primarily terrestrial groups for many thousands of years, if not over a million and a half years, if one includes the tenure of *Homo erectus,* who was a ground-dweller. Earlier, *Homo habilis* was probably a tree-dweller who spent considerable time on the ground scavenging for food, but slept in arboreal safety in the trees at night (Coolidge and Wynn 2009, 128-150).

Evolution can be a random arbiter, until humans come to see some habit as particularly useful or enjoyable, and so they behaviorally select it. Bruner and Iriki describe the process this way: "Once a novel, alternative, and bistable state is associated with increased fitness, additional resources will be invested to stabilize the system, probably generating further redundancy. Humans can induce such a loop directly and actively…" (2016, 103). That process is human-directed neural reuse, and it is still not widely accepted because it seems contrary to Darwinian evolution. However, it is similar to many of the processes now seen in the Extended Evolutionary Synthesis, which follows Darwin's enormous accomplishment and introduces new concepts and processes that are not random or always random (Van Arsdale 2017; Lange 2023).

The position is taken here that religious capacity succeeded, eventually (perhaps not initially), in at least one sense of "an adaptation". All religions support the social group. Its ability to unite, to encourage humans to function willingly in specific roles, and to endeavor to survive in current or potentially future environments—are all especially noteworthy. If this capacity encourages spiritually meaningful lives and helps to guard against depression, then the affected lives will eventually have increased fitness in the more traditional sense. Psychologically dysfunctional states tend to reduce fecundity in human populations (McFalls 1979; 2012), so religious thinking could, theoretically, determine life and death, thriving or decline. However, these are rather simplistic views of the complexity with which religion functions in modern societies.

1.4. How Religious Capacity Could Survive *without* Initial Adaptiveness

Because it is not possible for future environments to be anticipated in the long march of evolution, it is not teleological in any way. Some traits emerge and remain unimportant until they are suddenly needed in a new environment. In a sense, they are "stealth traits" that remain hidden sometimes for long periods.

It is not necessary for a biologically based trait to be openly, obviously, and overwhelmingly advantageous to survive in successive gene pools, especially if groups are small and there is much inbreeding. What is necessary is that *it is not lethal*, which many mutations are. The human line, as a branch of a Miocene ape population from which modern apes probably also came (Begun 2016). Populations survived with an enormous reduction in genetic diversity compared to the large, ancestral Eurasian ape population from which they all originally emerged.

Humans who now number in the billions still reproduce as if they were a population of 10,000 (Harpending et al. 1998; Harris 2015, 39). The human line lost a great deal of genetic diversity, and yet we survive as a successful species that is more adaptive, by some measures, than any other. Why? How? How did we survive with less diversity and yet become so flexible and successful? It is an interesting question with many different interconnected answers.

1.5 Population Genetics Suggests an Origin of Religious Capacity in Genetic Drift

Because the populations of ancestral humans were small, genetic drift was much stronger in relation to natural selection. This can be read as: "Natural selection was not strong." The concept of genetic drift is basic to the field of population genetics, and it refers to the chance disappearance (or appearance and potential spread) of genes because a population is small. It implies substantial inbreeding and is viewed as the "opposite" of natural selection. The important takeaway for this discussion is that, where natural selection is absent or muted, genetic drift is strong. In small populations, slightly deleterious genes are easily retained because of inbreeding. Where natural selection is strong, as in the large population now on Earth, genetic drift becomes weak. The two processes function like a "seesaw".

Population genetics has now been applied to the genomes of humans and other Primates. Harris has an excellent overview of this development (2015). Studies show that humans today have vast quantities of "neutral" genetic material, i.e., it was not positively selected (Lachance and Tishkoff 2013, 136). Humans have much more neutral genomic material than other higher Primates. That excess neutral material may be because of genetic drift, which was so dominant for so long. In such a history of small populations, it is conceivable that a substantial number of

deleterious or slightly deleterious traits would survive, and that certainly is confirmed by human health studies today (Lieberman 2008; 2013; O'Bleness et al. 2012).

Here, it is hypothesized that where drift was allowed to operate, some unusual, and perhaps some very beneficial traits arose and were not eliminated by natural selection, even if initially they seemed maladaptive, because natural selection was weak. They persisted and in some cases were crafted into socially useful biocultural faculties by the growing influence of cultural capacity, which came to dominate the social life of the members of the genus Homo, more than in any other Primate group.

1.6 When Religious Capacity Emerged, What Was the Payoff?

Religious capacity in humans, i.e., its phenotypic expression, is extraordinarily complex and may use far more brain capacities than many other human traits. If so, then the genetic basis of religious thinking, feeling, and behaving is very likely as complex as the phenotypic expressions. Yet, as complex as religious behavior is, it is fully identifiable from culture to culture, even when the observer does not know the language or the belief system. Adult humans can recognize religious behavior and thinking in other humans. They know it when they see it.

It is hypothesized that religious capacity came to be interpreted as advantageous culturally. Why? There are many answers. It could control group activities with rules carrying heavy sanctions (death, illness, misfortune). It could predict the weather and the seasons through knowledge lent by spirits and gods. It could bestow upon humans a sense of control over dangerous and unavoidable events, like childbirth. Chants, incantations, prayers, and

propitiations in a vast, but fully recognizable array gave humans a sense of order, control, and stability. These are no small gifts. Then, theology eventually structured reasons for the system of beliefs to retain and nurture itself. It became culturally self-perpetuating.

The adults of a prehistoric human band might reason: Even if an old soothsayer or medicine man was a bit unpredictable and went into trance or convulsions from time to time, so what? When he recovered, he mumbled knowledge he gained from the supernatural, however it appeared and was patterned according to the local culture. The result was special knowledge and control. In a species whose other cognitive traits were burgeoning, it may have been that religious capacity's quasi-imagined knowledge base was enough for the band, as a group, to keep hope for the future alive. Religious capacity may have eventually flourished partly because humans came to conceive a timeline, with cause-and-effect, with social consequences and with the eventual consequence of death. In that cognitive context, fore-knowledge was valuable. In every human religion, hope for an uncontrollable future is offered to believers, as well as knowledge of an unknowable future.

1.7 Emergence of Religious Capacity and Theological Imagination in *Homo sapiens* Depended on Neurological Changes

The neurological processes of incorporating different human cognitive capacities through evolutionary history are not yet fully understood, but there is progress. There is growing knowledge of "exaptation", where it is presumed that a new capacity "takes over" and uses neurological tissues for a new purpose. This can result in different capacities being seated in two

parallel positions on the two sides of the human brain. Brain asymmetry and bilateral differences are common in humans, and it is reasoned that it makes good use of limited space.

There is also a growing appreciation of a proposed process called "neural reuse", where the higher Primates, especially humans, are presumed to "self-select" capacities that they find useful and use them again and again. They become fixed in the neurological systems through repeated use and success doing so—relying on a high level of human plasticity, especially among infants and children (Gómez-Robles and Sherwood 2016). The reader should note this is contrary to classical Darwinian theory, in which use-or-non-use was not seen to make a difference. However, at present, the Extended Evolutionary Synthesis (EES) (Van Arsdale 2017; Lange 2023) makes some room for selection pressure at multiple levels of a species, for example, at the individual level, the group level, and the population level. This is an elaboration of Darwinian theory, in which only the individual was the recipient of evolutionary pressures. In the EES, selection pressures can be exerted at all levels. Evolutionary theory has evolved.

1.8 Two-Step Cognitive Evolution All Over Africa

Here, the above neurological processes are hypothesized—along with the population process of genetic drift—to be largely responsible for of the emergence of moral capacity in *Homo erectus,* and religious capacity in *Homo sapiens*. The evolution of these two traits was not caused strictly by "natural selection pressures" and "adaptative advantage". Natural selection, as a population process, was simply too weak in the small groups on the human lineage. The size of the band meant that genetic drift had a prominent role in the fixation of certain genes in the population—genes that may have not been strictly advantageous. That would support a hypothesis that the

genetic basis of religious capacity was fixed initially by chance, and then, perhaps much later, by utility in supporting the social group. Then, it spread, partly because religious capacity is so effective in establishing cultural identity, as well as "who is a friend" and "who is a foe", and especially, whom one can marry. After moral capacity and religious capacity arose at two different stages, the first nascent theologies and related theological archival and amplification behaviors arose as a result of the integration of two.

2. Origins of Moral Decision Making and Organization of Moral Adjudication in *Homo erectus*, as Precursors to Theological Function in *Homo sapiens*

Homo erectus emerged 1.9 million years ago, and probably controlled fire at 1-1.5 million years ago, if the findings from Wonderwerk Cave hold (Berna et al. 2012). It was that invention – the control of fire – that created a social learning environment called the "Human Hearth". It is hypothesized that an ability to think morally and arbitrate in a moral context arose because of the intense, close, intimate, teaching and learning environment of the evening's fire, along with the combined effects of all the other factors that others have listed: demography, larger home territory, longevity, brain size, stature, full upright gait, loss of sexual dimorphism, menopause in women, and the new and effective functioning of post-menopausal women in a grandmother role. By helping provide additional food and care to her grandchildren, grandmothers would help to assure that their own genes would be preserved by the children she successfully tended (O'Connell, Hawkes, and Blurton Jones 1999; 2002; Opie and Power 2011). *Homo erectus* almost surely had rudimentary language abilities around the time they learned to control fire and moved out of Africa on a generations-long trek all the way to Europe in one direction, and Southeast Asia in the other. *Homo sapiens* was not the first species in the genus Homo to leave

Africa, humanity's birthplace. Of course, some remained in Africa, including *Homo sapiens* to the modern day.

Each one of the characteristics listed above for *Homo erectus* provides support for a model of a species that was prepared for moral decision making in a social context of elders of both sexes, and that they likely conveyed the implicit rules of behavior around a common hearth or campfire, with the use of storytelling and perhaps reenactment, as of the day's hunt. The band size of *Homo erectus* was 100-110 individuals, so there was very likely more than one campfire. Table 1 summarizes the salient features of *Homo erectus* for a model of moral capacity's emergence. It remains a proposal, but it logically uses virtually everything we know about our ancestral species. *Homo erectus* was an enormously successful species for a long period of time on Earth.

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Table 1. Setting the Stage for Theological Thinking in *Homo sapiens*: Features Conducive to Evolution of Moral Capacity in *Homo erectus*

- Territory of 100 sq. miles, and band size of 100-110 individuals
- Percent time grooming is down, and rudimentary language begins
- By 1-1.5 mya, grammatical language had likely emerged
- Cranial capacity 1000-1100cc, and neocortex ratio 3.7 –3.8
- Fully bipedal, gracile, legs are longer than arms
- Aggressive scavenging in a larger home territory to feed a larger brain
- Reduced sexual dimorphism, females now almost as large as males
- Change in food getting strategy from "male-oriented" to "both sexes"
- Menopause as an adaptation; the "Grandmother Hypothesis"
- Longevity for all, and more post-reproductive years for women

- Longer developmental trajectory for cognitive and physical traits
- Group of elders of both sexes available; wisdom in the elderly for decision making

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2.1 *Homo erectus* and Language: Did These Members of Genus Homo Set the Foundation for Liturgical Speech?

It is about language that many people have the most questions, and the reader is referred to earlier theories that language emerged while Primate grooming declines. There is also a theory that language emerges as a function of the increasing size of the band, because keeping track of social relationships was a substantial cognitive task that language aided (cf. Aiello and Dunbar 1993; Dunbar 1996; 1998; Barnard 2008). There is corroboration that language likely emerged before our species evolved, from neurological studies on language learning:

> It has long been debated whether the mechanisms that underlie language are dedicated to this uniquely human capacity or whether in fact they serve more general-purpose functions. Our study provides strong evidence that language—indeed both first and second language—is learned, in specific ways, by general-purpose neurocognitive mechanisms that preexist *Homo sapiens*. The results have broad implications. They elucidate both the ontogeny (development) and phylogeny (evolution) of language. (Hamrick, Lum, and Ullman 2018, 1487).

The assessments of *Homo erectus* have changed over the years. The species' tenure was a long one, around 1.9 million years. A watershed event for this fully upright, bipedal species was leaving Africa and colonizing the Eurasian continent. Our view is that the species very likely

needed both fire and dogs before successfully achieving that journey, because the initial impetus was probably following game and securing food—which maximized the usefulness of fire, dogs, and language, all three. The hypothesized model here includes the notion that *Homo erectus* had at least rudimentary, and possibly grammatical language. The quote above suggests that the "neurocognitive mechanisms" for language were in place before *Homo sapiens*, and therefore ready to assist the integration of moral and religious capacities, followed by theological creativity.

2.2 Sleeping on the Ground: Its Importance Then, and Theoretical Function Now

How many good sermons have emerged from a good night's sleep? The stability of ground-based sleep lent an important depth to human thinking, and has had lasting consequences for at least a million and a half years, beginning with *Homo erectus*. The latest theory sees the emerging species *Homo erectus* finally abandoning tree dwelling for a terrestrial existence.

Principal among the researchers who support a greater sophistication for *Homo erectus* are Coolidge and Wynn (2009), a psychologist/anthropologist team who propose that *Homo erectus* was the first to have a full-time terrestrial existence. They contend that an earlier member of the genus Homo, *Homo habilis*, still slept in trees on precarious perches that did not allow full relaxation or deep sleep. They suggest that sleeping on the ground improved the length and depth of sleep, allowing *Homo erectus* to rehearse social actions in dreams, including hunting and social exchanges. Coolidge and colleagues (2015) continue these themes. They, like we, rely on Bruner and colleagues' fine paleoneurological work (2013; 2016; 2017). Readers should be cautioned that these theories belong to paleoneurologists and cognitive anthropologists, and they

have not yet entered into traditional anthropology (cultural or physical). The theories of "cognitive archaeology", that Wynn and colleagues represent, remain broadly secondary to "stones and bones" archaeology and physical anthropology, in general.

2.3 Cognitive Changes Result in Moral Decision Making in *Homo erectus*, and Later, in the Theological Imagination of *Homo sapiens*

Work that fully appreciates the long and successful tenure of *Homo erectus* is congruent with a model of moral thinking, discernment, and moral adjudication in that species. It is hypothesized that these capacities may not have been fully extant when *Homo erectus* learned to control fire and enjoyed a Human Hearth setting in which moral decision making could be achieved. Before that time, a conducive learning environment was not available that would have encouraged the emergence of systems of rules for good and bad behavior—later to be foundational for all theologies. Before the Human Hearth, there was no nightly venue for the sharing of opinions and guidelines among members of the band. The capacity for moral decision making was more fundamentally neurocognitive and only secondarily emotional (Glimcher 2014; Rappaport et al. 2023). However, different cultures fill in the reasons for right and wrong behavior using emotion laden stories, legends, and mythology. Religion can be very emotional, but moral decision making, by itself, is primarily a cognitive capacity.

The cognitive features that *Homo erectus* used to determine the moral valence of human actions and thoughts are: (1) A mental step both back and up, achieving a kind of "social distance"; (2) an evaluation using a valence from good to bad, which was then a widely used cognitive development; (3) a regretfully dispassionate reasoning, achieving a kind of emotional distance;

(4) a tentativeness in a mental balancing act, signaling difficulty in reaching decisions; (5) a sad rejection of "wantonness", signaling a longing for a simpler solution where answers were easier; (6) the experience of a burden, which almost all moral decision-making is; (7) a capacity for empathy with someone receiving moral judgment, signaling recognition of a oneness of the social group; and (8) after a decision is made, a sense of resolution on the part of the group, and hope and faith in the future on the part of the group.

Already existing to support this new framework for decision making was (1) a fully adequate Primate sociality that had been evolving for 55-65 million years when *Homo erectus* appeared, and (2) a growing measure of the biological capacity for culture, which emerged initially in the late Miocene and occurred concurrently in chimpanzees, in a weaker form. Culture is strong and obvious in *Homo erectus* from the species' stone tool traditions. Patterns are passed along from generation to generation, changing slowly. There was not yet a good reason for culture to change rapidly, as there is in today's complex, urban, worldwide culture, readying itself for exportation off-world to the Moon, Mars, and farther still.

2.4 Merged Capacities for Morality and Religion, Still Separable and Identifiable Today

To this point, the analysis of moral capacity in *Homo erectus* has relied on triangulation of theory and findings from (1) paleoneurology and archaeology, (2) modern neuroscience and cognitive science, and (3) our knowledge of characteristics of moral reasoning and religious expression worldwide. Religious capacity would come to encompass moral capacity and they would merge in *Homo sapiens*, so that today, it is difficult to tell them apart. When *Homo sapiens* evolved from *Homo erectus*, the evolutionary line already had moral capacity. In terms

of evolutionary processes, the manner in which moral capacity merged with the new capacity of religious expression depended on abilities imparted by the expanded parietal lobes of *Homo sapiens*. The expansion of the prefrontal cortex, the parietal lobes, and the cerebellum all worked to make the skull of *Homo sapiens* uniquely rounded. Theology joined the many other creative capacities that humans have. It became a creative medium and could change with the needs and requirements of the place and the era. Like art, sculpture, music, and dance, theology could be molded to fit the needs of a sentient species at different stages of development in different places.

3. Hypothesis: Religious Capacity Emerges with Parietal Expansion in *Homo sapiens*

The earliest finds as of this writing for *Homo sapiens,* the most recent species on the human evolutionary lineage, are from Jebel Irhoud, in present-day Morocco (Hublin et al. 2017). These finds take our species back over 300,000 years. The generally accepted horizon had been about 200,000 years ago. Hublin and colleagues' findings suggest two important things. First, they found skulls with a range of rounded forms, which suggests the species was in transition. This is common for a new species. Second, they described the evolution of our species as continent-wide in Africa, and not in East, or South, or North Africa. Our species was all over the continent, almost as soon as it arose. This reflected a tendency to wander in search of game and other resources, which appeared long before the species arose. It also reflected reliance on a more diverse genome or a set of distributed, emerging genomes with variations.

The implication of their work for a model of religious capacity is clear. Religious capacity, like our rounded cranial vault, probably emerged gradually, just like our species' parietal lobe

expansion. Bruner and colleagues (2013; 2017) find the parietal lobes and globe-shaped skull relatively stable at 150,000 years ago. Still, even today, there is some variety in the globularity of the human skull. Bruner and colleagues (2016; 2017) demonstrate with modern research methods that expansion to a fully globular skull is due largely to the precuneus, part of the parietal lobes. Therefore, attention is drawn specifically to the precuneus to complete a model on emergence of religious capacity. Table 2 summarizes, in sequential order, the principal developments that religious capacity relies upon. These are not features of religion per se, but of its foundations – the sequential species traits that made religious thinking possible in the species' evolution.

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Table 2. Foundations for Religious Capacity Gradually Emerge Over Millions of Years of Primate Evolution

- Sociality in all Primates, 55 – 65 million years ago
- Basic ape model from the Miocene, 19 million years ago
- Realignment of the senses, upgrades of vision and hearing
    - *In some groups of the ancestral ape population giving rise to the genera Homo and Pan in Africa, the following changes occurred:*
- Down-regulation of aggression, 8 – 10 million years ago, and continuing
- Lengthening developmental trajectory or secondary altriciality (Gómez-Robles et al. 2024)
- Greater social tolerance among adults, especially while feeding
- Upgrades in intellect to manage aggression in the social group
- Greater, genetically based sensitivity emerges, both general and emotional
- Biological foundations for culture emerge
- Moral capacity emerges in *Homo erectus*, 1-1.5 million years ago
- Religious capacity emerges in *Homo sapiens*, stabilizing at 150,000 years ago

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There is good evidence that religious capacity only emerged when certain brain organs developed fully that supported the features in Table 3. Several other species have been considered: *Homo erectus, Homo neanderthalensis,* and *Homo sapiens idaltu*. However, none of these species appear to have had the requisite brain architecture to support religious thinking (Rappaport & Corbally 2020). Only in *Homo sapiens sapiens* did the features in Table 3 eventually appear.

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Table 3. Religious Capacity in *Homo sapiens*: Experiential and Behavioral Components Central to Religious Experience of the Modern Species

Perception of and Response to a Spiritual Realm

- Awe and wonder
- Adoration and reverence

The Immediate Experience

- Good feelings when neural reward systems are tapped
- Calm and spiritually connected after ritual
- Reduced anxiety after ritual and social activities
- For some humans, hypo-excited or hyper-excited states

Acquiescence

- Introspection, concentration, meditation, self-study, and the habit of prayer
- Transformation of self above everyday life, achieving a selflessness periodically
- Acknowledgment of a spiritual being's transcendence above everything
- Acknowledgment of a spiritual being's immanence in everything, so feelings of being grounded
- Acceptance of a belief system's rationalization of order, so feelings of certainty and centeredness

- Acceptance of humans' place in the universe

Commitment

- Alignment, or continual comparison of the self with a system of belief
- Obedience to serving the spiritual and living in accordance with it.

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3.1 Expansion of the Precuneus and a Rounded Cranial Vault Imply Modern Religious Cognitive Specializations Used Today

It is hypothesized that religious capacity arose in *Homo sapiens* consistent especially with the expansion of the precuneus, part of the parietals, which encouraged a rounded cranial vault. Neubauer and colleagues write that, "While some aspects of the pattern of endocranial shape change are shared between humans and chimpanzees, the shape trajectories differ substantially directly after birth until the eruption of the deciduous dentition: in humans but not in chimpanzees, the parietal and cerebellar regions expand relatively (contributing to neurocranial globularity) and the cranial base flexes within the first postnatal year when brain growth rates are high. We show that the shape changes associated with this early 'globularization phase' are unique to humans and do not occur in chimpanzees before or after birth" (Neubauer et al. 2010, 555). Bruner and colleagues confirm that, "Neurocranial globularity in our species is due to an early postnatal stage of development characterized by expansion of parietal and cerebellar volume… Interestingly, chimpanzees and Neandertals lack this ontogenetic stage…" (2017, 1054). Here, we conclude that religious capacity, a non-obligatory species-level cognitive specialization of *Homo sapiens*, likely emerged gradually, just like our species' parietal lobe expansion. Bruner and colleagues (2016; 2017) demonstrate with modern research techniques that globularity is due largely to expansion of the precuneus. Therefore, one's attention is drawn

specifically to the precuneus when searching cognitive research results for support. Bruner and colleagues corroborate that, "The evolution of neurocranial morphology in *Homo sapiens* is characterized by bulging of the parietal region, a feature unique to our species" (2017, 1053). The reader should note that these paleoneurologists see the cognitive specializations emerging well after the horizon of the first fully globular crania, not until 150,000 years ago. We therefore hypothesize the emergence of religious capacity at some point between 400,000 and 150,000 years ago. That is the best estimate, based on findings to date.

3.2 Triangulation of Findings from Archaeology, Paleoneurology, Neuroscience, and the Ethnography of Religion

Paleoneurological observations on the parietals and the precuneus can be juxtaposed to modern cognitive research results on the precuneus, in order to go one step further in this analysis, to draw a profile of the very earliest religious cognition. This thrust is previewed by what is already known about primate evolutionary history, in terms of a changing emphasis of the senses to vision and hearing among humans and some higher apes, and away from the senses of taste and smell. Religious experience depends on the senses of sight, sound, and to a lesser extent on smell, as in use of incense. Humans are transported experientially to a condition of openness to receive the supernatural, listen to cautionary tales, and transcend everyday life in a feeling of oneness with a spiritual realm. These senses (in concert with the imaginings of a network of the human parietals, the prefrontal lobes, and the cerebellum) transport religious participants to another, if counter-factual, place that is related to the full expansion of the skull of *Homo sapiens*.

4 Functions of the Precuneus in Theological Thinking

It is hypothesized that there is a relationship between humans' unique brain architecture and the emergence of the human ability to engage in religious thinking, and we extend that to theological thinking, as well. This evolutionary emergence involved many human biological systems, not just parietal expansion, but also changes in the human senses, and types of social sensitivity that are genetically based (Beevers et al. 2009; Acevedo et al. 2014; Todd et al. 2014). It should be noted that the theological component referred to as "transcendence" (and appearing in various guises in various religions) is often dependent on the senses, or, interestingly, on their almost complete absence, as in deep meditation. Table 4 (top) illustrates important features of *Homo erectus* that were incorporated by *Homo sapiens* (lower). The incorporation of moral capacity by religious capacity can be described as "engulfing" it because there are few remaining human institutions in tribal or modern societies that function to render moral judgments without support from religious precepts. One can count these cultural traditions on one hand: Perhaps scout troops and college-age fraternities and sororities (and their equivalent age-mate groups in tribal societies), perhaps sports clubs, voluntary or civic associations without a religious identity, or work-based groups. However, many of these types of organizations sometimes appeal to prayer and religious creeds. Their mission statements often include religious concepts and terminology.

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Table 4. Intersection of Moral and Religious Capacities

Beginning from the time *Homo erectus* controlled fire 1 – 1.5 mya, and the "Human Hearth" learning environment emerged, these behaviors were available. The features of moral capacity were incorporated into religious capacity when *Homo sapiens* evolved.

- Moral Reasoning and Adjudication

- Storytelling, "cautionary tales," and defining rules
- Chanting, percussion
- Ritual
- Use of "special places" for adjudication, and teaching rules

Beginning around 150,000 years ago, when the parietals and precuneus expanded and a globular cranium stabilized for *Homo sapiens*:

- Imagining supernatural realms and beings
- Interaction of supernatural beings and humans
- Comparison of the self to "revealed" knowledge
- Music
- Judgment of humans by standards imparted by the supernatural
- Identification and use of "holy places"

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Exactly why the engulfing of moral capacity by religious capacity occurred is a subject for further theoretical development. At a social level, it can be hypothesized that religious sanctions threatening life and the order of the cosmos (as in religion) were surely motivational. However, the incorporation or "engulfing" needs cognitive and neurological research support. There may indeed be a neurological basis for the selection of "religious thinking" over the simpler "moral thinking", but this needs corroboration. Cultural neural reuse, after Christiansen and Müller (2014), may point the way toward the reasons that some "lower-level neural circuits" were favored over others, in crafting a new capacity that was grafted onto an older one. Nevertheless, this type of amalgamation is not unique and can involve more than two capacities. Human wayfinding using a mental Euclidean grid, geometry, and mathematics melded with economic

pursuits such as hunting, but also with maintaining long-distance networks to acquire precious materials, or a mate for a maturing son or daughter.

Table 5 implies fascinating hypotheses about the role of the precuneus in religious thinking and in the emergence of theories about the relationships between humans and the supernatural, i.e., theological thinking. The functions of the precuneus are especially interesting because they can shape both rational and irrational thoughts, both real and unseen beings, and environments that surround us every day as well as transcendental realms where only gods and spirits exist. The precuneus does not require that experiences be rational or scientific or even based on experience, and they can be counterfactual.

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Table 5. The Precuneus in Higher-Order Cognitive Functions That Enable Religious Experience, Theological Thinking, and Accretion of Theological Dogma

Functions for the Precuneus:

- Connectivity, centrality, highly active brain organ
- Default Mode Network, resting consciousness, which can "go quiet"
- Loss of self-consciousness in meditation, mystical or other altered states
- Visuospatial: Derivation and manipulation of counter-factual spaces
- Visuospatial: Derivation of spiritual beings who populate these spaces
- Self: Manipulation of the self in interaction with these spiritual beings
- Self: Assessment of self vis-à-vis codes of living given by them
- Self: Assessment of self vs. others according to these codes
- Episodic Memory
- Music

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In Table 5, it is important to note that the roles of the precuneus are indeed based on the findings of modern research. When one examines the list of cognitive features managed by the precuneus, it is difficult to imagine any type of religious thinking or behavior, or the formulation of theories about the relationships between humans and the supernatural *without* the precuneus. These theological theories are part of every culture, so their ubiquity alone suggests a very fundamental basis in brain structure and functioning. The precuneus clearly has a role in religious thinking and theological formulations, although its most imaginative work surely involves the prefrontal lobes. The precuneus does not function alone. Many researchers have been interested in its central location and relatively high level of activity, as measured by blood flow in the brain. It may have a central coordination function that does not appear in Table 5.

4.1 The Precuneus, Prayer, and Preaching

Two things stand out prominently in Table 5. First, the role of the precuneus in "managing" features of religious and theological thinking also means, for some features, that the precuneus is more "deactivated" than "activated." Dreamlike, diffuse, and impressionistic states of mind are often induced by drugs, but they are also induced by religious behavior and experience. A sense of "no boundaries" has been reported by many practitioners of an array of religious rituals. This state is often reported as a "loss of self-consciousness." The human resting default network has a central manager in the precuneus to maintain consciousness and self-consciousness when at rest. When it ceases to do this quite so carefully, the sense of a diffuse self can arise. That sense is central to much religious practice.

In other cases, the precuneus is actively involved in wakeful states, such as prayer. The precuneus and parietals, generally, allow humans to conceive and travel in imagined supernatural

spaces. Many researchers have likened this to the inherent "time travel" aspect of the human anticipation of future events. The species is exceedingly good at this, and we propose that so-called "active prayer" is one result of the effective operation of the precuneus and the remainder of the parietals, too, which govern visuospatial reckoning.

Another active state related to religion and theology is preaching, and the fact that preaching quite often uses parables or recounts stories from a mythical past. In all these activities, episodic memory is called upon and used continuously. When a religious practitioner recounts stories of miracles, like Jesus performed in his ministry, and that practitioner is questioned about them, the responses to followers come from a careful use of episodic memory. Today's experiences are interpreted in light of religious lore and precepts, and insightful, often engaging and colorful parallels are drawn in preaching to followers.

This imagination draws upon a storehouse of knowledge about "how things work" both physically and metaphysically. The reader is referred to Uncapher, Gordon, and Wagner (2014) and their "working model" of posterior parietal cortex (PPC) operations during episodic retrieval. It illustrates the importance of the intraparietal sulcus in top-down attention, evidence accumulation, and action intention (manual and oculomotor) (2014, 571). One can see how these processes are just as important for scientific modeling and artistic creativity, as they are for decision making on issues related to moral and religious questions. This follows an outline of cognitive similarities in science, religion, and art (Rappaport and Corbally 2015).

4.2 The Precuneus and Religious Music

The precuneus is fully involved in music, which we propose *Homo erectus* did not have because the precuneus was less evolved and expanded in that species. *Homo erectus* and *Homo*

neanderthalensis may have had chanting, percussion, and ritual, but probably not music. Indeed, the joining of religious and theological thinking to music and the other arts is surely one of the most enjoyable features of religious expression. The precuneus is actively involved in the production of music, and fully integrated with the amygdala, the brain's center for emotion.

4.3 The Precuneus and Religious Self-Reflection

The parietal lobes and the precuneus also have an important role in modern human decision making. Bruner and colleagues note, "The medial parietal cortex is also implicated in higher cognitive processes such as autobiographic memory retrieval, theory of mind and self-reflection" (2017, 1057). Because of the importance of these faculties, we propose that both moral adjudication in *Homo erectus* and religious judgment in *Homo sapiens* were and are mediated through the parietal lobes. Decision-making about the valence of human behavior always involves comparison of the behavior with other behavior, including the self's behavior.

The combination of features guided by the precuneus may suggest reasons why religious behavior and thought are so appealing to so many people. When religion effectively uses and integrates all of the faculties at the disposal of the precuneus, it can create an extremely strong experience for the modern human being.

5 Conclusions: Early Theological Thinking, and Its Oral and Text Traditions, Culminate in Modern *Homo sapiens*

A hypothetical profile of the earliest forms of theological thinking emerges out of neurological, archaeological, and ethnographic findings considered here. The *main leap* from religious thinking to theological thinking was in the task of creatively re-working (1) conceptions of

supernatural beings in interaction with living humans, in real or imagined places, with (2) the moral decision-making involved in religious thinking about "good" and "bad", and "right" and "wrong". This fusion gave rise to stories, and from those stories came other stories. The sum of all stories became, at first, the oral tradition (or the text) of a theology. Culture after culture was to develop richly populated pantheons of spirits and gods. In theologically derived stories, they played out their lives much as humans did, and they confronted the problems humans confront. However, they were not human, not mortal, but above humans. In their histories, they would serve again and again as lessons for human behavior.

One factor that *Homo erectus* and both early and modern *Homo sapiens* likely shared is an ability to "step back and up", so as to cognitively render decisions on others' behavior. This can be described as withdrawing from the normal to-and-fro of interaction to consider moral infractions deeply and carefully. Decisions and how they were made would become theological content and examples. With an ability of elders to pass on knowledge accumulated by previous generations, theology would accrete, be applied to new circumstances, and (while often considered immutable), it would be able to change.

In religious practice, *Homo sapiens* is sequestered singly or in groups, to interact with the supernatural. However, our species has a tendency to select a place very carefully (or construct them), according to the beauty of a location, its height, its quiet, its privacy, and its effectiveness in focusing group attention and participation. We propose that location was important for both species, but the selection criteria were somewhat different. Only in these special places can the accumulated theological knowledge of generations be shared, and that was by *Homo sapiens*.

Discussions by a campfire to revisit the day's hunt would give way to special circumstances, places, dates, events, even festivals.

Lastly, we address the differences between the two species in terms of invocation of the supernatural or mimicking the supernatural realm, quite often using art forms. *Homo erectus* may have practiced rituals related to ancestors or spirits, but they probably did not invoke the supernatural for the group, summon the supernatural, surround the gathered members of a group by song and other powerful or engaging sounds, light play, beauty, and reduced oxygen to encourage dreamy mental states. Religious rituals for *Homo sapiens* often seek to invoke the supernatural on the spot, to bring the supernatural near. The isolation and artistry of the special setting helps. Ritual usually involves group action, and it represents an attempt to join with the supernatural and experience the supernatural realm. All these, and more too are the talents only of *Homo sapiens*, and we propose they fall back on the qualities of religious experience encouraged by the parietals and especially the precuneus.

REFERENCES

Acevedo, Bianca P., Elaine N. Aron, Arthur Aron, Matthew-Donald Sangster, Nancy Collins, and Lucy L. Brown. 2014. "The Highly Sensitive Brain: An fMRI Study of Sensory Processing Sensitivity and Response to Others' Emotions." *Brain and Behavior* 4(4): 580-594.

Aiello, Leslie C., and Robin I. M. Dunbar. 1993. "Neocortex Size, Group Size, and the Evolution of Language." *Current Anthropology* 34(2): 184-93.

Barnard, Alan. 2008. “The Co-evolution of Language and Kinship.” In: *Early Human Kinship; From Sex to Social Reproduction.* Edited by Nicholas J. Allen, Hilary Callan, Robin Dunbar, and Wendy James. Malden, MA: Blackwell Publishing. Pp. 232-43.

Beevers, C. G., A. J., Ellis, T. T. Wells, and J. E. McGeary. 2009. *“*Serotonin Transporter Gene Promoter Region Polymorphism and Selective Processing of Emotional Images*.” Biological Psychology* 83 (3): 260-5.

Begun, David R. 2016. *The Real Planet of the Apes: A New Story of Human Origins*. Princeton, NJ: Princeton University Press.

Berna, Francesco, Paul Goldberg, Liora Kolska Horwitz, James Brink, Sharon Holt, Marion Bamford, and Michael Chazan. 2012. “Microstratigraphic evidence of *in situ* fire in the Acheulean strata of Wonderwerk Cave, Northern Cape province, South Africa.” *Proceedings of the National Academy of Sciences* 109(20): E1215-E1220.

Bruner, Emiliano, and Atsushi Iriki. 2016. “Extending Mind, Visuospatial Integration, and the Evolution of the Parietal Lobes in the Human Genus.” *Quaternary International* 405: 98-110.

Bruner, Emiliano, and Osbjorn Pearson. 2013. “Neurocranial Evolution in Modern Humans: The Case of Jebel Irhoud 1.” *Anthropological Sciences* 121: 31-41.

Bruner, Emiliano, Todd M. Preuss, Xu Chen, and James K. Rilling. 2017. “Evidence for Expansion of the Precuneus in Human Evolution.” *Brain Structure and Function* 222:1053-1060.

Christiansen, Morten H., and Ralph-Axel Müller. 2014. “Cultural Recycling of Neural Substrates during Language Evolution and Development.” In: *The Cognitive Neurosciences V,* Michael S. Gazzaniga and George R. Mangun, eds. Cambridge, MA: MIT Press. Pp. 675–682.

Coolidge, Frederick L. and Thomas Wynn. 2009. *The Rise of Homo Sapiens: The Evolution of Modern Thinking*. Hoboken, NJ: Wiley-Blackwell.

Coolidge, Frederick L., Thomas Wynn, Karenleigh A. Overmann, and James M. Hicks. 2015. "Cognitive Archaeology and the Cognitive Sciences." In: *Human Paleoneurology*, edited by Emiliano Bruner. New York: Springer. Pp. 177-208.

De Beaune, Sophie A., Frederick L. Coolidge, and Thomas Wynn. 2009. *Cognitive Arachaeology and Human Evolution*. Cambridge: Cambridge University Press.

Dunbar, Robin. 1996. *Grooming, Gossip, and the Evolution of Language*. London: Faber and Faber.

_____. 1998. "The Social Brain Hypothesis." *Evolutionary Anthropology* 6(5): 178-90.

Fiddick, Laurence, and H. Clark Barrett. 2001. "Evolution of Cognition." Berlin, Germany: Center for Adaptive Behavior and Cognition, Max Planck Institute for Human Development. Pp. 1-7.

Gazzaniga, Michael S. 1999. "The Interpreter Within: The Glue of Conscious Experience." Dana Foundation web site, April 1. [No page numbers online. http://www.dana.org/Cerebrum/Default.aspx?id=39343#sthash.I7zCiFeL.dpuf

Glimcher, Paul. 2014. The Emerging Standard Model of the Human Decision-Making Apparatus, in *The Cognitive Neurosciences*, 5th ed., M. S. Gazzaniga and G. R. Mangun, Eds., Cambridge, MA: MIT Press, pp. 683–691, Ch 59. Accessed: Mar. 18, 2024. [Online]. Available: https://doi.org/10.7551/mitpress/9504.003.0075

Gómez-Robles, Aida, and Chet C. Sherwood. 2016. "Human Brain Evolution; How the Increase of Brain Plasticity Made Us a Cultural Species." *MÈTODE Science Studies Journal* (May). Online, Universitat de València. DOI: 10.7203/metode.7.7602

Gómez-Robles, A., Nicolaou, C., Smaers, J.B. and Chet C. Sherwood. 2024. The evolution of human altriciality and brain development in comparative context. *Nature Ecology and Evolution* 8, 133–146 (2024). https://doi.org/10.1038/s41559-023-02253-z

Haldane, J[ohn] B[urdon] S[anderson]. 1990[1932]. *The Causes of Evolution.* Princeton, NJ: Princeton University Press.

Hamrick, Phillip, Jarrad A. G. Lum, Michael T. Ullman. 2018. Child First Language and Adult Second Language Are Both Tied to General-purpose Learning Systems." *Proceedings of the National Academy of Sciences* 115(7): 1487-1492. DOI: 10.1073/pnas.1713975115.

Harpending, Henry C., Mark A. Batzer, Michael Gurven, Lynn B. Jorde, Alan R. Rogers, and Stephen T. Sherry. 1998. "Genetic Traces of Ancient Demography." *Proceedings of the National Academy of Sciences* 95: 1961-1967.

Harris, Eugene E. 2015. *Ancestors in Our Genome; the New Science of Human Evolution.* Oxford: Oxford University Press.

Hublin, Jean-Jacques, Abdelouahed Ben-Ncer, Shara E. Bailey, Sarah E. Freidline, Simon Neubauer, Matthew M. Skinner, Inga Bergmann, Adeline Le Cabec, Stefano Benazzi, Katerina Harvati and Philipp Gunz. 2017. "New Fossils from Jebel Irhoud, Morocco and the Pan-African Origin of *Homo sapiens*." *Nature 5*46: 289-292**.**

Lachance, Joseph, and Sarah A. Tishkoff. 2013. "Population Genomics of Human Adaptation." *Annual Review of Ecology, Evolution, and Systematics* 44: 123-143.

Lange, Axel. 2023. *Extending the Evolutionary Synthesis: Darwin's Legacy Redesigned*. Boca Raton, FL: CRC Press.

Lieberman, Daniel E. 2008. "Speculations about the Selective Basis for Modern Human Craniofacial Form." *Evolutionary Anthropology* 17: 55-68.

_____. 2013. *The Story of the Human Body: Evolution, Health and Disease.* New York: Pantheon Press.

McFalls, Joseph A. 1979. *Psychopathology and Subfecundity*. New York: Academic Press.

_____. 2012. *Disease and Fertility* (Studies in Population). New York: Academic Press.

Neubauer, Simon, Philipp Gunz, and Jean-Jacques Hublin. 2010. "Endocranial Shape Changes During Growth in Chimpanzees and Human: A Morphometric Analysis of Unique and Shared Aspects." *Journal of Human Evolution* 59:555-566.

Neubauer, Simon, Jean-Jacques Hublin, and Philipp Gunz. 2018. "The Evolution of Modern Human Brain Shape. *Science Advances* 4(1): eaao5961. DOI: 10.1126/sciadv.aao5961

O'Bleness, Majesta, Veronica B. Searles, Ajit Varki, Pascal Gagneux, and James M. Sikela. 2012. "Evolution of Genetic and Genomic Features Unique to the Human Lineage." *Nature Reviews Genetics* 13: 853–66.

O'Connell, James F., Kristen Hawkes, and Nicholas G. Blurton Jones. 1999. "Grandmothering and the Evolution of *Homo erectus*." *Journal of Human Evolution* 36: 461–485.

O'Connell, James F., Kristen Hawkes, and Nicholas G. Blurton Jones. 2002. "Meat-Eating, Grandmothering and the Evolution of Early Human Diets." In *Human Diet: Its Origin and Evolution*, edited by Peter Ungar and Mark F. Teaford, 49–60. Westport, CT: Bergin & Garvey.

Opie, Kit, and Camilla Power. 2011. "Grandmothering and Female Coalitions: A Basis for Matrilineal Priority?" In *Early Human Kinship: From Sex to Social Reproduction*, edited by Nicholas J. Allen, Hilary Callan, Robin Dunbar, and Wendy James, 168–186. Malden, MA: Blackwell Publishing.

Rappaport, MB, and CJ Corbally. 2015. Matrix Thinking: An Adaptation at the Foundation of Human Science, Religion, and Art. *Zygon; Journal of Religion and Science* 50(1): 84-112.

Rappaport, MB, and CJ Corbally. 2020. *The Emergence of Religion in Human Evolution.* Abingdon, Oxfordshire: Routledge.

Rappaport, Margaret Boone, Christopher J. Corbally, Riccardo Campa. 2023. Rescue and Recovery as a Theological Principle, and a Key to Morality in Extraterrestrial Species. *Zygon* 58(3): 636-655. https://doi.org/10.1111/zygo.12879

Todd, Rebecca M., Daniel J. Müller, Daniela J. Palombo, A. Robertson, T. Eaton, N. Freeman, B. Levine, A. K. Anderson. 2014. "Deletion Variant in the *ADRA2B* Gene Increases Coupling between Emotional Responses at Encoding and Later Retrieval of Emotional Memories." *Neurobiology of Learning and Memory* 112: 222-229.

Uncapher, Melina R., Alan M. Gordon, and Anthony D. Wagner. 2014. "Parietal Lobe Mechanisms Subserving Episodic Memory Retrieval." In: *The Cognitive Neurosciences V*, Michael S. Gazzaniga and George R. Mangun, eds. Cambridge, MA: MIT Press. Pp. 567-576.

Van Arsdale, Adam. 2017. Human Evolution as a Theoretical Model for an Extended Evolutionary Synthesis. In: Richard G. Delisle, Ed., *The Darwinian Tradition in Context*. New York: Springer.