

## What Big Eyes You Have, Grandma!

Big eyes are to see with, but what about the unseen? The principle of parsimony in evolution.

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When Little Red Riding Hood saw the Big Bad Wolf dressed in her Grandma's nightgown (Fig. 1), she quickly had to interpret several observations. "Grandma" had very big eyes which, the wolf claimed, were the better to see her with. And big ears, the better to hear her with. And big, big teeth, the better to eat her with! Little Red Riding Hood seemed to accept the wolf's explanations, perhaps invoking an evolutionary biologist's use of the principle of parsimony, that the simplest explanation for a highly organized trait is adaptive natural selection. Eyes are for seeing, ears for hearing, and hard, pointy things in the mouth are for crunching food. Her reason for accepting "Grandma's" explanations were generally right, though she should have realized that slashing teeth are not a primate's natural apparatus, so that "Granny" wasn't really Granny. Fortunately (for her, not the wolf), the woodsman arrived in time.

The evolutionary idea expressed here is simple. When we see an organ made of light-sensitive cells fronted by a clear disc that focuses light onto those cells, and the cells interconnect and travel to specific areas of the brain in a way that maintains the two-dimensional array structure of those retinal cells, it is reasonable to



A



B

Figure 1. Fairy tales? Little Red Riding Hood meets (A) and gets close to (B) Granny. Drawings by Arthur Rackham (1867–1939) and Gustave Doré (1832–1883), respectively.

assume that eyes evolved as receptors for light. Not only are the eyes real, but so is the light they are

adapted to detect. Likewise, big ears are to hear with: They are receptors for the molecular vibrations we call sound, sending the resulting information to the auditory parts of the brain. And teeth exist because there are real-world prey (including ingénues) to be ripped to shreds so we can stay alive.

These issues are relevant to another that has been affecting—or afflicting—anthropology in the current American political climate, that of religion. We are regularly assaulted by various forms of creationism as we go about our teaching and research. Students with fundamentalist views feel emboldened to question evolutionary explanations. The expanding insurgence of religion in society affects universities and funding agencies alike.

### WHAT IS PARSIMONY?

A classical question in philosophy is "What's really out there?" In 1802, the mathematician Pierre-Simon Laplace (1749–1827) presented his theory of celestial mechanics to Napoleon, who asked what place the Creator had in his explanation. "Sir," Laplace is said to have replied, "I have no need of that hypothesis." This again is the principle of parsimony: the simplest explanation we can devise that is consistent with the facts is likely to be closest to the truth. The shortest path between two points is a straight line, and that's the path that nature takes. (However, I don't know if that's how Red Riding Hood got to Grandma's.)

To biologists, it is more parsimonious to explain biological diversity by

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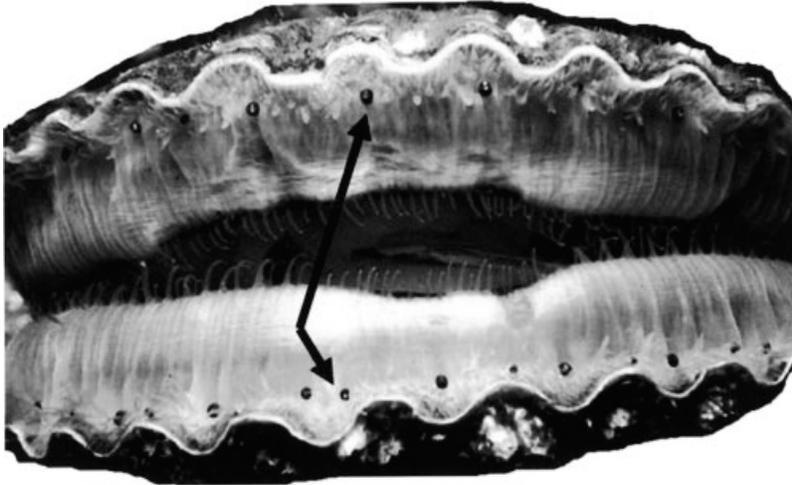


Figure 2. No, this is not a burger. It is a scallop with around 100 lensed eyes (viewed face-on, the arrows show the dark spots along the wavy rim of both shells). Source: public domain.

a single process, evolution, than to invoke unrelated *post hoc* explanations for each case. It was Charles Darwin's explicit intent to show that he, like Laplace, had no need for the Creator hypothesis. But, taken at their word, religious creationists offer a different explanation of nature that they feel is also empirical and parsimonious and, indeed, supported by direct affirmation from the Creator Himself.

Religion makes two kinds of claim. The first is about history; for example, the current Western version is that a 2,000-year-old book tells us about the literal truth of biology. It proffers assertions about 40-day floods that put seashells on mountaintops and about origins in a garden of Paradise 6,000 years ago. Some claim to know what an omniscient God would design if He were the Designer and what counts as "intelligent."

The second claim made by religion is quite different; it is about the inside rather than the outside world. Many claim to have, or have had, direct communicative experience with an "otherness" that is variously reported as God or spirits. In *Moby Dick* (1851), Herman Melville (a believer, not a skeptic) wrote that in trying to understand the nature of God "we are too much like oysters observing the sun through the water, and thinking that thick water the thinnest of air" (Fig. 2). The Bible also asserts that we

only see these things "through a glass darkly." What does biology have to say in response to these claims?

### BIOLOGY RESPONDS

Biology does not deny the phenomenon of religion, a universal aspect of human culture. Obviously, religion in its many manifestations is important to many people. But what is its relationship to the world outside of our heads? Biologists point out that, step by step, the empirical claims of religion have been shown to be wrong. The earth really is more than 6,000 years old! As Thomas Huxley said in 1860, "Extinguished theologians lie about the cradle of every science . . . and history records that whenever science and orthodoxy have been fairly opposed, the latter has been forced to retire from the lists . . . But orthodoxy is the Bourbon of the world of thought. It learns not, neither can it forget and though, at present, bewildered and afraid to move, it is as willing as ever to insist that the first chapter of Genesis contains the beginning and the end of sound science."<sup>1</sup> True to form, some religions still resist the facts of life.

Despite this resistance, some biologists have tried to erect a Peace Bridge across the cultural divide by claiming that religion and biology are properly considered to be separate but equal

aspects of human authority. What Gould dubbed "nonoverlapping magisteria" are "science in the empirical constitution of the universe, and religion in the search for proper ethical values and the spiritual meaning of our lives."<sup>2</sup>

That sounds nice, and a plethora of recent books by biologists and philosophers of science has been chiming in (or cashing in) on this issue. They offer a spectrum of accommodating claims,<sup>3-8</sup> including what Darwin himself (barely) tolerated, a start-it-and-leave-it-alone God.<sup>9</sup> But it's a con game, because the two areas are not really independent. Religion is not buying, because religious beliefs are not just about good manners, but about the nature of the real world. An omnipotent God can't be caged in an immaterial feel-good box and not be allowed to change the material world by answering prayers, curing a sick child, or granting victory in war. The believers' God transcends the immaterial, not just the other way around.

Biology isn't buying the separation of powers either. We accept no barriers to subjects we can explain by the "universal acid" of evolution.<sup>10</sup> We can't grant even a glimmer of concession to religion because we assume that everything can be understood in material terms. We never allow a paper to argue that an experiment went wrong because God interfered or accept untestable miracles. We don't even concede spiritual experience to religion: We want molecular explanations of the mind and consciousness, too.

Biologists make no attempt at appeasement. Celebrity atheists respond to religious idolotry with a Newtonian equal-and-opposite reaction: militant anti-religious popular treatments argue stridently that science shows the folly, if not the idiocy, of religion.<sup>11-14</sup> They've had their fill of "Intelligent" Designers and aren't going to take it any more. There is no evidence supporting Biblical literalism in relation to the earth, history, or the origin of species. Religion is benighted poppycock that has caused untold mayhem. These defiant heretics want to storm across the Peace Bridge and seize the far bank for evolution.

Most reactions from evolutionary biology go beyond the fact that religious accounts of history can be falsified to challenge even the claims of religious experience. They argue that religion is not a manifestation of external truth but of the adaptive value of an *illusion*. Religious illusion had fitness value, and various ideas have been advanced as to what that was.<sup>15</sup>

One idea is that religion is an epiphenomenon, a manifestation of the evolutionary survival value of imagination. By imagining things not before us, our ancestors could plan better hunting, gathering, or raiding parties or remember how to survive rare circumstances like droughts. That same neural facility is co-opted when we imagine God or a friendly, giving Santa Claus (Fig. 3).

Alternatively, religion *per se* might be adaptive. The shared illusion of God holds society together, no matter how unsocial religion often leads us to be toward other societies. The ability to conceive God is a constraint that helps keep social order and makes us more efficient in the struggle for survival. Some even take this view beyond classical Darwinian stress on individual fitness to argue that religion evolved by group selection.<sup>15,16</sup> Groups whose members shared a belief in the illusion were motivated to act in concert and out-compete other groups lacking that ability.

Yet another account holds that we have evolved soothing neurotransmitter physiology that creates the God illusion to calm ourselves from the anomie that otherwise would result from the realization that we are mortally trapped in a cold, remorseless cosmos.<sup>17</sup> This chemically induced, illusory serenity helps us care for ourselves and our genetic kin, keeping us cool under fire, and thus is a fitness advantage. Dopiness is bliss!

These arguments are parsimonious in that they apply to religion the same evolutionary explanation, adaptive natural selection, that we use to account for the existence of any other trait, like eyes, ears, and teeth. If religion is an adaptive illusion, there is no need to demonstrate the falsity of any particular culture's mythology because religion would then just be our made-

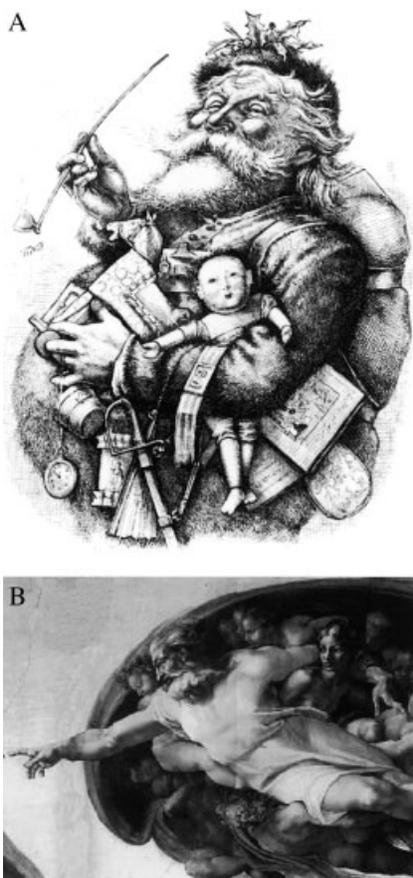


Figure 3. The imaginary and the real? A. Nice, paternal Santa who takes care of your kids. Drawing by Thomas Nast (1840–1902). B. Nice, paternal God who takes care of you (Michaelangelo's guess, Sistine Chapel, AD 1512).

up internal biology, not an interpretation of sensed input from the external world. In that case, it's no surprise that different cultures manifest the illusion differently, as classic works on the subject suggested long ago.<sup>18,19</sup> So, having dispensed with the false material claims, biology provides what seems to be a consistent, parsimonious account of the spiritual claims as well. But is it?

### A DIFFERENT INTERPRETATION OF PARSIMONY

The argument that religion is an evolutionary illusion is really another *post hoc* explanation because while creationists can't prove a trait is too complex to evolve by material means, our assertions alone can't prove that someone's experience of the paranor-

mal is a made-up illusion. Instead, we could consider a different kind of parsimonious explanation that would not have this baggage and would be consistent with our explanations for eyes, ears, and gnashing teeth: Might we have evolved a structural basis designed for these experiences by specifically sensing something in the external world that people report variously as God, "otherness," or a "presence"? In this scenario, the reported experiences vary among people and cultures because, like everything else in life, our ability is imperfect and still evolving to sense whatever it is. That would be why, like oysters viewing the sun, we have only a vague and imprecise sense of it. Some have no such experience, while shamans claim regular close connections. Since natural selection is not perfectly prescriptive, perhaps ancestors sensing whatever it is well enough might have been good enough for their Darwinian success.

This is how we explain similar limitations and variation in our other senses. Our success in putting religion's historical claims to the stake may give us confidence to extrapolate the same skepticism to its spiritual claims, too. But the fact that nobody has yet discovered what that sensed otherness actually is doesn't justify asserting that it isn't. Every year we discover things in biology that we hadn't dreamed of, but that in retrospect we can see were beneath our very noses for some time, a kind of dark matter of life.<sup>20</sup> But isn't there a difference between a fanciful notion of otherness and our senses of sight and sound? After all, we know which organs evolved to detect light and sound. If paranormal experience is not illusory, is there some structure evolved to experience it? In fact, the answer may be yes.

A considerable body of neurological evidence has identified focal regions of the brain in which paranormal experiences occur (Fig. 4).<sup>21–25</sup> They include the right temporal lobe<sup>24,25</sup> and specific parts of the right parietal<sup>26</sup> and frontal-parietal.<sup>21</sup> Neural imaging and characteristic EEGs show replicable patterns of local activity in this part of the brain when people report experiences variously described as paranormal or as a per-

ception of presences, otherness, or God. Temporal lobe epilepsy has also repeatedly been associated with such experiences. This area of the brain seems to be particularly active in strongly mystic, meditative, or religious activity in people like Buddhists, shamans, and pious nuns.

It is easy to imagine, in principle, how a gene coding for a calming neurotransmitter or the general ability of synapse connections to construct illusory mental images of things not directly visible could evolve. But it requires at least a little leap of faith, so to speak, to explain how evolution could produce the specific illusory idea of "God" independently in different cultures around the world and with such varying details, or why this particular kind of imagination evolved a specific home in the brain, which some have suggested patterned the brain specifically for cognitive religious experience.<sup>21</sup>

In fact, at least some neurobiological evidence may go a step further, and in the sensory-structure direction. It has been claimed that episodes of temporal lobe epilepsy and reports of paranormal experience are correlated with bursts of geomagnetic flux and, furthermore, that illusory responses of this kind can be induced experimentally by exposing the brain to changing magnetic fields.<sup>21–24,26</sup> (the latter claim is controversial<sup>27</sup>). Similarly, a left temporal-parietal area usually associated with self rather than other may respond in this way to electrical stimulation.<sup>28</sup> All sorts of other experiences and substances can also induce these kinds of experiences.

Even if the neurological evidence reliably suggests that paranormal experiences are biologically specific, that doesn't tell us what it is. It certainly does not tell us that paranormal experience is a response to a personal God. However, some authors infer from its neural inducibility that religious experiences are illusory rather than about the external world<sup>24,25,28</sup> and that is clearly a *non sequitur*. Because if Grandma's ears are to hear real sound with, and her eyes are to see real light with, what scientific evidence forces us to believe that this is a co-opted epiphenomenon rather than a sensory structure? The fact that par-

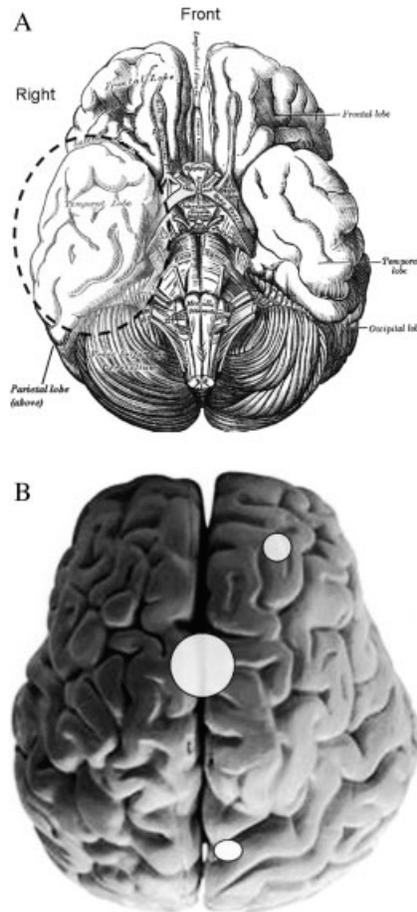


Figure 4. Reported loci of replicable paranormal experience. (A) Dashed oval on a classical drawing of the brain shows the temporal lobe area, viewed from below. Modified from *Gray's Anatomy*. (B) White circles show PET-scan images active during self-reported religious experience.<sup>21</sup>

anormal experiences can be induced experimentally does not make them always illusory, any more than optical illusions argue against the existence of light or the evolution of eyes to see it. However, even the findings of specific neural activation patterns remain phenomenological; it would be important and interesting to understand the genetic mechanisms that are behind them. There are now systematic, testable ways to approach that challenge.

### A MODEST PROPOSAL

A straightforward approach is to undertake a gene-mapping study of paranormal experiences. The idea is simple and has identified genes associated with hundreds of traits of all

kinds. A sample of individuals is collected: cases and controls, or families whose members vary in their paranormal experiences. All individuals' phenotypes are ascertained through self-report or neural imaging of their experiences. A small DNA sample harmlessly obtained from each person is typed for a battery of polymorphic marker sites evenly spaced in known locations across the genome. A statistical search is then done to find marker alleles that are preferentially found in individuals who score positive for the experiences. The association identifies markers, and hence chromosome regions, that contain genes having variation that accounts for the reported experience.

The next steps are to identify those genes and aspects of their protein-coding or expression-regulating sequences that have evolved rapidly in the human lineage or that vary with the reported experience. Such regions could be identified by comparing the homologous sequences in the human, chimpanzee, and macaque genomes, along with those of many other mammals for which the complete genome sequence is available. Special attention would fall naturally on genes or variation uniquely found in the human genome. The candidate genes can then be manipulated experimentally in mice to determine the functional effects of the evolutionarily changed sequence elements that are found. It would be necessary to learn how to recognize entranced mice, of course, but experts in mouse behavior might be enticed to help in the quest.

A lot is known about sensory systems. They share several characteristics, including that they are based specific receptor proteins<sup>29,30</sup> that are usually embedded in the surface membranes of cells in the receiving organs, such as the olfactory epithelium or retina, or perhaps, in this case, the right temporal lobe. One task would be to identify all receptor genes (indeed, all genes) that are activated in the appropriate brain regions at the time paranormal experiences occur. There are various ethical ways to obtain data on gene expression, including biopsies obtained at brain surgery or from victims of injury or accident. If mapping results were truly convincing, institutional

review board would probably approve expression studies on these genes in chimpanzees for something this important.

The genetic basis of any complex trait is challenging to work out, with no guarantee of success, and mapping is, at best, only a beginning. But we know at least something about *where* these experiences occur, and with luck we can start to find out *what* they are. It is possible that nothing new will be found. For example, if paranormal experience turns out just to involve local expression of the same internal neurotransmitter receptors that are at work in the rest of our brain functions, then science has been right ever since Darwin himself: Religious experience is an illusory epiphenomenon, an elaboration of abilities inherited from earlier primates. It will still be interesting to understand how and why this specific kind of experience is localized by the brain. But if, perchance, any previously unsuspected sensory system is discovered, it will be extremely interesting to determine what kind of information is being responded to. If that turns out to be geomagnetic flux or some currently unknown kind of information, how do our cells detect it and why would that have been favored by evolution? Do other species have it and, if so, how do they use it? Why would such a physical force manifest itself in the diverse image and likenesses of gods?

### THE WATCHMAKER'S VISION

This research might seem an unscientific search for the supernatural, but the phenomenon of paranormal experience is real and there's nothing unscientific about trying to understand it. In the unlikely event that a wholly unknown source of environmental information was discovered in this way, it would join the other *natural* phenomena we already know about. Of course religious people would want the research to reveal that they are communicating with spirits, not magnets. Some would like to see Darwin displaced from his throne, his statue in the British Museum's coffee shop replaced by one of Bishop "Soapy Sam" Wilberforce, Huxley's antagonist in the famous Oxford

debate. Finding the genetic basis for their experiences would also enable the pious to identify the mutations responsible for atheism (they'll name the gene *Unitarian1*). It would be a Pyrrhic vindication, however, because it would make heresy a treatable genetic disease rather than a punishable sin.

Such a result seems improbable based on what we know, but anything is possible. The core of science is to be open even to the unlikely, so long as it's testable. When we reject hypotheses about the paranormal on the basis of criteria like parsimony, we're assuming, like Laplace, that the hypotheses aren't necessary, but using our version of parsimony. That may be correct, but it is only one version. In many ways the religion-science debate basically still rests on a nineteenth-century view of evolution that hasn't changed since Darwin's time. From then to the spate of recent books, the discussion has concerned nature viewed after the fact and from the outside.

It has been a largely phenomenological argument over whether the complex structures of eyes, flagella, or seashells on mountaintops are the past work of natural or supernatural forces. In 1959, the University of Chicago held a famous Darwin Centennial symposium organized by anthropologists. The symposium included a set of papers on evolution and religion.<sup>31</sup> It's interesting that despite the historical occasion to reflect on a century of work since Darwin, these papers had almost no biological content. They were about I and thou, Yin and Yang, encyclicals, Genesis, whether there need be conflict between religion and science, and whether Thomas Huxley was right about "extinguished theologians."

At that time, today's neurobiological and gene-mapping tools to deal with personal experience weren't available, but the symposium included nary a word even about how science had at least shown by then that the real-world claims of received religion simply are not true. It was as if there was no real-world substance in Darwin, just differences in what people in science and religion believe. Even today, the argument remains largely a shouting contest, largely over cultural power rather than science. Both sides are thoroughly convinced that they know the

truth. Will things have changed in two years when we celebrate the 150<sup>th</sup> anniversary of Darwin's work?

Progress toward understanding the biological basis of otherness experiences could be within our grasp if we rethink aspects of the problem that might be open to legitimate scientific exploration. Are people reporting some previously unknown something out there to be found or just living a genetic illusion? Until we know, and no matter what the answer is, the issue raises points about how we interpret the traits we see in life, and what we mean by a parsimonious explanation in evolution. Something to keep in mind if your Grandma's teeth look rather strange.

### NOTES

I welcome comments on this column: kenweiss@psu.edu. I have feedback at [www.anthro.psu.edu/weiss\\_lab/index.html](http://www.anthro.psu.edu/weiss_lab/index.html). I thank Anne Buchanan and John Fleagle for many helpful suggestions about this manuscript, which doesn't mean they believe what I say.

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