Religion and the Brain

A Debate

December 01, 2009

Does evolution explain why the human brain supports religious belief? Dimitrios Kapogiannis and Jordan Grafman, scientists at the National Institutes of Health, follow up on a recent scientific paper by stating that brain networks that evolved for other purposes have given rise to our capacity for religious belief and experience. Andrew Newberg, the radiologist and psychiatrist who wrote How God Changes Your Brain*, takes a different approach. He argues that the brain may be an instrument of religious experience but is not necessarily the origin of that experience. Each side of the debate first wrote a position statement; the sides then exchanged statements and wrote rejoinders.*

This story has four sections: Dimitrios Kapogiannis and Jordan Grafman's opening statement; Andrew Newberg's opening statement; Kapogiannis and Grafman's response to Newberg; Newberg's response to Kapogiannis and Grafman.

How Our Brains Evolved to Accommodate Religious Belief

Dimitrios Kapogiannis and Jordan Grafman's opening statement

Every school of philosophical thought has proposed its own account of how religious belief originated. Philosophers typically consider religion to be a cultural and historical phenomenon without a foundation in science. They neither attempt to bridge different approaches to religion—psychological, cognitive, behavioral, social, political and historical—nor distinguish among religion's different aspects, such as belief, experience and ritual, in a way that enables people to test concrete hypotheses. However, recent progress in understanding the

neurobiology of social cognition has opened the door to a neuroscientific perspective on religion.

Scientific explanations for complex biological phenomena are not reductionist. Rather, they require synthesis of the various components and their interactions at different levels. To explain religion in biological terms, therefore, we need to define both its characteristics in an individual and the variability of its expression among people and cultures.

Religions and their accompanying belief systems are cultural universals. Relying upon cultural evolution alone to explain this ubiquity requires acceptance that the innovation of religion transpired at the dawn of human history and *all* human societies have perpetuated it separately, which seems highly unlikely. Moreover, we now know that other evolutionary phenomena, such as symbolic language and morality, have solid bases in biology and information processing.

Many current theorists regard religion as either an evolutionary adaptation or a byproduct of certain adaptive changes, driven in either case by the development of larger social groups and more complex interactions among them. These theories link the emergence of religion in our ancestors with the development of cognitive processes: theory of mind, the ability to interpret the intentions and emotions of others; social cognition, or neural processes concerned with such social phenomena as morals and group identity; intuitive (prescientific) theories about natural phenomena; causal reasoning; and symbolic language. These cognitive processes have different evolutionary origins, and presumably they resulted from the expansion of specific brain regions. Indeed, our research involving functional brain imaging of the invoking of religious beliefs leads us to conclude that religion emerged as a combination of cognitive functions, the main evolutionary advantage of which was probably unrelated to religion.

In an individual, the term *religiosity* refers to a cluster of personality traits related to the adoption of religious beliefs and engagement in

behaviors reflecting those beliefs. Due to both environmental and genetic factors, degrees of religiosity vary widely among modern humans. From an evolutionary standpoint, the variety stems from a lack of selection pressure—no single set of beliefs and associated behaviors conferred a survival advantage relative to others. As an evolutionary adaptation, religiosity resembles language, which humans adapted for social communication. The evolution of linguistic ability in the ancestors of modern homo sapiens clearly occurred at the biological level, and this evolution is a hallmark of modern humans. Fossil records reveal a gradual increase in the size of brain areas critical for language over tens of thousands of years. When groups of biologically nearly identical modern humans became geographically and socially separated, individual languages—like discrete religions— emerged and acquired their own *cultural* evolutionary histories (with a rate of change higher than Darwin's theory of evolution would predict for biological traits). These distinct histories result from an accumulation of seemingly random changes, but also from the selection of features that conferred some advantage, such as languages' differential prevalence of vowels and consonants based on climate.

Yet virtually all human beings have a comparable capacity for language, while the capacity for religion appears to be highly variable. Among our predecessor primate species—or groups within them—natural selection must have extinguished those with language deficiencies. In contrast, there are people with no supernatural beliefs—at least in the Western world, where alternative theories about how the world was created and how it evolved are widespread. It appears, therefore, that because natural selection did not eradicate populations that did not hold religious beliefs—or did not strongly adhere to them—there can be a high degree of variability in modern populations with regard to religion.

Brain Networks Involved in Religion

What, then, is the neurobiological basis of the highly variable human belief system? We found evidence that well-characterized brain

networks are involved. Despite seemingly daunting differences, we organize religious belief around three principles, or dimensions, at the cognitive level—at least among members of Western societies—and both religious and non-religious people share these organizing principles. A secondary process, then, determines an individual's specific expression of his or her beliefs. Researchers previously have implicated these neural circuits in understanding others' actions, intents and emotions, as well as in processing abstract language and imagery.[1] These basic cognitive and social skills are prerequisites for developing a sophisticated religious belief system.

In particular, the evolution of brain networks concerned with understanding the actions of others seems to have made possible concepts of a godlike entity's involvement in human life. The crucial brain areas for this function are in the part of the frontal portion of the brain that also is involved in observing purposeful human action and detecting underlying intentions. These brain areas work with other regions to decode the emotional impact of the actions we observe.

A self-centered analysis of complex social interactions must have been crucial not only for the survival and status of an individual among larger social groups, but also for the evolutionary stability of these groups. An individual's emotional life includes decoding others' emotions and employing them in association with his own goals. Moreover, regulating emotions—through such skills such as deception, for example—optimizes social performance. Our research demonstrates that a person's sense of love and anger from a godlike entity derives from these social functions.[1] This sense is based in brain areas whose evolution enabled us to detect emotion from others' facial expressions and tones of voice, as well as attribute personal relevance to social phenomena.

The previous two dimensions—understanding others' actions and intents and decoding their emotional impact—encompass perceptions of the level of involvement and emotion of God or another supernatural entity in the construction of religious belief. The third dimension refers to the

source of religious knowledge—what individuals have learned and experienced. This final dimension, we propose, influences how our brains code beliefs and connect them with other sources of knowledge. Together, the three dimensions we have identified help individuals construct religious belief systems that interact with other belief systems, social values and morals to help determine goals, control behaviors and balance emotions.

We should note that detecting another person's intent is perhaps the earliest (pre-linguistic) form of causal reasoning;[2] it allows us to predict future outcomes based on others' current behaviors. Perhaps, in early, prescientific attempts to explain physical phenomena or historical coincidences, our ancestors needed to imagine supernatural intervention. Children arrive at such default explanations at specific times during their development and sometimes hold on to them as superstitions throughout adulthood.

Such supernatural explanations may be reinforced by evolutionarily ancient neural networks that code rewards and punishments, and the uncertainty regarding expected rewards and events we find threatening.[3,4] In a danger-laden world, such as the one in which our ancestors evolved, the human brain may indeed have coded as a reward any explanation minimizing fear or the uncertainty of threats,[3,4] and this coding might even have offered a survival advantage.[5,6] A coherent world theory that assumed the existence of a supernatural being or beings may thus have had survival value at the individual level. Furthermore, adoption of such explanations by members of a group may have increased the predictability of their behavior, defined and signaled group membership and, therefore, promoted cooperation and had survival value at the group level.

The complexity of social interactions in these larger groups required abstract symbolic coding of ideas and mental states, and thus paved the way for symbolic language to evolve. This complexity also required people to mentally simulate possible social scenarios and outcomes,

which supported the evolution of mental imagery (an ability that, in turn, promotes learning, even at the elementary level of motor imagery). These abilities, along with the associated brain areas, enabled humans to develop a wide variety of religious and other beliefs. Doctrine, which refers to beliefs that are transmitted culturally rather than grounded in personal experience, is a special type of abstract idea; it engages brain areas involved in the processing of abstract language.

Another piece of the puzzle is the key involvement of visceral emotions that occur in both social interactions and religious behavior. In the course of human evolution, basic emotions such as disgust and fear acquired new social equivalents such as moral outrage and guilt. Religious practice successfully engages these social emotions. We have shown that, when devout people disagree with certain religious beliefs, activity increases in the brain's anterior insular cortices—areas involved in disgust, aversion, guilt and fear of loss.

More Than a Primitive Response

We conclude that there is nothing special about the source of religious knowledge or the brain networks involved. In the brain, religious knowledge relates to, and may be vulnerable to modification by, other sources of knowledge. These neural connections could account for the historical observation that religious ideas tend to cluster with certain political or social ideas more than we would expect simply from a random co-occurrence—an observation suggesting that religious ideas could be subordinate to a higher-order classification of concepts.

Critics might seize upon our findings as evidence that religion is a phenomenon of the primitive mind, and it might one day disappear as science "enlightens" humanity. Not so fast: Our need for religion might be embedded in our biology. Religious belief engages some of the most recently evolved brain areas, which perform uniquely human functions that define our species: the ability to comprehend the intentions and feelings of our fellow humans, symbolic language, reasoning. For better or worse, humans are not strictly logical creatures but social animals.

We imagine, observe, interpret, love, and occasionally detest each other. Therefore, we cannot consider religion strictly an outdated response to the modern world.

Instead, we believe that religious belief emerged for the purpose of social structure. Social structure originally was based upon principles derived from small family, group and tribal social interactions and a need to explain natural phenomena that did not appear to have an obvious human or animal physical cause. Then, as societies grew larger, religious belief further developed through the establishment of greater religious infrastructure. This emergence and adaptation of religious belief depended on the sophisticated cognitive and neurobiological processes we have described. In addition, if human brain evolution gave us *foresight* as a weapon against stronger foes and natural phenomena, then religious beliefs that concerned an afterlife might have been an effort to extend the boundaries of life in a way that was consistent with this newly found ability.

Although we have rightly ceded explanations for natural phenomena to science, we still struggle to create optimal social relations within and among societies, and in this quest, religion continues to play a vital role.

Religion, Evolution and the Brain: What Caused What?

Andrew Newberg's opening statement

Where did religious and spiritual beliefs come from? The answer to this question depends on your own belief system. The position of some people who are not religious echoes Sigmund Freud and, more recently, Richard Dawkins: Religion is primarily a pathological mistake made by the brain. Others with a less negative view consider religion to be a constructive creation of the brain. People holding the latter view might claim that evolutionary forces affected the human brain in such a way that it created religion as a means to better adapt to the world around us. Can evolution explain why the human brain supports religious beliefs? I argue that although explanations that focus on how brain structures and

functions have evolved may provide important information regarding the raison d'être of religion, this "neuroevolutionary" approach can be limited.

One problem with this approach to religion is the difficulty in discerning the element or elements that are adaptive—that undergo change to enhance the probability of survival. For instance, different models have focused on the sense of control over the world that religion helps us to achieve, religion's provision of social cohesiveness and moral foundations, its potential physical and mental health benefits or its utility in providing answers to questions that we cannot fathom. Still other theorists cite the importance of religious and spiritual *experiences* as primary evolutionary sources of religion.

A religious perspective challenges all of these neuroevolutionary approaches by reversing the causal arrow's direction: Perhaps religious belief causes the brain to change rather than the other way around.

A religious individual looks outward for religion's origin. Thus, the most common answer is straightforward: Religion comes from God. For a religious individual, it is no surprise that religion and spirituality are a part of the human brain—a God who provided human beings with no physiological way of having any kind of relationship with God would leave us with a fundamental theological problem. This explanation holds that religious beliefs originate with God, but thereafter, the human brain takes over to determine how we manifest those beliefs in our religious and spiritual practices. So, while an understanding of the brain may help us better comprehend how we become religious or spiritual, the brain only constrains or directs us toward those beliefs; it does not create them. This argument also helps explain why each religion has a different perspective on the meaning and nature of God, particularly God's relationship to human beings.

We can question the validity of the religious explanation—which clearly argues against a neuroevolutionary cause of religion—because there are no scientifically derived empirical data to support it. How, then, do we

know which explanation is correct? The fundamental problem is in evaluating how the brain perceives and understands reality. This dilemma forces us to re-evaluate what constitutes absolute fact and consider the potential need for an integrated epistemological approach to the question of how we know what is real.

The difficulty we face is how to evaluate the validity of different perspectives on the origins of religious and spiritual beliefs. Members of the emerging discipline of neurotheology—the study of how spiritual experiences and neural processes affect one another— are attempting to address this quandary by striving to combine neuroscience data with religious and theological ideas in order to better understand the intersection of religion and neuroscience. Neurotheology differs from other approaches to neuroscience in that it maintains a strong foothold in religious and spiritual beliefs. Thus, neurotheologians do not necessarily attempt to *explain* religion exclusively on the basis of neuroscience. Religious thinkers might have some things to say about neuroscience as well.

Ultimately, neurotheologians should both maintain and take into account religious and spiritual doctrines, practices and experiences while upholding appropriate scientific rigor. Trying to strike this balance raises fascinating and challenging methodological issues. So, while some of my arguments might sound more rational than others, depending on your belief system, it is important at least to reflect on each of the perspectives before reaching any conclusions about such a complex subject.

Scientific Approaches to Religion

When we evaluate evolution-based theories and other perspectives on religion, we must address several methodological concerns. Many scientific approaches explore religion; each can lead to a different conclusion about religion’s nature and origin. Therefore, even after we avoid the major temptation to explain away religion because of the lack of scientific evidence, methodological complications hinder our quest to

make rigorously derived conclusions supporting an evolutionary basis for religion.

The Neurophysiology of Spiritual Practices

One scientific model for studying the origin of religion employs brain-imaging technologies to explore the physiological changes associated with a spiritual practice such as prayer or meditation. For example, using positron emission tomography (PET), single photon emission computed tomography (SPECT) and functional magnetic resonance imaging (fMRI),[7] researchers derive simultaneous measures of biological changes in the brain, including cerebral blood flow and metabolism, and electrical and electrochemical (neurotransmitter) activity. Investigators use subjective measures to assess each participant's psychological and spiritual feelings or thoughts, and then they compare the biological and subjective measures. Researchers evaluate additional physiological measures such as blood pressure, body temperature, heart rate and galvanic skin response (a measure of autonomic nervous systems activity) because these are frequently associated with brain changes, and previous research has shown that religious and spiritual phenomena affect body physiology.

The ideal result of these procedures would be a detailed portrait of brain activity correlated with a particular religious or spiritual experience. Such research has indeed helped to delineate the physiological correlates of such experiences, but physiological correlates by themselves cannot explain origin and nature—in other words, we cannot conclude that the brain activity is the specific *cause* of religious experience. Most studies have shown that multiple brain areas are involved, which complicates the ability to identify one or two physiological mechanisms that explain religion.

Other problems are more fundamental. Most important, it is difficult to assess whether the brain generates or simply receives certain types of experiences, such as the feeling of being in God's presence. A brain scan shows associated changes but does not demonstrate whether these

changes caused the experience or were produced in response to an external stimulus.

Furthermore, researchers typically cannot obtain the psychological and spiritual data during such an experience, since that would require interrupting it. Even one tap on the shoulder to ask a research participant how he felt at that moment would destroy the occurrence we are trying to study. Thus, we can never be certain exactly when an intense religious experience actually occurred during an imaging session.

Finally, subjective measures typically are based on participants' responses to questions about what they felt, thought or perceived during the experience, but these responses, reflecting cognitive processes, are not necessarily the basis of a true spiritual episode. An inherent scientific bias in such studies is that investigators are measuring nothing more than cognitive processes of thought, feeling and experience, rather than something inherently spiritual (whatever that means from a scientific perspective).

Creating or Altering Spiritual Experiences

A second scientific method for studying the origin of religion involves trying to alter a participant's religious and spiritual experiences. This approach might employ the use of drugs to directly affect or stimulate a spiritual experience. Because certain hallucinogenic drugs and stimulants can induce spiritual experiences, careful research, perhaps utilizing modern imaging techniques, may help elucidate which neurobiological mechanisms are involved. Researchers already have investigated the use of such hallucinogenic agents, but more extensive study, particularly related to religious and spiritual episodes, is necessary to gain a better understanding of the range of their effects.[8] From a scientific perspective, one of the limitations of such studies is that different hallucinogens affect different neurotransmitter systems, thus making it difficult to determine whether any one neurotransmitter system is responsible for the drug-induced religious experience. Moreover, if multiple neurotransmitters are involved, how can we

conclude which neural pathway—and hence, which evolutionary element—resulted in religion?

In addition, the role of drugs in many shamanic and native cultures turns the neuroevolutionary theory of religion on its head. For thousands of years these groups have used psychotropic compounds to induce spiritual states. But rather than conceiving of such effects as biological or artificial, these cultures see the drugs as opening the mind up to the spiritual realm. For them, drug use is not unlike putting on a pair of glasses to see more clearly. The drugs merely take the brain to another level where it can perceive the world in a clearer or, perhaps, higher way. From this viewpoint, the brain enables spiritual and religious phenomena rather than causing them. To put it another way, such cultures would think brain evolution an effect of the spiritual realm rather than a cause of it.

Spiritual Experiences Related to Brain Injury or Disorders

A third neuroscientific method for exploring spiritual and religious phenomena is to study patients diagnosed with neurological or psychiatric conditions. For instance, studies have linked temporal lobe epileptic seizures, brain tumors, stroke and other brain injuries to spiritual experiences or alterations in religious beliefs. Temporal lobe epilepsy in particular has been associated with hyperreligiosity and religious conversions.[9] Psychiatric disorders such as schizophrenia and mania also have been associated with spiritual experiences and conversions. Delineating the type and location of the brain alterations involved in these conditions will help scientists explore the biological substrates associated with patients' spiritual episodes. However, clinical researchers must take care to avoid referring to spiritual experience only in pathological terms or as associated with conditions of brain disease or injury. This approach sometimes leads people to classify religion as delusional or abnormal because they define it only as part of a disease state.

In contrast, most religious individuals do not exhibit signs of a neurological or psychological disorder, and researchers have demonstrated that religion can help people cope with stress and, in many cases, reduce anxiety and depression. Thus, while psychopathological approaches provide a unique perspective on religious phenomena, they suggest that religion is not at all adaptive. This conclusion contradicts theories proposing that religion is an evolutionary process.

A Specific Focus on Brain Evolution

A more specific evolutionary approach to the study of religion typically focuses on two important aspects of human evolutionary development: social interactions and cognitive processes. Both appear central to religion.[1] Socially, it seems that human beings need to seek out and develop personal relationships that eventually can lead to the formation of a society on a grander scale. Cognitively, the human brain appears to continuously categorize and analyze the world to develop meaning and, perhaps more important, to determine appropriate social behaviors that will have survival benefits. Therefore, even though social behavior and religion appear to involve the same brain structures, we cannot assume that social behavior, rather than cognitive understanding and control, was the primary adaptive advantage that led to expansion of religion throughout the human world. Rather, any evolutionary advantage of religion could be multifactorial; it could include beneficial adaptations to social, cognitive, health, ethical and environmental factors.

The abilities to perceive and evaluate environmental dangers, to respond appropriately to situations and to weigh alternatives are critical to evolutionary adaptation. Our brains differentiate self from other, order things in space and time, perceive interrelationships among objects in the world and use symbols and language to express ideas. Religion may help to engage these cognitive processes, which we use to try to understand and control our world.

At issue is how each of us understands reality. Our individual perceptions of reality ultimately lead each of us to conclude whether

religion is nothing more than a product of the brain (adaptive or not) or a necessary result of a spiritual realm that our brain may occasionally access. This fundamental epistemological problem challenges all aspects of human thought—scientific, philosophical and theological.

How Do We Know What's Real?

This epistemological problem may prove to be the ultimate challenge to a purely scientific understanding of religion. How do we know whether anything we perceive is real or not? Put another way, how do we know if the reality of the external world corresponds, at least partially, to our mental representation of it? Humans have posed the question of realness since the dawn of philosophy, science and religion, and the question has generated various answers.

This reality question lies at the very heart of neuroscience. If our understanding of the world comes from the brain, it is subject to a variety of misinterpretations, misperceptions and misunderstandings. How, then, are we to know whether the reality we perceive—scientific, religious or otherwise—is the true representation of the world? Ultimately, after much philosophical, theological and scientific exploration, we may be forced to arrive at the rather uncomfortable circular statement that what we take to be real is dependent only on how real it feels to us. From the neuroscientific perspective, this is consistent with a wide array of research showing how our brains construct our senses of reality.

We return at last to neurotheology as an approach to understanding the nature of all types of experiences of reality. Both science and religion provide potentially important information about the world that our brains perceive. We may ultimately find that religion is nothing more than a manifestation of the brain's function set in place by millions of years of evolution. We might find that perceived spiritual dimensions help us to get in touch with the more fundamental nature of reality. Either way, we should tread carefully and strive to understand reality—on all levels.

Response to Andrew Newberg

Dimitrios Kapogiannis and Jordan Grafman

We read Newberg's essay with an eye toward common ground. We wholeheartedly agree with Newberg that religion can help people cope with stress by lowering anxiety and also may provide an ethical basis for interacting with the world.

Our quarrel with Newberg's perspective is that he shies away from the scientific method's commonly accepted grounding in natural causes and effects, reproducible experience and logical reasoning. Our essay is a purely scientific dialogue: We did not seek to criticize the usefulness of experimental design, but instead explored whether religious beliefs are special compared with other belief systems by discovering the brain systems and cognitive/social processes involved.

Newberg raises a number of points that we think deviate from a rigorous examination of religion. For example, he argues that religious belief may "cause the brain to change rather than the other way around." But research demonstrates that almost all behaviors cause the brain to change via practice and adaptation. Religious belief is not unique in that regard.

Furthermore, Newberg implies that exercise of brain functions over time wouldn't significantly influence the development of new knowledge or ways of being. Yet it is absurd to suggest that brain functions don't influence the development of belief systems. At the level of the individual, exercise of a brain function (say logical reasoning or imagination) can have a profound influence over the range of beliefs she accepts. Similarly, at the level of society, promotion of the use of brain functions (say abstract language or empathy) can also change the prevailing pattern of beliefs.

It is also reasonable to speculate that, in an evolutionary time scale, gradual evolution of a range of brain functions enabled the emergence

and adoption of myriad religious beliefs. Even modern biblical scholars and many religious practitioners would admit that there is little objective evidence that God has completely scripted the requirements of religious belief. The hypothesis to challenge here should be that religious belief emerged out of the cognitive and social capabilities of humans and that those abilities depended upon the structure and function of the human brain.

Even if we could persuade Newberg that the above argument is valid, he still might argue that we need a special branch of cognitive neuroscience, including dedicated neurotheologians, to study religious belief, and he may be on solid ground here. Nonetheless, psychology has always had a theoretical and an applied component. We and others on the theoretical side work to determine the underlying principles of human behavior and neural functions, while those in the applied school assess how those basic principles relate to specific circumstances. The key to understanding both theoretical and applied findings is to maintain the link between the two and to identify analogies to results in other disciplines.

At times we found Newberg's statement confusing. For example, he wrote that it is difficult to assess whether the brain generates or *receives* (our italics) certain types of experiences, such as the feeling of God's presence. Let us be clear: It is simply a supernatural declaration to say that God has issued a stimulus to alert us to his presence without our having the ability to detect it with modern instrumentation. For better or worse, no scientific instrument ever designed by humans can detect God, and our findings suggest that we don't have a dedicated sensory organ or neural area dedicated to Him. On the other hand, many cognitive functions, such as imagination, do not have any obvious external causes and instead are generated internally. Scientifically, we can approach those functions only by correlating subjective experiences with objective measurements of neuronal activity. Here again, there is nothing special about the study of religion in the brain. It seems that Newberg only plays devil's advocate in raising the issue of the legitimacy of the

neuroscientific methods for studying religion, since he bases his research on the same scientific principles as we do.

Newberg does not seem to observe the distinction between the evolutionary origins of religion as an almost universal human trait, which fits the timescale of biological evolution, and the origins of specific religions, which are better explained by cultural evolution. Moreover, he seems to wonder how it is possible for religion to have evolved for adaptive reasons, since much of the evidence for its neural correlates has emerged from the study of pathological states, such as epilepsy or schizophrenia. Again, there is nothing unique to religion, since our knowledge of physiology in general largely stems from studies of disease states. The deregulation of a mental or physiological function often provides the clues that lead to the understanding of its normal function. Lastly, Newberg refers to cultures that use drugs and shamans to explore religious belief and to reach ecstatic states. These are social phenomena worthy of documentation and study for their cultural effects and their impact on a person's experience and life view. Study of these agents or rituals likely will lead to the detection of brain regions important for these activities but not unique to them.

Science and religion may never reach common ground. Newberg seems to advocate a balance between incompatible reasoning systems. We have quite a different view of neurotheology, which we consider a branch of neuroscience that seeks to categorize and explain cultural phenomena based on tried and true neuroscience methods. Shamanistic cultures may offer different explanations for the origin of the world than does modern science; what we do not see is why this is relevant to the scientific study of religion.

In our view, religion constitutes a legitimate domain for scientific study, since the relevant phenomena are real and of great importance. We should determine the merit of any approach in terms of generalizeable knowledge. To quote Einstein, "Science without religion is lame, religion without science is blind."

Response to Dimitrios Kapogiannis and Jordan Grafman

Andrew Newberg

Kapogiannis and Grafman's research has provided another excellent piece to the puzzle of the nature of religiosity and religious belief. Their work also provides an impetus for further study to uncover the biological correlates of religion. This has great importance for advancing and strengthening research in the field linking neuroscience and religion, which I refer to as neurotheology. Their scientific investigation helps clarify the brain regions associated with specific components of religious belief.

In much of my own work, I have suggested that a large neural network appears to be involved in religious phenomena, including experiences and a vast array of beliefs. This model includes many of the regions Kapogiannis and Grafman have identified, but their new research provides even more detail. Given the richness and diversity of religious phenomena, which Kapogiannis and Grafman appropriately point out, the brain network that "gets into the act" is probably relatively large.

However, although experimentally defining cognitive and emotional aspects of religion in the context of research is necessary for adequate study, it also raises important concerns, as I have noted. In particular, by pre-defining how religion makes us feel and think, we may end up simply showing how the brain helps us feel and think in general rather than discovering something that is truly unique to religion. In other words, we might miss the part of ourselves that is inherently religious or spiritual if all that we attempt to study is the cognitive neuroscience of religion.

In terms of neuroscience, much of the research to date, including that of Kapogiannis and Grafman, measures general physiological correlates of religious phenomena. It also will be crucial to identify specific neurotransmitter systems that are involved in religious experience. This will likely be the next step in evaluating the neurophysiology of

religious phenomena. And because many brain regions are implicated, researchers should focus their attention on more than one neurotransmitter system.

Kapogiannis and Grafman's findings are consistent with previous models of religious phenomena, which implicate parts of the frontal, temporal and parietal lobes. As Kapogiannis and Grafman note, these areas are involved in higher cognitive processes, social behaviors and emotions. Such processes also play a critical role in religious phenomena. It is reasonable for any neuroevolutionary analysis of religion to lead to the conclusion that religion is built upon existing brain structures and their functions rather than on the development of a separate circuitry whose sole function would be supporting religious experience. Consistent with the findings of Kapogiannis and Grafman, there is no "God spot" in the brain. Rather, religion makes use of existing brain structures and their functions, and it appears that religious beliefs match up exceedingly well with those functions.

However, it is difficult to determine which of the functions related to religion ultimately provided the adaptive advantage that led religion to thrive throughout human history. Simply finding a relationship does not necessarily imply causality, and whether these findings ultimately imply that religion is nothing more than a brain-based phenomenon is another matter. The findings we are discussing link religion and the brain, but the brain may be receptive to religious experiences rather than creating them. Whether the brain generates religious belief or serves as a conduit for it remains a complicated question.

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Institutes of Health, follow up on a recent scientific paper by stating that brain networks that evolved for other purposes have given rise to our capacity for religious belief and experience. Andrew Newberg, the radiologist and psychiatrist who wrote How God Changes Your Brain, *takes a different approach. He argues that the brain may be an instrument of religious experience but is not necessarily the origin of that experience. Each side of the debate first wrote a position statement; the sides then exchanged statements and wrote rejoinders.*

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How Our Brains Evolved to Accommodate Religious Belief

Dimitrios Kapogiannis and Jordan Grafman's opening statement

Every school of philosophical thought has proposed its own account of how religious belief originated. Philosophers typically consider religion to be a cultural and historical phenomenon without a foundation in science. They neither attempt to bridge different approaches to religion—psychological, cognitive, behavioral, social, political and historical—nor distinguish among religion's different aspects, such as belief, experience and ritual, in a way that enables people to test concrete hypotheses. However, recent progress in understanding the neurobiology of social cognition has opened the door to a neuroscientific perspective on religion.

Scientific explanations for complex biological phenomena are not reductionist. Rather, they require synthesis of the various components and their interactions at different levels. To explain religion in biological terms, therefore, we need to define both its characteristics in an

individual and the variability of its expression among people and cultures.

Religions and their accompanying belief systems are cultural universals. Relying upon cultural evolution alone to explain this ubiquity requires acceptance that the innovation of religion transpired at the dawn of human history and *all* human societies have perpetuated it separately, which seems highly unlikely. Moreover, we now know that other evolutionary phenomena, such as symbolic language and morality, have solid bases in biology and information processing.

Many current theorists regard religion as either an evolutionary adaptation or a byproduct of certain adaptive changes, driven in either case by the development of larger social groups and more complex interactions among them. These theories link the emergence of religion in our ancestors with the development of cognitive processes: theory of mind, the ability to interpret the intentions and emotions of others; social cognition, or neural processes concerned with such social phenomena as morals and group identity; intuitive (prescientific) theories about natural phenomena; causal reasoning; and symbolic language. These cognitive processes have different evolutionary origins, and presumably they resulted from the expansion of specific brain regions. Indeed, our research involving functional brain imaging of the invoking of religious beliefs leads us to conclude that religion emerged as a combination of cognitive functions, the main evolutionary advantage of which was probably unrelated to religion.

In an individual, the term *religiosity* refers to a cluster of personality traits related to the adoption of religious beliefs and engagement in behaviors reflecting those beliefs. Due to both environmental and genetic factors, degrees of religiosity vary widely among modern humans. From an evolutionary standpoint, the variety stems from a lack of selection pressure—no single set of beliefs and associated behaviors conferred a survival advantage relative to others. As an evolutionary adaptation, religiosity resembles language, which humans adapted for

social communication. The evolution of linguistic ability in the ancestors of modern homo sapiens clearly occurred at the biological level, and this evolution is a hallmark of modern humans. Fossil records reveal a gradual increase in the size of brain areas critical for language over tens of thousands of years. When groups of biologically nearly identical modern humans became geographically and socially separated, individual languages—like discrete religions— emerged and acquired their own *cultural* evolutionary histories (with a rate of change higher than Darwin's theory of evolution would predict for biological traits). These distinct histories result from an accumulation of seemingly random changes, but also from the selection of features that conferred some advantage, such as languages' differential prevalence of vowels and consonants based on climate.

Yet virtually all human beings have a comparable capacity for language, while the capacity for religion appears to be highly variable. Among our predecessor primate species—or groups within them—natural selection must have extinguished those with language deficiencies. In contrast, there are people with no supernatural beliefs—at least in the Western world, where alternative theories about how the world was created and how it evolved are widespread. It appears, therefore, that because natural selection did not eradicate populations that did not hold religious beliefs—or did not strongly adhere to them—there can be a high degree of variability in modern populations with regard to religion.

Brain Networks Involved in Religion

What, then, is the neurobiological basis of the highly variable human belief system? We found evidence that well-characterized brain networks are involved. Despite seemingly daunting differences, we organize religious belief around three principles, or dimensions, at the cognitive level—at least among members of Western societies—and both religious and non-religious people share these organizing principles. A secondary process, then, determines an individual's specific expression of his or her beliefs. Researchers previously have

implicated these neural circuits in understanding others' actions, intents and emotions, as well as in processing abstract language and imagery.[1] These basic cognitive and social skills are prerequisites for developing a sophisticated religious belief system.

In particular, the evolution of brain networks concerned with understanding the actions of others seems to have made possible concepts of a godlike entity's involvement in human life. The crucial brain areas for this function are in the part of the frontal portion of the brain that also is involved in observing purposeful human action and detecting underlying intentions. These brain areas work with other regions to decode the emotional impact of the actions we observe.

A self-centered analysis of complex social interactions must have been crucial not only for the survival and status of an individual among larger social groups, but also for the evolutionary stability of these groups. An individual's emotional life includes decoding others' emotions and employing them in association with his own goals. Moreover, regulating emotions—through such skills such as deception, for example—optimizes social performance. Our research demonstrates that a person's sense of love and anger from a godlike entity derives from these social functions.[1] This sense is based in brain areas whose evolution enabled us to detect emotion from others' facial expressions and tones of voice, as well as attribute personal relevance to social phenomena.

The previous two dimensions—understanding others' actions and intents and decoding their emotional impact—encompass perceptions of the level of involvement and emotion of God or another supernatural entity in the construction of religious belief. The third dimension refers to the source of religious knowledge—what individuals have learned and experienced. This final dimension, we propose, influences how our brains code beliefs and connect them with other sources of knowledge. Together, the three dimensions we have identified help individuals construct religious belief systems that interact with other belief systems,

social values and morals to help determine goals, control behaviors and balance emotions.

We should note that detecting another person's intent is perhaps the earliest (pre-linguistic) form of causal reasoning;[2] it allows us to predict future outcomes based on others' current behaviors. Perhaps, in early, prescientific attempts to explain physical phenomena or historical coincidences, our ancestors needed to imagine supernatural intervention. Children arrive at such default explanations at specific times during their development and sometimes hold on to them as superstitions throughout adulthood.

Such supernatural explanations may be reinforced by evolutionarily ancient neural networks that code rewards and punishments, and the uncertainty regarding expected rewards and events we find threatening.[3,4] In a danger-laden world, such as the one in which our ancestors evolved, the human brain may indeed have coded as a reward any explanation minimizing fear or the uncertainty of threats,[3,4] and this coding might even have offered a survival advantage.[5,6] A coherent world theory that assumed the existence of a supernatural being or beings may thus have had survival value at the individual level. Furthermore, adoption of such explanations by members of a group may have increased the predictability of their behavior, defined and signaled group membership and, therefore, promoted cooperation and had survival value at the group level.

The complexity of social interactions in these larger groups required abstract symbolic coding of ideas and mental states, and thus paved the way for symbolic language to evolve. This complexity also required people to mentally simulate possible social scenarios and outcomes, which supported the evolution of mental imagery (an ability that, in turn, promotes learning, even at the elementary level of motor imagery). These abilities, along with the associated brain areas, enabled humans to develop a wide variety of religious and other beliefs. Doctrine, which refers to beliefs that are transmitted culturally rather than grounded in

personal experience, is a special type of abstract idea; it engages brain areas involved in the processing of abstract language.

Another piece of the puzzle is the key involvement of visceral emotions that occur in both social interactions and religious behavior. In the course of human evolution, basic emotions such as disgust and fear acquired new social equivalents such as moral outrage and guilt. Religious practice successfully engages these social emotions. We have shown that, when devout people disagree with certain religious beliefs, activity increases in the brain's anterior insular cortices—areas involved in disgust, aversion, guilt and fear of loss.

More Than a Primitive Response

We conclude that there is nothing special about the source of religious knowledge or the brain networks involved. In the brain, religious knowledge relates to, and may be vulnerable to modification by, other sources of knowledge. These neural connections could account for the historical observation that religious ideas tend to cluster with certain political or social ideas more than we would expect simply from a random co-occurrence—an observation suggesting that religious ideas could be subordinate to a higher-order classification of concepts.

Critics might seize upon our findings as evidence that religion is a phenomenon of the primitive mind, and it might one day disappear as science "enlightens" humanity. Not so fast: Our need for religion might be embedded in our biology. Religious belief engages some of the most recently evolved brain areas, which perform uniquely human functions that define our species: the ability to comprehend the intentions and feelings of our fellow humans, symbolic language, reasoning. For better or worse, humans are not strictly logical creatures but social animals. We imagine, observe, interpret, love, and occasionally detest each other. Therefore, we cannot consider religion strictly an outdated response to the modern world.

Instead, we believe that religious belief emerged for the purpose of social structure. Social structure originally was based upon principles derived from small family, group and tribal social interactions and a need to explain natural phenomena that did not appear to have an obvious human or animal physical cause. Then, as societies grew larger, religious belief further developed through the establishment of greater religious infrastructure. This emergence and adaptation of religious belief depended on the sophisticated cognitive and neurobiological processes we have described. In addition, if human brain evolution gave us *foresight* as a weapon against stronger foes and natural phenomena, then religious beliefs that concerned an afterlife might have been an effort to extend the boundaries of life in a way that was consistent with this newly found ability.

Although we have rightly ceded explanations for natural phenomena to science, we still struggle to create optimal social relations within and among societies, and in this quest, religion continues to play a vital role.

Religion, Evolution and the Brain: What Caused What?

Andrew Newberg's opening statement

Where did religious and spiritual beliefs come from? The answer to this question depends on your own belief system. The position of some people who are not religious echoes Sigmund Freud and, more recently, Richard Dawkins: Religion is primarily a pathological mistake made by the brain. Others with a less negative view consider religion to be a constructive creation of the brain. People holding the latter view might claim that evolutionary forces affected the human brain in such a way that it created religion as a means to better adapt to the world around us. Can evolution explain why the human brain supports religious beliefs? I argue that although explanations that focus on how brain structures and functions have evolved may provide important information regarding the raison d'être of religion, this "neuroevolutionary" approach can be limited.

One problem with this approach to religion is the difficulty in discerning the element or elements that are adaptive—that undergo change to enhance the probability of survival. For instance, different models have focused on the sense of control over the world that religion helps us to achieve, religion's provision of social cohesiveness and moral foundations, its potential physical and mental health benefits or its utility in providing answers to questions that we cannot fathom. Still other theorists cite the importance of religious and spiritual *experiences* as primary evolutionary sources of religion.

A religious perspective challenges all of these neuroevolutionary approaches by reversing the causal arrow's direction: Perhaps religious belief causes the brain to change rather than the other way around.

A religious individual looks outward for religion's origin. Thus, the most common answer is straightforward: Religion comes from God. For a religious individual, it is no surprise that religion and spirituality are a part of the human brain—a God who provided human beings with no physiological way of having any kind of relationship with God would leave us with a fundamental theological problem. This explanation holds that religious beliefs originate with God, but thereafter, the human brain takes over to determine how we manifest those beliefs in our religious and spiritual practices. So, while an understanding of the brain may help us better comprehend how we become religious or spiritual, the brain only constrains or directs us toward those beliefs; it does not create them. This argument also helps explain why each religion has a different perspective on the meaning and nature of God, particularly God's relationship to human beings.

We can question the validity of the religious explanation—which clearly argues against a neuroevolutionary cause of religion—because there are no scientifically derived empirical data to support it. How, then, do we know which explanation is correct? The fundamental problem is in evaluating how the brain perceives and understands reality. This dilemma forces us to re-evaluate what constitutes absolute fact and

consider the potential need for an integrated epistemological approach to the question of how we know what is real.

The difficulty we face is how to evaluate the validity of different perspectives on the origins of religious and spiritual beliefs. Members of the emerging discipline of neurotheology—the study of how spiritual experiences and neural processes affect one another— are attempting to address this quandary by striving to combine neuroscience data with religious and theological ideas in order to better understand the intersection of religion and neuroscience. Neurotheology differs from other approaches to neuroscience in that it maintains a strong foothold in religious and spiritual beliefs. Thus, neurotheologians do not necessarily attempt to *explain* religion exclusively on the basis of neuroscience. Religious thinkers might have some things to say about neuroscience as well.

Ultimately, neurotheologians should both maintain and take into account religious and spiritual doctrines, practices and experiences while upholding appropriate scientific rigor. Trying to strike this balance raises fascinating and challenging methodological issues. So, while some of my arguments might sound more rational than others, depending on your belief system, it is important at least to reflect on each of the perspectives before reaching any conclusions about such a complex subject.

Scientific Approaches to Religion

When we evaluate evolution-based theories and other perspectives on religion, we must address several methodological concerns. Many scientific approaches explore religion; each can lead to a different conclusion about religion’s nature and origin. Therefore, even after we avoid the major temptation to explain away religion because of the lack of scientific evidence, methodological complications hinder our quest to make rigorously derived conclusions supporting an evolutionary basis for religion.

The Neurophysiology of Spiritual Practices

One scientific model for studying the origin of religion employs brain-imaging technologies to explore the physiological changes associated with a spiritual practice such as prayer or meditation. For example, using positron emission tomography (PET), single photon emission computed tomography (SPECT) and functional magnetic resonance imaging (fMRI),[7] researchers derive simultaneous measures of biological changes in the brain, including cerebral blood flow and metabolism, and electrical and electrochemical (neurotransmitter) activity. Investigators use subjective measures to assess each participant's psychological and spiritual feelings or thoughts, and then they compare the biological and subjective measures. Researchers evaluate additional physiological measures such as blood pressure, body temperature, heart rate and galvanic skin response (a measure of autonomic nervous systems activity) because these are frequently associated with brain changes, and previous research has shown that religious and spiritual phenomena affect body physiology.

The ideal result of these procedures would be a detailed portrait of brain activity correlated with a particular religious or spiritual experience. Such research has indeed helped to delineate the physiological correlates of such experiences, but physiological correlates by themselves cannot explain origin and nature—in other words, we cannot conclude that the brain activity is the specific *cause* of religious experience. Most studies have shown that multiple brain areas are involved, which complicates the ability to identify one or two physiological mechanisms that explain religion.

Other problems are more fundamental. Most important, it is difficult to assess whether the brain generates or simply receives certain types of experiences, such as the feeling of being in God's presence. A brain scan shows associated changes but does not demonstrate whether these changes caused the experience or were produced in response to an external stimulus.

Furthermore, researchers typically cannot obtain the psychological and spiritual data during such an experience, since that would require interrupting it. Even one tap on the shoulder to ask a research participant how he felt at that moment would destroy the occurrence we are trying to study. Thus, we can never be certain exactly when an intense religious experience actually occurred during an imaging session.

Finally, subjective measures typically are based on participants' responses to questions about what they felt, thought or perceived during the experience, but these responses, reflecting cognitive processes, are not necessarily the basis of a true spiritual episode. An inherent scientific bias in such studies is that investigators are measuring nothing more than cognitive processes of thought, feeling and experience, rather than something inherently spiritual (whatever that means from a scientific perspective).

Creating or Altering Spiritual Experiences

A second scientific method for studying the origin of religion involves trying to alter a participant's religious and spiritual experiences. This approach might employ the use of drugs to directly affect or stimulate a spiritual experience. Because certain hallucinogenic drugs and stimulants can induce spiritual experiences, careful research, perhaps utilizing modern imaging techniques, may help elucidate which neurobiological mechanisms are involved. Researchers already have investigated the use of such hallucinogenic agents, but more extensive study, particularly related to religious and spiritual episodes, is necessary to gain a better understanding of the range of their effects.[8] From a scientific perspective, one of the limitations of such studies is that different hallucinogens affect different neurotransmitter systems, thus making it difficult to determine whether any one neurotransmitter system is responsible for the drug-induced religious experience. Moreover, if multiple neurotransmitters are involved, how can we conclude which neural pathway—and hence, which evolutionary element—resulted in religion?

In addition, the role of drugs in many shamanic and native cultures turns the neuroevolutionary theory of religion on its head. For thousands of years these groups have used psychotropic compounds to induce spiritual states. But rather than conceiving of such effects as biological or artificial, these cultures see the drugs as opening the mind up to the spiritual realm. For them, drug use is not unlike putting on a pair of glasses to see more clearly. The drugs merely take the brain to another level where it can perceive the world in a clearer or, perhaps, higher way. From this viewpoint, the brain enables spiritual and religious phenomena rather than causing them. To put it another way, such cultures would think brain evolution an effect of the spiritual realm rather than a cause of it.

Spiritual Experiences Related to Brain Injury or Disorders

A third neuroscientific method for exploring spiritual and religious phenomena is to study patients diagnosed with neurological or psychiatric conditions. For instance, studies have linked temporal lobe epileptic seizures, brain tumors, stroke and other brain injuries to spiritual experiences or alterations in religious beliefs. Temporal lobe epilepsy in particular has been associated with hyperreligiosity and religious conversions.[9] Psychiatric disorders such as schizophrenia and mania also have been associated with spiritual experiences and conversions. Delineating the type and location of the brain alterations involved in these conditions will help scientists explore the biological substrates associated with patients' spiritual episodes. However, clinical researchers must take care to avoid referring to spiritual experience only in pathological terms or as associated with conditions of brain disease or injury. This approach sometimes leads people to classify religion as delusional or abnormal because they define it only as part of a disease state.

In contrast, most religious individuals do not exhibit signs of a neurological or psychological disorder, and researchers have demonstrated that religion can help people cope with stress and, in many

cases, reduce anxiety and depression. Thus, while psychopathological approaches provide a unique perspective on religious phenomena, they suggest that religion is not at all adaptive. This conclusion contradicts theories proposing that religion is an evolutionary process.

A Specific Focus on Brain Evolution

A more specific evolutionary approach to the study of religion typically focuses on two important aspects of human evolutionary development: social interactions and cognitive processes. Both appear central to religion.[1] Socially, it seems that human beings need to seek out and develop personal relationships that eventually can lead to the formation of a society on a grander scale. Cognitively, the human brain appears to continuously categorize and analyze the world to develop meaning and, perhaps more important, to determine appropriate social behaviors that will have survival benefits. Therefore, even though social behavior and religion appear to involve the same brain structures, we cannot assume that social behavior, rather than cognitive understanding and control, was the primary adaptive advantage that led to expansion of religion throughout the human world. Rather, any evolutionary advantage of religion could be multifactorial; it could include beneficial adaptations to social, cognitive, health, ethical and environmental factors.

The abilities to perceive and evaluate environmental dangers, to respond appropriately to situations and to weigh alternatives are critical to evolutionary adaptation. Our brains differentiate self from other, order things in space and time, perceive interrelationships among objects in the world and use symbols and language to express ideas. Religion may help to engage these cognitive processes, which we use to try to understand and control our world.

At issue is how each of us understands reality. Our individual perceptions of reality ultimately lead each of us to conclude whether religion is nothing more than a product of the brain (adaptive or not) or a necessary result of a spiritual realm that our brain may occasionally

access. This fundamental epistemological problem challenges all aspects of human thought—scientific, philosophical and theological.

How Do We Know What's Real?

This epistemological problem may prove to be the ultimate challenge to a purely scientific understanding of religion. How do we know whether anything we perceive is real or not? Put another way, how do we know if the reality of the external world corresponds, at least partially, to our mental representation of it? Humans have posed the question of realness since the dawn of philosophy, science and religion, and the question has generated various answers.

This reality question lies at the very heart of neuroscience. If our understanding of the world comes from the brain, it is subject to a variety of misinterpretations, misperceptions and misunderstandings. How, then, are we to know whether the reality we perceive—scientific, religious or otherwise—is the true representation of the world? Ultimately, after much philosophical, theological and scientific exploration, we may be forced to arrive at the rather uncomfortable circular statement that what we take to be real is dependent only on how real it feels to us. From the neuroscientific perspective, this is consistent with a wide array of research showing how our brains construct our senses of reality.

We return at last to neurotheology as an approach to understanding the nature of all types of experiences of reality. Both science and religion provide potentially important information about the world that our brains perceive. We may ultimately find that religion is nothing more than a manifestation of the brain's function set in place by millions of years of evolution. We might find that perceived spiritual dimensions help us to get in touch with the more fundamental nature of reality. Either way, we should tread carefully and strive to understand reality—on all levels.

Response to Andrew Newberg

Dimitrios Kapogiannis and Jordan Grafman

We read Newberg's essay with an eye toward common ground. We wholeheartedly agree with Newberg that religion can help people cope with stress by lowering anxiety and also may provide an ethical basis for interacting with the world.

Our quarrel with Newberg's perspective is that he shies away from the scientific method's commonly accepted grounding in natural causes and effects, reproducible experience and logical reasoning. Our essay is a purely scientific dialogue: We did not seek to criticize the usefulness of experimental design, but instead explored whether religious beliefs are special compared with other belief systems by discovering the brain systems and cognitive/social processes involved.

Newberg raises a number of points that we think deviate from a rigorous examination of religion. For example, he argues that religious belief may "cause the brain to change rather than the other way around." But research demonstrates that almost all behaviors cause the brain to change via practice and adaptation. Religious belief is not unique in that regard.

Furthermore, Newberg implies that exercise of brain functions over time wouldn't significantly influence the development of new knowledge or ways of being. Yet it is absurd to suggest that brain functions don't influence the development of belief systems. At the level of the individual, exercise of a brain function (say logical reasoning or imagination) can have a profound influence over the range of beliefs she accepts. Similarly, at the level of society, promotion of the use of brain functions (say abstract language or empathy) can also change the prevailing pattern of beliefs.

It is also reasonable to speculate that, in an evolutionary time scale, gradual evolution of a range of brain functions enabled the emergence and adoption of myriad religious beliefs. Even modern biblical scholars and many religious practitioners would admit that there is little objective

evidence that God has completely scripted the requirements of religious belief. The hypothesis to challenge here should be that religious belief emerged out of the cognitive and social capabilities of humans and that those abilities depended upon the structure and function of the human brain.

Even if we could persuade Newberg that the above argument is valid, he still might argue that we need a special branch of cognitive neuroscience, including dedicated neurotheologians, to study religious belief, and he may be on solid ground here. Nonetheless, psychology has always had a theoretical and an applied component. We and others on the theoretical side work to determine the underlying principles of human behavior and neural functions, while those in the applied school assess how those basic principles relate to specific circumstances. The key to understanding both theoretical and applied findings is to maintain the link between the two and to identify analogies to results in other disciplines.

At times we found Newberg's statement confusing. For example, he wrote that it is difficult to assess whether the brain generates or *receives* (our italics) certain types of experiences, such as the feeling of God's presence. Let us be clear: It is simply a supernatural declaration to say that God has issued a stimulus to alert us to his presence without our having the ability to detect it with modern instrumentation. For better or worse, no scientific instrument ever designed by humans can detect God, and our findings suggest that we don't have a dedicated sensory organ or neural area dedicated to Him. On the other hand, many cognitive functions, such as imagination, do not have any obvious external causes and instead are generated internally. Scientifically, we can approach those functions only by correlating subjective experiences with objective measurements of neuronal activity. Here again, there is nothing special about the study of religion in the brain. It seems that Newberg only plays devil's advocate in raising the issue of the legitimacy of the neuroscientific methods for studying religion, since he bases his research on the same scientific principles as we do.

Newberg does not seem to observe the distinction between the evolutionary origins of religion as an almost universal human trait, which fits the timescale of biological evolution, and the origins of specific religions, which are better explained by cultural evolution. Moreover, he seems to wonder how it is possible for religion to have evolved for adaptive reasons, since much of the evidence for its neural correlates has emerged from the study of pathological states, such as epilepsy or schizophrenia. Again, there is nothing unique to religion, since our knowledge of physiology in general largely stems from studies of disease states. The deregulation of a mental or physiological function often provides the clues that lead to the understanding of its normal function. Lastly, Newberg refers to cultures that use drugs and shamans to explore religious belief and to reach ecstatic states. These are social phenomena worthy of documentation and study for their cultural effects and their impact on a person's experience and life view. Study of these agents or rituals likely will lead to the detection of brain regions important for these activities but not unique to them.

Science and religion may never reach common ground. Newberg seems to advocate a balance between incompatible reasoning systems. We have quite a different view of neurotheology, which we consider a branch of neuroscience that seeks to categorize and explain cultural phenomena based on tried and true neuroscience methods. Shamanistic cultures may offer different explanations for the origin of the world than does modern science; what we do not see is why this is relevant to the scientific study of religion.

In our view, religion constitutes a legitimate domain for scientific study, since the relevant phenomena are real and of great importance. We should determine the merit of any approach in terms of generalizeable knowledge. To quote Einstein, "Science without religion is lame, religion without science is blind."

Response to Dimitrios Kapogiannis and Jordan Grafman

Andrew Newberg

Kapogiannis and Grafman's research has provided another excellent piece to the puzzle of the nature of religiosity and religious belief. Their work also provides an impetus for further study to uncover the biological correlates of religion. This has great importance for advancing and strengthening research in the field linking neuroscience and religion, which I refer to as neurotheology. Their scientific investigation helps clarify the brain regions associated with specific components of religious belief.

In much of my own work, I have suggested that a large neural network appears to be involved in religious phenomena, including experiences and a vast array of beliefs. This model includes many of the regions Kapogiannis and Grafman have identified, but their new research provides even more detail. Given the richness and diversity of religious phenomena, which Kapogiannis and Grafman appropriately point out, the brain network that "gets into the act" is probably relatively large.

However, although experimentally defining cognitive and emotional aspects of religion in the context of research is necessary for adequate study, it also raises important concerns, as I have noted. In particular, by pre-defining how religion makes us feel and think, we may end up simply showing how the brain helps us feel and think in general rather than discovering something that is truly unique to religion. In other words, we might miss the part of ourselves that is inherently religious or spiritual if all that we attempt to study is the cognitive neuroscience of religion.

In terms of neuroscience, much of the research to date, including that of Kapogiannis and Grafman, measures general physiological correlates of religious phenomena. It also will be crucial to identify specific neurotransmitter systems that are involved in religious experience. This will likely be the next step in evaluating the neurophysiology of religious phenomena. And because many brain regions are implicated, researchers should focus their attention on more than one neurotransmitter system.

Kapogiannis and Grafman's findings are consistent with previous models of religious phenomena, which implicate parts of the frontal, temporal and parietal lobes. As Kapogiannis and Grafman note, these areas are involved in higher cognitive processes, social behaviors and emotions. Such processes also play a critical role in religious phenomena. It is reasonable for any neuroevolutionary analysis of religion to lead to the conclusion that religion is built upon existing brain structures and their functions rather than on the development of a separate circuitry whose sole function would be supporting religious experience. Consistent with the findings of Kapogiannis and Grafman, there is no "God spot" in the brain. Rather, religion makes use of existing brain structures and their functions, and it appears that religious beliefs match up exceedingly well with those functions.

However, it is difficult to determine which of the functions related to religion ultimately provided the adaptive advantage that led religion to thrive throughout human history. Simply finding a relationship does not necessarily imply causality, and whether these findings ultimately imply that religion is nothing more than a brain-based phenomenon is another matter. The findings we are discussing link religion and the brain, but the brain may be receptive to religious experiences rather than creating them. Whether the brain generates religious belief or serves as a conduit for it remains a complicated question.