

## The Neuropsychology of Religion

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# NeuroTheology:

## Brain, Science, Spirituality & Religious Experience

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### Chapter 10

## THE NEUROPSYCHOLOGY OF RELIGION, by Scott Atran



### *THE NEUROPSYCHOLOGY OF RELIGION*

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#### **1. Religion's Evolutionary Landscape: Cognition and Commitment.**

Consider religion to be a community's (1) costly and hard-to-fake commitment (2) to a counterfactual world of supernatural agents (3) who master people's existential anxieties, such as death and deception. This intellectual framework guides a research program that aims to foster scientific dialogue between cultural anthropology, cognitive psychology and evolutionary biology regarding a set of phenomena vital to most human life and all societies (Atran 2002). The present chapter mainly concerns the third criterion of religion (3), and its implications for neuropsychology. This introductory section, however, first summarizes the overall intellectual framework.

The criterion (1) of costly commitment rules out cognitive theories of religion as sufficient, however insightful. Such theories lack motive (Atran & Sperber 1991, Boyer 1994, Barrett 2000). In principle, they can't distinguish nonreligious fantasy from religious belief. They fail to tell us why, in general, the greater the sacrifice to the apparently absurd – as in Abraham's willingness to offer up his beloved son - the more others trust in one's commitment (Kierkegaard 1955[1843], Weber 1946).

The criterion (2) of belief in the supernatural rules out commitment theories of religion as sufficient, however insightful. Such theories disregard cognitive structure and its causal role (Irons 1996, Nesse 1999, Wilson 2002). They don't distinguish strong secular ideologies, such as orthodox belief in Marxism or the Market, from religious belief.

Religions invoke supernatural agents to deal with (3) emotionally eruptive existential anxieties, such as death and deception (Feuerbach 1972[1843], Freud 1990[1913]) They generally have malevolent and predatory deities as well as more benevolent and protective ones. Supernatural agent concepts trigger

our naturally-selected agency-detection system, which is trip-wired to respond to fragmentary information, inciting perception of figures lurking in shadows, and emotions of dread or awe (Guthrie 1993; cf. Hume 1956[1757]). To be sure, nondeistic “theologies”, such as Buddhism and Taoism, doctrinally eschew the supernatural. Nevertheless, common folk who espouse these faiths routinely entertain belief in an array of gods and spirits. Even Buddhist monks ritually ward off malevolent deities by invoking benevolent ones.

Sometime during the Pleistocene hominids became their own worst predators, encouraging natural selection of an ability to rapidly detect and react to supremely intelligent and rapacious agents (Alexander 1987). Mistaking a non-agent for an agent would do little harm, but failing to detect an agent - especially a human or animal predator - could well prove fatal. From an evolutionary perspective, it’s better to be safe than sorry. This cognitive proclivity would favor the emergence of malevolent deities in every human culture, just as the countervailing Darwinian imperative to attach to protective caregivers would cognitively favor the apparition of benevolent deities.

Indeed, many mammals, such as social carnivores and primates, evince behaviors consistent with an integrated appreciation of evolved predator-protector-prey schema. In “chase play” the young typically “dare” a protector (parent, sibling) to chase them as a predator would, only to “surrender” to the pettings, lickings and other comforting behaviors of the chaser. Only humans, however, appear to have evolved a fully developed agency-awareness module, or “folkpsychology,” capable of representing alternative worlds and states of mind (Baron-Cohen 1995, Suddendorf 1999). This capacity to model different models of things is necessary to the conception of counterfactual worlds, including the supernatural.

Such “meta-modeling” or “meta-representational” ability has wide-ranging consequences for human survival. It allows people to conceive of alternative worlds and to entertain, recognize and evaluate the differences between true and false beliefs. Given the ever-present menace of enemies within and without, concealment, deception and the ability to both generate and recognize false beliefs in others would favor survival.

Supernatural causes and beings are generally meta-represented as more or less vague ideas about other ideas, like a metaphor that meta-represents the earth as a mother but not quite, or an angel as a winged youth but not quite. The supernatural cannot be simply represented as a proposition about a state of affairs whose truth, falsity or probability can be factually or logically evaluated. No statement or thought about the supernatural can be empirically disconfirmed or logically disproven.

Because human representations of agency and intention include representations of false belief and deception, human society is forever under threat of moral defection. By invoking omniscient and omnipotent supernatural agents who have only (or almost only) true beliefs, people steadfastly commit to one another in a moral order that goes beyond apparent reason and self-conscious interest. In the competition for moral allegiance, secular ideologies are at a disadvantage. For, if people learn that all apparent commitment is self-interested convenience or worse, manipulation for the self-interest of others, then their commitment is debased and withers. Especially in times of vulnerability and stress, social deception and defection in the pursuit of self-preservation is therefore more likely to occur. Religion passionately rouses hearts and minds to break out of this viciously rational cycle of self-interest, and to adopt group interests that may benefit individuals in the long run. More generally, religious commitment to the supernatural underpins the “organic solidarity” (Durkheim 1995[1912]) that makes social life more than simply a contract among calculating individuals. It creates the arational conditions for devotion and sacrifice that enable people and societies to endure even against terrible odds. A supernatural agent can ultimately punish cheaters, defectors and free riders, no matter how devious or careful they may be.

Purely ideological commitments to moral principles also lack interactive aspects of personal agency – and the emotional intimacy that goes with it – as well the promise to allay the eruptive and uncontrollable existential anxieties for which there appears to be no rational expectation of resolution, such as vulnerability (to injustice, pain, dominance), loneliness (abandonment, unrequited love), and calamity (disease, death). Evolutionarily, at least some basic emotions preceded conceptual reasoning: surprise, fear, anger, disgust, joy, sadness (Darwin 1965[1872], Ekman 1992). These may have further evolved to incite reason to make inferences about situations relevant to survival decisions. This was

plausibly an important selection factor for the emergence of reason itself. Existential anxieties are by-products of evolved emotions, such as fear and the will to stay alive, and of evolved cognitive capacities, such as episodic memory and the ability to track the self and others over time. For example, because humans are able to meta-represent their own selves and mentally travel in time (Wheeler et al. 1997), they cannot avoid overwhelming inductive evidence predicting their own death and that of persons to whom they are emotionally tied, such as relatives, friends and leaders. Emotions compel such inductions and make them salient and terrifying. This is “The Tragedy of Cognition.” Religions customarily propose a supernatural resolution in some minimally counterfactual afterlife.

In religion, as in love and strife, sanctified displays of passionate commitment to others are given in the face of existential anxieties for which no predictable outcome or rational solution is possible, as at marriages, send offs and funerals. These sacred vows are promises to help one another in future situations where there is need, and no hope of reward. This enables people to trust and do uncalculating good for one another. That’s the good news. The bad news is that just as a marriage commitment to one person precludes similar to commitment to another, so a religious commitment to one society or moral order usually precludes commitment to another. Not that all religions explicitly insist on mutually exclusive commitments, though many do. Rather, every religion professes absolute and nonnegotiable commitments that set the limits of tolerance. This adversarial process leads to unending development of new religious and cultural forms. Thus, despite the rise of secular ideologies and science, and corresponding predictions of religion’s inevitable demise, new religious movements (NRMs) continue to arise at a furious pace - perhaps at the rate of two or three per day (Lester 2002).

Communal rituals rhythmically coordinate emotional validation of, and commitment to, moral truths in worlds governed by supernatural agents (Turner 1969, Rappaport 1999). Rituals involve sequential, socially interactive movement and gesture and formulaic utterances that synchronize affective states among group members in displays of cooperative commitment. Religious rituals habitually include displays of social hierarchy and submission typical of primates and other social mammals (outstretched limbs baring throat and chest or genitals, genuflection, bowing, prostration, etc.). Even priests and kings must convincingly show sincere obeisance to higher supernatural authority lest their own authority be doubted (Burkert 1996; cf. Watanabee & Smuts 1999).

Religious ritual also involves more primitive communicative forms that Tinbergen calls “ritualized social releasers” (1951:191-192). Social releasers exhibit sense-evident properties, “either of shape, or colour, or special movements, or sound, or scents,” which readily elicit a well-timed and well-oriented cooperative response in a conspecific: for mating, parenting, fighting, defense, food gathering, and the like. But humans, it appears, are the only animals that spontaneously engage in creative, rhythmic bodily coordination to enhance cooperation. Unlike, say, avian mating calls or flight formations, human music or body dance (which are omnipresent in worship) can be arbitrarily and creatively elicited, transferred, combined, or interpolated to fit many different purposes and contexts (e.g., from use of love songs in mating displays to use of mating displays in sales jingles).

A key feature of the creativity of human worship is use of music in social ritual. Even the Taliban, who prohibited nearly all public displays of sensory stimulation, promoted a cappella religious chants. In a survey of persons who reported a religious experience (Greeley 1975), music emerges as the single most important elicitor of the experience (49 % of cases), followed by prayer (48%) and attending group services (41 %). Reading the Bible (31 %) and being alone in church (30 %) trail significantly behind. Listeners as young as three years old reliably associate basic or primary emotions to musical structures, such as happiness, sadness, fear and anger (Trainor & Trehub 1992; cf. Cunningham & Sterling 1988, Panksepp 1995). Electrocardinal measures of frontal brain activity suggest that people exhibit greater relative left frontal activity to joyful and happy music and greater relative right frontal activity to fearful and sad music, with activity greater for fearful than sad reactions and for joyful than happy reactions (Schmidt & Trainor 2001).

Music invites interpersonal relationships, creating emotional bonds between people, through the “attunement” of somatic states – much as the rocking and cooing behavior of mother and infant attunes the parental bond (Stern 1985). This is especially apparent in “call-response” format, as in Yoruba dances

and Hebrew services. Moreover, in religious contexts, music is frequently experienced as authorless, like the sacred texts that often accompany it. The pre-tonal religious music of small-scale societies usually has its mythic beginnings in the origins of the world, which invites audiences to share in a sense of timeless intimacy. For the Catholic Church, Gregorian chants were taught to men by birds sent from heaven. Even Bach, Mozart and Beethoven were but vehicles of The Divine.

In sum, religion is not an evolutionary adaptation per se, but a constantly re-emerging cultural path by which people readily navigate the complex evolutionary landscape that sets cognitive, emotional and material conditions for ordinary human interactions. It arises, in part, from developed cognitions of folkpsychology and agency. This involves meta-representation, which makes deception possible and threatens any social order; however, these same meta-cognitive capacities provide the hope and promise of open-ended solutions through representations of counterfactual supernatural worlds that cannot be logically or empirically verified or falsified. Core religious beliefs minimally violate ordinary notions about how the world is, with all of its inescapable problems, thus enabling people to imagine minimally impossible worlds that appear to solve existential problems, including death and deception (Norenzayan & Atran 2002). Because religious beliefs and experiences cannot be deductively or inductively validated, validation occurs only by assuaging the very emotions that motivate religion. Through movement, sound, smell, touch and sight, religious rituals affectively coordinate actors' minds and bodies into convergent expressions of public sentiment – a sort of N-person bonding that communicates moral consensus.

## **2. Existential Motivation: Deception and Death**

In this section, I summarize competing arguments and recent experiments with colleagues relating to the claim that religion crucially involves supernatural agents who address existential anxieties, such as deception and death.

One idea common to psychoanalysis (Freud 1990[1913], Erikson 1963) and attachment theory (Bowlby 1969, Kirkpatrick 1998) is that deities are surrogate parents that assuage existential anxieties. One reason for rejecting or substantially modifying this idea as it stands comes from anthropology. Ethnographic reports indicate that malevolent and predatory deities are as culturally widespread, historically ancient and as socially supreme as benevolent deities. Examples include the cannibalistic spirits of small-scale Amazonian, sub-Saharan African and Australian aboriginal societies as well as the bloodthirsty deities of larger-scale civilizations that practiced human sacrifice, such as Moloch of the Ancient Middle East, the death goddess Kali of the tribal Hindus and the Maya thunder god Chaak. Serpent-like devils and demons seem to be culturally ubiquitous (Munkur 1983), perhaps evoking and addressing a primal fear shared by our primate line (Mineka et al. 1984).

Neuropsychologist Michael Persinger (1987) also sees readiness to believe in God as a psychological compulsion to recover the lost parental security of childhood. This innate drive is supposed to be conceptually generalized to God by stimulus-response conditioning through reward and punishment. Learning to generalize to God need involve little more than simple word association: “In this way, the properties of objects [e.g., parents] are transferred to words [e.g., “God”]”:

The parents no longer have the properties of omnipotence and omnipresence. Through experience, the adult has learned that parents are discrete and mortal beings with limited space and little time. The childhood expectations have been generalized to God. (1987:66)

Details of the God concept are determined by a person's culturally-conditioned experiences. Thus: “Matrilineal societies... have female gods. In patrilineal societies, where the male line is most important, the god is portrayed with clear masculine features.”

Although it is vaguely true that the deities of different societies take on culturally-specific aspects of those societies (Durkheim 1995[1912]), there is often no simple mapping or straightforward projection of social structures onto to god features. For example, the matrilineal Nair (Warrior Caste) of Kerala in South India have the same pantheon of 330 male and female deities as do patrilineal Hindus. Off the Arabian Sea's Kerala coast, the matrilineal Lakshadweep Islanders have no God but Allah, and worship Mohammed as His Prophet just as the patrilineal Arabs do.

Some of the syncretic Moslem and Christian societies of Asia and Africa have high-ranking women deities, and even important animal and plant deities. A recurrent myth in male-dominated

patrilineal societies of Africa, such as the Gola of Liberia (d'Azevedo 1973), is that female deities originate what men desire to control (Horton 1963). For the patrilineal Tsembaga of New Guinea, the most important single spirit is "Smoke Woman" (Kun Kaze Ambra), who "acts as an intermediary between the living and all other categories of spirits." This female deity "might, out of jealousy, do mischief to any woman with whom a [male] novice of hers consorts" (Rappaport 1979:103).

Another reason for doubting that gods are just surrogate parents from cognitive psychology, in particular the branch of cognitive psychology known as "theory of mind" or "folkpsychology." Cross-cultural experimental evidence from child development studies indicate that young children reliably distinguish the intentions of parents from those of God and other supernatural agents just as soon as they can attribute intention and belief to anybody or anything at all. Attributing intention and belief critically involves the child's ability to meta-represent propositions about the world as true or false. This ability emerges around age 4 (Wimmer & Perner 1983, Wellman 1990).

In one of the few studies to replicate findings on "theory of mind" in a small-scale society (cf., Avis & Harris 1991), Knight, Barrett, Atran and Ucan Ek' (2001) showed monolingual Yukatek Maya children a tortilla container and told them, "Usually tortillas are inside this box, but I ate them and put these shorts inside." Then they asked each child in random order what a person, God, the sun (k'in), the principal forest spirits (yumil k'ax'ob, "Masters of the Forest"), and other minor spirits (chiichi') would think was in the box. In line with recent studies of American children (Barrett et al. 2001), the youngest Yukatek children (4 year-olds) overwhelmingly attribute true beliefs to both God and people in equal measure. By age 5, the children attribute mostly false beliefs to people but continue to attribute mostly true beliefs to God (Figure 1).

Children 5 and over attribute true beliefs according to a hierarchy with God at the top and people at the bottom (Figure 2). Yukatek consider the Masters of the Forest powerful and knowledgeable spirits that punish people who try to overexploit forest species. Yukatek children tend to believe that forest spirits, God and the sun, "live" (kukuxtal) but do not "die" (kukumil). For Maya adults, such beliefs have reliably measurable behavioral consequences for biodiversity, forest sustainability, and so forth (Atran et al. 2002). In brief, from an early age people reliably attribute to supernaturals cognitive properties that are different from parents and other people. Furthermore, people reliably behave differently in accordance with these different attributions.

Children's ability to distinguish god concepts from parent concepts comes about only with the acquisition (innately-driven maturation) of a capacity for meta-representation, that is, part of a fully developed folkpsychology. It is logically impossible for such a cognitive capacity, or "theory of mind," to arise from conditioning or trial-and-error learning; that is, a faculty of greater representational power (meta-representation) cannot arise piecemeal by induction or accretion from a faculty of lesser representational power (simple representation or perception of a state of affairs) (Fodor 1974; cf. discussions in Hirschfeld & Gelman 1994). Nevertheless, the idea that deities often co-opt childhood emotions associated with parental prepotency is well taken. Only, this cannot be the whole story. In religion's counterfactual and counterintuitive worlds one and the same deity can even have the dualizing role of predator and protector, or prey and protector. These may well be humankind's most popular deities. It is not an infant-parent or child-kin group template from which god concepts extend, but plausibly a more encompassing evolutionary program for detecting and dealing with agency and intention, both good (inspiring trust) and bad (inspiring fear).

Another experiment that ties religion to belief in the supernatural's ability to deal with human existential anxieties was recently carried out by Ara Norenzayan, Ian Hansen and myself. In particular, this experiment links adrenaline-activating death scenes to increased belief in God's existence and the efficacy of supernatural intervention in human affairs. Results show that people cognitively commit themselves more to the supernatural under stressful interpretations of events involving other people than they do when events are emotionally uneventful. This is so even when those uneventful events specifically involve a religious component. Commitment theories of religion also neglect such special effects of the supernatural.

Our experiment was built on a study by Larry Cahill and colleagues (1994) in the laboratory of James McGaugh. They showed college students a series of slides and a storyline about a boy riding a bike. Some subjects were exposed to an uneventful story: the boy rides his bike home, and he and his mother drive to the hospital to pick up his father (who is a doctor). For the other participants, the story begins and ends in much the same way, but the middle is very different: the boy is hit by a car and rushed to the hospital's emergency room, where a brain scan shows severe bleeding from the boy's brain and specialized surgeons struggle to reattach the boy's severed feet. After exposure to the stories, and before being tested for recall, half the subjects were given either a placebo pill or a drug (propranolol) that blocks the effects of adrenaline. The placebo and drug groups recalled the uneventful story equally well. Only the placebo group, however, remembered the emotional story more accurately than the uneventful one. (Similar effects occur from amygdala damage, McGaugh et al. 1995).

Our hypothesis was that stressful events associated with existential anxieties (e.g., death) not only deeply affect how people remember events but also religious coloring of those events. We first controlled for religious background and measured for religious identification. Then we primed each of three groups of college students with a different story (Table 1): Cahill et al.'s uneventful story (neutral prime), Cahill et al.'s stressful story (death prime), and another uneventful story whose event-structure matched the other two stories but which included a prayer scene (religious prime). After this, each group of subjects read a reprint from a New York Times article (2 Oct. 2001) whose lead ran: "Researchers at Columbia University, expressing surprise at their own findings, are reporting that women at an in vitro fertilization clinic in Korea had a higher pregnancy rate when, unknown to the patients, total strangers were asked to pray for their success." The article was given to students under the guise of a different story about "media portrayals of scientific studies." Finally, the students rated the strength of their belief in God and the power of supernatural intervention on a nine-point scale.

Results show that strength of belief in God's existence (Figure 3) and in the efficacy of supernatural intervention (Figure 4) are reliably stronger after exposure to the death prime than either to the neutral or religious prime (there were no significant differences between either uneventful story). This was so whatever students' religious background or prior degree of religious identification. In sum, emotional stress associated with death-related scenes seems a stronger natural motivator for religiosity than mere exposure to emotionally unstressful religious scenes, such as praying.

This provides some confirmation of the claim that emotionally eruptive existential anxieties motivate belief in the supernatural. We also plan to test the further claim that invocation of the supernatural not only cognitively validates these eruptive emotions, but is affectively validated by assuaging the very emotions that motivate belief in the supernatural. With this in mind, it is worth noting that uncontrollable arousal mediated by adrenergic activation (as for subjects exposed to death scenes) may lead to posttraumatic stress disorder (PTSD) if there is no lessening of terror and arousal within hours; however, adrenergic blockers (propranolol, clonidine, guanfacine, and possibly antidepressants) can "interrupt the neuronal imprinting that leads to long-term symptoms" (McReady 2002:9). A possibility arises, then, that heightened expressions of religiosity following exposure to death scenes that provoke existential anxieties could also serve this blocking function.

### **3. Religion and Psychopathology: Possession, Epilepsy, Schizophrenia, Autism**

Stress is a key factor in emotionally drawn out communal rituals, such as initiation rites and exorcisms, and mystical states, like divine visions and revelations. In cases of religious possession, society often draws a fine line between supernaturally-caused possession and organically-caused madness that is often stress related:

Between madness and possession, the difference is small in the eyes of the Arab.... [T]he madman is designated by the word maġnoun; the possessed person is called madroub or 'struck' by a spirit. To chase away the intruding spirit from the possessed body, one turns to a faqir [an indigent wanderer or street person who practices healing and sorcery by virtue of being 'gifted with supernatural power, because of his friendship with Allah'].... A faqireh [female sorceress] seizes the possessed person, places him in the middle of the room and begins turning around him

as she plays the tambourine. At the sound of this primitive music, the spirit stirs restlessly; the afflicted person has convulsions. (Jausen 1948[1907]:327).

Recurring cases of possession are reported from Africa and Afro-America (Leiris 1958, Douyon 1966, Lewis, 1971, Kilson 1972, Walker 1972, Pressel 1974, Ben-Amos 1994), European America (Freed & Freed 1964), Native America (Lowie 1924, Reina 1966), China (Yap 1960), India (Crooke 1907, Whitehead 1988[1921]), North Africa and the Middle East (Jausen 1948[1907]). Cases in the USA often involve possession by devils, witches (Ludwig 1965, Warner 1977) and, more recently, aliens (cf. Blackmore 1999). Variants of possession include “soul kidnapping” (Lowie 1924:177-178) or “soul loss” (Warner 1977) through the agency of malevolent spirits. Black magic and bewitchment, in which spirits cast charms or spells on victims, can also exhibit aspects of possession. This is especially so in regard to the onset of symptoms and debilitating pathology, as with depression and disease (Redfield & Villa Rojas 1934:177-180). If not exorcised, death may be expected.

Although there is no clear psychopathology associated with possession, there is a more or less identifiable family of associated symptoms: listlessness, depression, guilt feelings, fainting and dissociation are frequent. Acute or chronic stress (or emotional or psychic “tension”) is habitually cited as precipitating and accompanying non-institutionalized cases of possession. Institutionalized cases tend more to have psychotic pathologies, such as schizophrenic hallucination, epileptic confusion, mania, senility, and so forth. In one institutionalized Chinese sample of possessed patients, Yap (1960) reported mainly hysterics (48.5%), schizophrenics (24.3 %) and depressives (12.2 %).

In many societies, auditory and visual hallucinations that our medical establishment associates with certain forms of temporal-lobe epilepsy and schizophrenia often take on a religious color. They become the “voices” and “visions” of personal revelation for the subjects themselves and, depending upon the society, they may become the charge of local religion as well. To a significant extent, persons prone to schizophrenia may find themselves better suited for a more cloistered religious life (Kelley 1958). In some societies, epileptics may be preferentially chosen as shamans (Eliade 1964). For example, in North India (Crooke 1907:259-260): “The Shaman lives a life apart, practises or pretends to practise various austerities, wears mysterious and symbolical garments, and performs noisy incantations in which a sacred drum or an enchanted rattle takes a leading part. On occasion he should be able to foam at the mouth and go into a trance or fit, during which his soul is supposed to quit his body and wander away into space. By some these seizures have been ascribed to epilepsy.”

One prominent neurobiological focus of these extreme religious experiences - as well as nonpathological experiences involving glossolalia, trance and meditative ecstatic visions- is the amygdala-hippocampus complex (Beard 1963, Slater & Beard 1963, Bear 1979, Gloor et al. 1982, Geschwind 1983, Persinger 1984). Accounts of visual and auditory hallucinations among some of history’s leading religious converts and mystics intimate possible temporal-lobe epilepsy. A particularly controversial case concerns the dramatic conversion of the Apostle Paul. Paul was a vicious persecutor of Christians. One day, he collapsed on the road to Damascus and suddenly experienced auditory and visual hallucinations. As a result, he converted to Christianity and became perhaps the single most important figure in fostering its spread beyond a few marginal Jewish communities of the Roman Empire. Psychologist William James (1902) surmises that Paul’s newfound voice of conscience may have been “a physiological nerve storm or discharging lesion like that of epilepsy,” although lack of evidence for subsequent mental deterioration argues against temporal-lobe epilepsy (Woods 1913). Another famous case concerns a 16<sup>th</sup>-century saint, Teresa of Avila. She experienced vivid visions, intense headaches and fainting spells, followed by “such peace, calm, and good fruits in the soul, and ... a perception of the greatness of God” (St. Theresa 1930:171). Biographers suggest that she may well have experienced epileptic seizures (Sackville-West 1943), similar perhaps to the fits suffered by the Russian writer and religious mystic, Fyodor Dostoevsky.

The absence of details precludes an accurate diagnosis in such cases. Yet, there is little doubt that extreme and even pathological religious experiences have been interpreted over the ages as unequivocal signs of divine enlightenment or possession in different times and places. In contemporary Europe and North America, however, such manifestations more often lead to confinement in a mental asylum (except



in the movies). In studies of schizophrenia-like psychoses of epilepsy in British hospitals, A.W. Beard and colleagues found that 38% of patients had hallucinations and mystical delusions, although fewer than 9% had religious convictions prior to the onset of symptoms (Beard 1963, Slater & Beard 1963). Typical reports of religious experiences among temporal-lobe epileptics include: “greater awareness,” “seeing Christ come down from the sky,” “seeing Heaven open”; “hears God speak”; “feels himself transfigured and even believes that he is God,” and so forth (cf. Karagulla & Robertson 1955, Geschwind 1983).

A study of sudden religious conversion in 6 temporal-lobe epileptics (3 also had epileptogenic areas in frontal areas) revealed: hearing “divine music and angelic voices,” “she heard a church bell ring in her right ear; and the voice said: ‘Thy Father hath made the whole, Go in peace!’”; having “a day-time visual hallucination in which he saw angels playing with harps”; “he had a sudden dream-like ... flash of light, and exclaimed ‘I have seen the light’,” feeling “heavenly voices abusing him, felt rays were being shone on him to punish him (a sensation of burning)”; “terrified that I would not be able to carry out... the love of God... [H]e also became paranoid, believing that he was being poisoned”; sensing “a holy smell”; believing “that he was able to pick up other people’s thoughts,” or “that he could understand other people’s thoughts” (Dewhurst & Beard 1970).

Sudden alterations of activity in the hippocampus and amygdala can affect auditory, vestibular, gustatory, tactile, olfactory perceptions and lead to hallucinations involving voices or music, feelings of sway or physical suspension, the tastes of elixirs, burning or caressing, the fragrance of Heaven or the stench of Hell. For example, because the middle part of the amygdala receives fibers from the olfactory tract, direct stimulation of that part of the amygdala will flood co-occurring events with strong smells. In religious rituals, incense and fragrances stimulate the amygdala so that scent can be used to focus attention and interpretation on the surrounding events. In temporal-lobe epilepsy, the sudden electrical spiking of the area infuses other aspects of the epileptic experience with an odorous aura.

The hippocampus processes verbal and vocal signals, helping to link the intentions behind those signals (originating in the prefrontal cortices) to appropriate states of arousal and emotivity (via the amygdala and hypothalamus). Religious rituals sequence and rhythmically pattern these signals (prayers, preaching, incantations, chants) to infuse them with sustained affect, and to increase the motivation for any uses to which they may be put. In temporal-lobe epileptics, the hippocampus may be spontaneously stimulated to produce or interpret verbal signals as eruptive “voices” of unknown source and uncertain intention, which may threaten in the acute phase of schizophrenic-like hallucination or soothe during remission (cf. Larkin 1979).

Hallucinations can involve different sensory modalities. Thus, the brain’s auditory, vestibular and visual channels are closely intertwined. The inner ear conveys both sounds and a sense of balance. In religious ritual, music or chanting can set the body to swaying, triggering pleasant feelings. Loud noises and irregular sound patterns can cause sudden, disorienting movements, triggering surprise and fear and temporarily throwing the body out-of-kilter (although people can become habituated to noise levels and idiosyncracies in sound patterns, so that what feels unpleasant to some feels pleasant to others). Loud music or sudden noises (as well as bright or flashing lights) can drive the epileptic into seizures marked by feelings of terror and paranoia.

Because of the innate adaptation of our moving bodies to the gravitational conditions on earth, the coordination of the retina’s frame with the inner ear’s frame gives us a proper sense of movement only when we are upright from the ground. When the two frames are thrown out of whack (moving on a boat, whirling in a dance, suddenly rising after lying down), the body says that you’re moving but the ground lets you know that you’re not. Notions of “up,” “down,” “side,” “ceiling,” “floor” and “wall” become confused. When ritually controlled, this desynchronization often induces an emotionally positive sense of floating, suspension, or slow motion in a fast-moving world. When uncontrolled, as in epileptic experiences, it can provoke a frightening, emotionally aversive sense of dislocation and bewilderment. It can also produce nausea (as in motion sickness) and perhaps a sense of being poisoned (nausea and vomiting may be adaptations for elimination of toxins from the body).

These and other findings concerning relations between religious experiences and temporal-lobe epilepsy provide a main support for Persinger’s (1987:113; cf. Persinger 1997) claim that transient

patterns of stimulation in the temporal lobe – especially around the amygdalohippocampal complex - “create the God experience.” The problem with his hypothesis from a neuropsychological standpoint is that it takes little account of the importance of agency and relations with the prefrontal cortices. The key issue here is that of functional connectivity, that is, temporal correlations between spatially remote physical events. In particular, frontal-temporal connectivity – and not just temporal activation as such - implies a distributed rather than localized neural substrate for many types of religious experience. For example, disinhibited functions in the temporal lobes (e.g., seizure foci) will generally elicit a compensatory response from inhibitory circuits in the frontal lobes. If Newberg et al. (2001a,b) are right about systematic alterations in the activity of the parietal lobe’s orientation association area, then issues of connectivity become correspondingly more complex. For the present, though, I want to concentrate on what I think are the least controversial - or at least the most empirically-supported - arguments about frontal-temporal connectivity in religious experience.

Brain-imaging shows heightened electrical stimulation and increased blood flow to this area of the brain during bouts of epileptic seizure, schizophrenic hallucination, speaking in tongues and trance, and deep meditation and prayer. But whereas schizophrenia-like episodes of epilepsy and schizophrenic hallucinations appear to be associated with decreased activity in the frontal cortices (Stern & Silbersweig 1998), meditation and prayer seem to be associated with increased activity (Newberg et al. 2001a,b). In pathological cases there is a corresponding, clinically apparent lack of awareness of reality, whereas in non-pathological cases there is a reported hyperawareness of reality.

In a study of 60 inpatients with schizophrenic or schizophrenic-like auditory hallucinations, Oulis and colleagues (1995) found high levels of conviction about the reality of the sensory stimuli, clarity of content, location of their source, and lack of volitional control. The voices associated with such pathological states indicate a dampening of subcortical interactions with the prefrontal cortices and an absence or submission of will (Damasio 1994). The louder and more intrusive the hallucinations and intensity of delusional beliefs, the more anxious and fearful patients become, whether diagnosed as schizophrenics (Hustig & Hafner 1990) or temporal-lobe epileptics (LaBar et al. 1995). A study of command hallucinations among 106 schizophrenic outpatients revealed the hallucinations to be often violent in content, leading to attempts to harm others (including innocent bystanders) or oneself (including 2 cases of command suicide) (Zisook et al. 1995).

The hallucinations and delusions associated with pathological states indicate a disconnection between self-will and the (supernatural) will commanding the hallucinations. Schizophrenics (and schizophrenic-like temporal-lobe epileptics) may say, “I am God,” or “I am God’s slave,” or both. According to Stern and Silbersweig (1998:239), such “delusions of control (or passivity) could result when a self-generated movement [e.g., self-generated verbally-mediated thoughts] is not associated with a sense of volition and /or is mistakenly believed to arise from another source, or both.” These authors show that medial temporal activations (hippocampus) are prominent in hallucinating schizophrenics, but absent when control subjects listen to or imagine voices. Such temporal-lobe activations occur in the setting of a relative lack of prefrontal activity and corresponding deficits in executive functions that assign volition and agency.

By contrast, in non-pathological cases, neuropsychologist Patrick Macnamara observes: [In] most accounts of mystical experience...the subject is invited to consent to the experience before it is given or “revealed” (see the the Annunciation to Mary in the New Testament). The suspension of agency and will, if anything, is antithetical to mystical experiences (if not to hallucinatory experience)... If there is a central focus to religious belief I would place it in the effort to develop the right relationships to the deity/deities... and all this in service to development of greater self-awareness... These after all are major functions of both orbitofrontal and dorsolateral frontal lobes. (Personal communication, 2000)

A literature review reveals that intense prayer encourages self-control and self-esteem in ways that reduce both acute and chronic stress, and which appear to depend heavily on prefrontal activation (Worthington et al. 1996). Newberg et al. (2001a,b) report EEG and SPECT data showing increased electro-chemical activity in, and blood flow to, the inferior frontal and dorsolateral prefrontal cortical regions during

intense meditation and prayer. These areas send inhibitory efferents directly onto a number of limbic and brainstem sites implicated in stress: amygdala, hippocampus, hypothalamus, and locus ceruleus (the nuclei that manufacture the stress hormone, norepinephrine) (Hugdahl 1996). There is often a marked delusional misidentification of faces, even familiar ones, which may be related to “misinterpretation of social interactions” (Phillips & David 1995).

More generally, experiments from cognitive neuropsychology indicate that such schizophrenic patients have a deficit in their ability to appreciate other people’s mental states. Subjects fail in the performance of tasks involving social inferences, such as correctly assessing intentions from indirect speech (Corcoran et al. 1995). This points to a malfunctioning “theory of mind” and intentional agency, which is patently not the case for most people who have deep or periodic episodes of religious experience (including many of our political leaders).

Finally, schizophrenics with prefrontal deficits also seem unable to properly formulate or process counterfactual propositions that require imagining oneself in possible social worlds that are different from the actual one. For example, after a career failure or the death of a loved one, nonpsychotic persons often imagine “what might have been, if I had only done such and such.” This is an ordinary behavior that seems to be lacking among some schizophrenics (Knight & Grabowecky 1995, Hooker et al. 2000). Although a common occurrence after death of a loved one is “dream sleep” (vivid and realistic dreams concerning the deceased that burst into awareness), the grieving subject is usually aware of the difference between dream and reality. Understanding counterfactual situations may be important for dissociating imaginations of the supernatural (e.g., the transubstantiated body and blood of Christ) from factually mundane observation and existence (ordinary wine and wafers), that is, dissociating the quest for self-awareness from the awareness needed for survival.

Autism is another form of psychopathology increasingly associated with deficits in “theory of mind” and faulty appraisals of social intentions (Leslie & Frith 1987, 1988, Baron-Cohen 1995). The term “autism” was coined by Kanner in 1943; however, until the mid-1960s, when the first epidemiological survey of autism was conducted in England (Lotter 1966), autism was considered a precocious form of schizophrenia (Goldfarb 1964). As with certain forms of schizophrenia and temporal-lobe epilepsy, autistics often show abnormalities in the limbic region and associated areas of the brain stem. Autistic children have trouble remembering and processing recent verbal-auditory material, which is consistent with autopsy reports and clinical analyses indicating abnormalities in the hippocampus (Bauman & Kemper 1985, DeLong 1992). Studies of lesioned monkeys with damage to the amygdala reveal autistic-like behavior associated with “hypoemotionality” (unnaturally fearless or tame, impairment in social interaction, aimless examination of objects) (Klüver & Bucy 1939, Bachevalier & Merjanian 1994).

Autistics also tend to manifest repetitive, rhythmic movements and “fixed memory” formulaic sequences akin to some forms of ritual behavior, but to no evident purpose. Catherine Johnson, a mother of two autistic children and co-author of Shadow Syndromes (Ratey & Johnson 1998), nevertheless sees the use of these ritualistic movements as a stepping-stone for religious education:

A child with autism can “get” the idea of God... For one thing, the repetition and ritual of religion is perfect... For another, I’m hoping that the visual power of the high church ceiling activates the “God part” of his brain.... Neuroscientists have found there is a region of the brain that, when stimulated, causes people to experience the presence of God. ([www.feat.org/search/news.asp](http://www.feat.org/search/news.asp), “Autism and God,” 18 September 2000)

One apparent problem with autism, as with certain forms of schizophrenia described above, is an inability to imagine counterfactual situations. This can be particularly striking in children suffering from Asperger’s Syndrome, a high-functioning form of autism. They seem to be very literal-minded and to believe exactly what they are told:

We went overseas, and when the plane was over the clouds, he asked me: “So this is where God lives? I can’t see him.” ([accesscom.com/~hcross/mindblind.htm](http://accesscom.com/~hcross/mindblind.htm))

My daughter is fixated with angels. My son told her that when you die you go to heaven and become an angel.... (Excited at this pointed) (“Goody, Goody!”)... I barged right in the room and

told her not to listen to her brother [for fear she would try to kill herself right there and then].  
(Listserv by St. John's University for Asperger Syndrome)

To deal with such deficits in counterfactual thinking, St. Paul's Catholic Church in Alabama provides instruction for autistic children aimed at helping them to understand and take First Communion:

The church requires that children who receive Holy Communion be able to recognize the difference between ordinary bread and the Eucharist," said the Rev. Sam Sirianni, director of the office of worship for the Diocese of Trenton. The St. Paul's program was designed to teach the difference... but it also taught more basic things, like how to behave properly in church... learning how to behave in a crowded situation like a Mass was good for the children... people with autism often find crowds frightening, and the more situations they learn to deal with, the better. (Albert Raboteau, "Celebrating a Milestone," Austism Society of Alabama. National and World New Forum (web site), 25 June 2000).

Unlike hallucinating schizophrenics or temporal-lobe epileptics, however, autistics do not usually misrepresent their own voices and intentions as those of other agents (including supernatural agents), or misinterpret the intentions of others as those of demons or deities. Rather, severe autistics show little evidence of inferring anybody's intentions (despite retaining other aspects of intelligence and intellect intact). Their world appears to be populated not by supernatural agents, or even natural agents like friends and enemies, but by mindless, zombie-like beings that have no autonomous will, desires or thoughts.

Recent studies indicate that in largely secular societies, like our own, where there is a history of separation between Church and State, extreme mystical states are generally attributed to cerebral pathology. But in societies where institutional religions dominate, the contents of hallucinations, delusions and possessed beliefs, as well as the diagnoses of their causes, are more generally taken to be religious in origin (Kent & Wahass 1997, Wahass & Kent 1997). Religious treatment may have positive or negative effects, depending upon the community's beliefs about the supernatural origins of the illness, such as whether the person is blessed by God or possessed by Satan.

These differences in belief, which determine different moral judgments about the mutual responsibilities of individuals and societies, can lead to social or political conflict. For example, in an unprecedented ruling, Chicago immigration officials recently decided to grant political asylum to a 10-year-old autistic boy whose mother had claimed his disability and sporadically violent behavior is so misunderstood in Pakistan, their homeland, that he would be tortured and persecuted if he returned there. In her successful application to the Chicago Office of Asylum, she stated that: "He was forced to undergo various degrading and dangerous mystical treatments consistent with the curse of 'Allah,' which is how the Islamic majority in Pakistan view his condition" (Deardoff 2001).

In Moslem societies such as Pakistan or Saudia Arabia, the religious community is obliged to recognize the asocial behavior of an autistic child or schizophrenic a social problem requiring forceful intervention of the religious community. From the secular standpoint of US immigration officials and their medical advisers, this leads the boy's homeland community to "violate" the individual's rights. By contrast, in some states of the USA (e.g., Texas) medical diagnoses of severe and violent autism or schizophrenia imply no special secular or religious responsibility of the community towards an individual who breaks a law. In such cases, the individual may be even more radically isolated from society in prison and prosecuted (Western Europeans would say "persecuted") unto death (execution).

Whatever the religious take, there is an increasing scientific consensus that autism owes at least in part to alterations in the normal functioning of the prefrontal cortices, especially the ventro-medial region that is involved in the affective assessment of social interactions and intentions (cf. Damasio 1994). There are massive subcortical connections between the prefrontal cortices, the temporal lobes and the limbic system. None of the religious pathologies that I have summarized – temporal-lobe epilepsy, schizophrenia, autism – implies a localized neural substrate for extreme religious experiences in the temporal lobe (or anywhere else in the brain).

#### **4. Neurotheology: Claims and Doubts**

In their most intense manifestations, ritual ceremonies and liturgy rivet attention on specific and conspicuous sources of sensory stimulation, including stimulation emanating from one's own body:

drums or clapping hands, dancing or nodding, incense or sweat secretion, incantation or deep breathing, the light shows through stained-glass scenes or the making of signs and designs. Often, these actions and the associated stimuli induce altered states of consciousness: for example, through hyperventilation in whirling dance, deep-breathing meditation, or “going up to the mountain” (where the rarefied air leads to the effect). This focused sensory stimulation, in turn, undoubtedly arouses powerful emotional responses in the “limbic system” (hippocampus, amygdala, hypothalamus) much as naturally-provoked surprise, fear, anger and joy do (but in more controlled and sustained doses).

A possible scenario is that the overly-stimulated amygdala goes into undirected hyperactivity. It is unable to process the emotional significance of individual stimuli, though perhaps producing a general sense of foreboding. Consistent with this scenario (but by no means proving it), EEG patterns of electrical activation during “mystical experiences” bear striking similarities to those recorded during bouts of temporal-lobe epilepsy (Persinger 1983, Gloor et al. 1981, Geschwind 1983). The hypothalamus receives this confounding flood of information, relaying it to the autonomic nervous system. This provokes increased discharges in both the sympathetic (or ergotropic) and parasympathetic (or trophotropic) branches of the autonomous nervous system.

The sympathetic branch is responsible for priming the body for action, such as fight or flight. The parasympathetic branch carries signals that relax or quiet the body, such as rest and sleep. Augmented sympathetic discharges increase heart rate, blood pressure, sweat secretion, pupillary dilation, skeletal muscle tone, level of stress hormones (e.g., adrenaline), cortical excitation. Augmented parasympathetic discharges lead to corresponding decreases in visceral and skeletal reactions. In normal states, increased activation in the activity of one branch usually leads to decreased activity in the other. In mystical states, both branches appear to be activated simultaneously, although one or the other is usually dominant.

In meditative states, such as Zen Buddhist or Hindu Yogi, EEG patterns indicate a “trophotropic syndrome.” Here, parasympathetic activity dominates, although continued sympathetic activity “seems in some way to be a correlate of the heightened perceptual sensitivity reported by such subjects” (Gellhorn & Keily 1972:399). According to Gellhorn and Keily (1972:402): “The principal psychological distinction from the normal would appear to be the suspension of autonomous will or intentionality.” More frenzied mystical states, such as viscerally-charged (rather than meditative) trance-possession and Sufi whirling, may be characterized by an “ergotropic syndrome.” Sympathetic activity dominates but continued parasympathetic activity may be associated with a concurrent sense of catharsis that is often compared to the after effects of sexual orgasm. Konrad Lorenz (1996[1944-1948]:267-268) describes an arousal syndrome in vertebrate predators similar to the “ergotropic syndrome.” After prolonged effort and heightened arousal associated with chasing prey, an avian or mammalian carnivore experiences an acute “sensual pleasure” after catching it through the rapid, rhythmic movement of “shaking to death.” This is followed by a particular form of emotional release:

A striking predator finds itself in an exceptional state of maximal arousal.... Immediately after striking its prey, the bird shows the same degree of abreaction as a human being... directly after orgasm. Far from greedily beginning to devour, the raptor – even if it is very hungry – will first sit still for several minutes on its prey... and then embark on the slow, laborious process of plucking its prey, as though half-asleep. Even when the raptor finally begins to eat it, it does so in a “dispassionate,” mechanical nature, as though not quite conscious.

The hippocampus, which modulates the expression of emotions elicited by hypothalamic stimulation and provides conceptual significance to the emotions through projections to the amygdala (LeDoux 1993), may also go into overdrive during rhythmically-induced mystical experiences. As a result, the regular channels of neural transmission are thrown out of balance. Evidence from SPECT brain-imaging is consistent with this possibility. Blood flow, and therefore traffic flow of signals between neurons, increases to the frontal lobes but decreases to the posterior superior parietal lobe (Newberg et al. 2001b). PET imaging indicates that the frontal lobes, particularly the prefrontal cortices, are associated with the executive conceptual functions of will and self control, as well as the self’s temporal orientation (Wheeler et al. 1997). The top back portion of the parietal cortex, especially the left side, is associated with three-dimensional body imaging and spatial orientation (Lynch 1980). Possibly, the asymmetric flow

of information towards the lower front of the brain and away from the upper back of the brain, may have something to do with the most outstanding aspect of reported mystical experiences: namely, a vivid but diffusely conceived awareness of a boundless universe, centered on (joined to, merged with) a self that has no physical markers or constraints.

The most completely developed “neurotheological” theory of these sorts of mystical experience that links brain and religion stems from the work of psychiatrist Eugene d’Aquili and radiologist Andrew Newberg. The authors use their own brain-imaging (SPECT) studies of meditating Buddhists and Franciscan nuns at prayer to demonstrate that experience of God, or “Absolute Unitary Being” (AUB), is hard-wired into the human brain (d’Aquili & Newberg 1998, 1999; Newberg et al. 2001a). Thus, for subjects who reported a feeling of boundless perspective and self-transcendence during meditation, the researchers found decreased blood flow in the brain’s “object association areas” where perceptions between boundary and self are normally processed. They speculate that the ultimate mystical state of “hyperlucid unitary consciousness often experienced as God” (Nirvana, *unio mystica*, etc.) occurs when the sympathetic and parasympathetic systems are both discharging at maximal levels, with neither predominating (d’Aquili & Newberg 1998:200, 1999:26).

The authors see religious experiences as the result of normal, healthy physiology, and not pathological or random events. With this, I agree. They conclude that the experience of God, which is potentially within us all, is as “real” as the experience of ordinary objects and events (Newberg et al. 2001a). With this, I have problems. Agreement about what is a rock or a person is individually and collectively much easier to come by than agreement about what may be a magic mountain or holy spirit.

D’Aquili and Newberg (1999:51-57, 164-176) postulate seven functionally localized “cognitive operators” that are “likely to be preprogrammed into the brain.” These operators “represent the way the mind functions on all input into the brain... sensory input, thoughts and emotions.”

1. The Holistic Operator (right parietal lobe) allows us to conceive the world as a whole, and “to apprehend the unity of God and the oneness of the universe.”
2. The Reductionist Operator (left parietal lobe) gives us our “scientific, logical, and mathematical approach... to the universe,” but is also critical to understanding the totality of God and the universe in each of the parts.
3. The Causal Operator (left frontal lobe and left posterior superior parietal lobe), “permits reality to be viewed in terms of causal sequences.”
4. The Abstractive Operator (inferior portion of the parietal lobe in the left hemisphere) forms general concepts from individual facts, including the concepts of “mathematics, government, justice, culture, and family.”
5. The Binary Operator (inferior parietal lobe) permits us to extract meaning from the world “by ordering its abstract elements into dyads... (e.g., good versus evil).” It is crucial to “mythic structure”: “Myths... develop the notion that the opposites we see are actually illusory, a notion that comprise [sic] part of the ideologies of Buddhism and Hinduism.”
6. The Quantitative Operator (inferior parietal lobe close to areas underlying the Binary and Abstractive Operators) abstracts quantity from the perception of various elements.
7. The Emotional Value Operator (limbic system) assigns affective value to percepts and concepts.

Operators (1) and (2) are reminiscent of Gestalt psychology and are so vague and general as to apply to virtually anything. No set of empirical tests or experiments could disconfirm their operation. As Maharishi Mahesh Yogi intoned: “atom and solar system, macrocosm and microcosm, self and universe, are all one and the same.” Talk of pre-programmed operators is not compelling.

Operator (3) is more specific and more plainly wrong. For the last couple of decades, researchers in developmental and cognitive psychology have begun describing functionally quite different causal mechanisms, including various types of mechanical and teleological causes (Sperber et al. 1995). For example, the type of mechanical causality (kinetics) employed by human neonates to interpret the movements of inanimate substances entails physical contact between causally-related objects and spatio-temporal contiguity along any causal path. By contrast, the type of teleological causality (agency) that children apply to the interpretation of the causal interactions between animate objects, especially humans,

assumes no physical contact between interacting objects or spatio-temporal contiguity. Agentive causality is more closely associated with the prefrontal cortices. Moreover, these different types of causality have distinct maturation schedules in the brain.

Operator (4) is a relic of behaviorist psychology. Experiments in cognitive and developmental psychology and anthropology indicate that people do not first learn only specific facts before they abstract general ones (Rosch et al. 1976, Atran 1998). For example, people first come to understand that something is simultaneously an animal of a certain generic kind (e.g., a cat), only later do they come to categorize it as also being of a more specific (tabby) or general (mammal) sort of animal. The learning sequence may be very different for other domains. Thus, people everywhere are more prone to initially individuate persons than to individuate animals or plants or rocks. This makes good evolutionary sense. It usually matters whether your conflict or liaison is with this Jones or that Smith, but not which bear can eat you or which apple you can eat. It makes little evolutionary sense to have a domain-general operation of abstraction or generalization.

For Operator (5), d'Aquili and Newberg (1999:55) reason that lesions in the inferior parietal lobe "prevent patients from being able to name the opposite of any word prescribed to them. This area is thus the seat of... the binary operator." But cutting neural pathways in areas that facilitate antonymy no more shows this area to be the "seat" of antonymy than cutting off air traffic over the Mid-Atlantic shows the Mid-Atlantic to be the seat of the air industry. In any event, antonymy is only one kind of binary contrast ("cat" isn't an antonym of "dog," "mouse" or "kitten" but can be opposed to them).

Operator (6) supposedly accounts for quantification. Now, quantity is not extracted from perception of elements, but is imposed by placing them in one-to-one correspondence with an abstract cardinal set (class of similar classes), such that the last correspondence counted is the number assigned (7 windows and 7 flocks of birds are both just 7). There may be different innate components to number concepts (Hauser 2000). For example, Chomsky (1986) suggests that the notion of discrete infinity attaching to number is a by-product of the language faculty. There is much anecdotal evidence in anthropology, and a recent unpublished study in psychology, indicating that some nonliterate peoples can't determine cardinality (past four) because they simply haven't had the cultural need to put the various components of quantification together. (Needless to say, all such societies have religion). Apparently, such people perceive a difference between, say, 24 and 32 claps but not between, 22, 23, 24, 25, or 26 claps (Susan Carey, personal communication). Similarly, the application of number to space (extension), which characterizes Western science (rulers, coordinates, etc), was until recently alien to the rest of the world (and to the world's religions). There is no evidence such cultural breakthroughs involved rewiring of the inferior parietal lobe, or that even the simpler components of number reside there.

Operator (7) is a catch-all for "affect." Cognitive theories of emotion, such as appraisal theory (Leventhal & Scherer 1987, Ellsworth 1991), suggest that the value structure of emotions is organized very differently from the relations among emotions in the limbic system. In an aversive situation, for example, anger and sadness may have nearly matching cognitive value structures (anger involves the perception of a responsible external agent, sadness doesn't), as may fear and hope (which differ only on valence) (Keltner et al. 1993). Nevertheless, anger has more physiological and "limbic" manifestations in common with fear than anger has with sadness, or fear has with hope.

Brain researcher Rhawn Joseph (2001) proposes another ambitious version of neurotheology: "[C]ross" neurons as well as "mystical/religious" feeling neurons... probably evolved 30,000 and perhaps 100,000 years ago – possibly in reaction to the experience of "cross-like" stimuli in nature [e.g., dead trees that take the form of a cross, birds that fly with extended cross-like wings] coupled with feelings of fear or religious awe.... The sign of the cross is not uncommon and when staring at a cross the temporal lobes are activated.

Using similar logic, however, how can one exclude competing claims for the primacy of (Moslem) crescents, (Jewish) stars, (Native American) circles, and (Indo-Aryan) swastikas? Mystics of all creeds regularly signal appearances and apparitions in nature of their favorite forms. And what about those Achulean "triangles" 250,000 years ago?

Joseph's claim that Neanderthals already had a definite religious sensibility rests on sparse and controversial data. A number of paleoanthropologists question whether Neanderthals ceremoniously dealt with death: "Neanderthals buried their dead only to discourage scavengers and eliminate odor" (Rudavski 1991:44). Flower pollen could have been carried to the grave by the wind or the feet of mourners (Johanson and Edgar 1996:100). Underground streams could have led to accumulation of bear bones in cave niches and to groups of fallen roof blocks. This would produce the illusion of an intentionally made storage pit (Chase and Dibble 1987). There is also the possibility that the conventional aspects of Neanderthal burials may have lacked symbolic charge owing to deficient prefrontal cortical development (a sharper flexion of the cranial base in modern humans tucked the face under the frontal lobes to allow prefrontal development, Balter 2002:1221).

Although temporal and frontal lobes are admittedly involved in religious symbolism, Joseph locates the "abode of God" for each individual within the limbic system. Here also is the seat of "limbic-religious blood lust" and "limbic taboos, [such] as eating and sexuality." Because "sex and food (along with fear, rage, and aggression) are probably the most powerful of all limbic emotions," they are also probably chief "motivators" of religious ritual. An alternative account of the prominence of food and sex in religious ritual might simply be that controlling them is a good way to keep religion in mind: religion-motivated abstinence fires religion-mediated desire.

Joseph offers a version of "intelligent design" in evolution:

[I]f... there is no hereafter or spirit world, then why has our brain become adapted for perceiving and dreaming about what supposedly does not exist. Why would the limbic system evolve specialized neurons... that subserve the capacity to dream about... spirits, angels, and... the souls of the dear departed? ... We see because there are people and objects to view .... If there was nothing to visually contemplate we would not have evolved eyes or visual cortex.... Shouldn't the same evolutionary principles apply to religious experience? .... A true scientist would not rule out such a possibility.

But the fact that we have neurons that "subserve" some capacity tells us little if anything about their evolution, much less about adaptation. We also have "specialized neurons" that subserve a host of mundane perceptual illusions. Does this fact justify the inference that such neurons were naturally selected or ordained to produce perceptual illusions?

Finally, Joseph takes the fact that most human DNA is not active as evidence for natural evolution from and towards spirituality: So much unused capacity needs purpose, namely, as a biological reservoir for evolution as a progressive learning process towards a more complete and active understanding of God: "Although temple priests masquerading as scientists have claimed that life miraculously emerged fully formed from the dust and muck of the earth." Rhetoric aside, this ignores that evolutionary creation usually arises only from huge waste (sperm, pollen, T cells, ideas).

In brief, despite intriguing findings concerning neurobiological correlates for certain types of intense religious experience, broader neurotheological interpretations of the findings are unwarranted. They involve speculation that not only strays way beyond the facts but crucially ignores or contradicts much recent work in cognitive and developmental psychology and cognitive anthropology. Even if neurotheological speculations about the biological correlates of mystical experiences were true, there is no evidence that less extreme, more "routine," religious experiences have some characteristic brain-activation pattern. Many people never have a full-fledged mystical experience, yet are affectively committed religious believers. Although about one-fourth to one-third of American and British subjects polled report having had a "religious experience" in their lives (Hay 1990, Spilka et al. 1992), only 2-3% claim to have had an intensely emotional "mystical experience," such as feeling all things in the world are one (Thomas & Cooper 1978, Hay & Heald 1987 cited in Beit-Hallahmi & Argyle 1997:79). We know next-to-nothing about the neurobiology of the vast majority of run-of-the-mill religious experiences and beliefs that sustain most people's faith.

### **5. Conclusion: Mystical Episodes May Inspire New Religions, But Don't Make Religion.**

Stressful personal episodes become religious experiences by instantiating publicly-relevant schemas. Within such cultural schemas, even the eccentric voices and visions of clinically-diagnosed



schizophrenics and epileptics can become publicly-sanctioned revelations, as they are in some societies. The religious hallucinations and delusions of schizophrenics, the sensory enlightenments of temporal-lobe epileptics (the Apostle Paul or Saint Theresa de Avila?), and the mystical visions and voices of persons are at the extreme end of the “normal” distribution (Jacob, Jesus, Mohammed, Maharishi Mahesh Yogi?).

In historically seminal moments, their unpredictable, “miraculous” revelations have undoubtedly inspired common belief in divine intention and grace. Malfunctioning or hyperactive theories of mind and intentional agency are cognitively and emotionally ripe for supernatural cooptation. Revivalist and starter cults are more likely than established religions to acknowledge the divine character of these more extreme mystical experiences. As Adam Smith (1993[1776]:439) noted, this is because such religious sects aim to radically reform or recreate religious obeisance “by carrying it to some degree of folly or extravagance.” A startling episode of intense sensory arousal in a face-to-face with the supernatural may prove unforgettable and emotive enough to permanently inculcate religious belief in a person, and perhaps to jump-start new belief in society.

Previous neurobiological studies of religion (including neurotheology) have focused on tracking participant’s neurophysiological responses during episodes of religious experience and recording individual patterns of trance, vision, revelation and the like. This has favored comparison of religious experience with temporal-lobe brain-wave patterns during epileptic seizures and acute schizophrenic episodes. Cognitive structures of the human mind/brain in general, and cognitions of agency in particular, are usually represented in these studies in simple-minded terms (binary oppositions, holistic vs. analytical tensions, hierarchical organization, etc.) that have little input from, or pertinence to, recent findings of cognitive and developmental psychology. Perhaps more telling is recent work on the role of the prefrontal cortices in processing concepts of agency and self and in cognitive mediation of relevant emotions originating in (what was once called) “the limbic system.”

For the most part, however, relatively few individuals have emotionally arousing mystical experiences, at least in our society, although the overwhelming majority of individuals consider themselves to be religious believers (polls over the last 30 years consistently show that well over 90% of Americans profess religious convictions). Neither is there any evidence that more “routine” religious experiences have a characteristic temporal-lobe signature, or any other specific type of brain-activity pattern. The neurophysiological bases that commit the bulk of humanity into the care of supernatural agents remain a complete mystery.

## References

- Alexander, R. (1987) The biology of moral systems. New York: Aldine de Gruyter.
- Atran, S. (1998) Folkbiology and the anthropology of science: Cognitive universals and cultural particulars. Behavioral and Brain Sciences 21:547-609.
- Atran, S. (2002) In gods we trust: The evolutionary landscape of religion. New York: Oxford University Press.
- Atran, S., Medin, D., Lynch, E., Vapnarsky, V., Ucan Ek', E., Coley, J., Timura, C. & Baran, M. (2002) Folkecology, cultural epidemiology, and the spirit of the commons: A garden experiment in the Maya Lowlands, 1991-2001. Current Anthropology 43:421-450.
- Atran, S. & Sperber, D. (1991) Learning without teaching: Its place in culture. In L. Tolchinsky-Landsmann (ed.), Culture, schooling and psychological development. Norwood NJ: Ablex.
- Avis, J. & Harris, P. (1991) Belief-desire reasoning among Baka children. Child Development 62:460-467.
- Bachevalier, J. & Merjanian, P. (1994) The contribution of medial temporal lobe structures in infantile autism: A neurobehavioral study in primates. In L. Bauman & T. Kemper (eds.), The neurobiology of autism. Baltimore: Johns Hopkins Press.
- Balter, M. (2002) What made humans modern? Science 295:1219-1225.
- Baron-Cohen, S. (1995) Mindblindness. Cambridge, MA: MIT Press.
- Barrett, J. (2000) Exploring the natural foundations of religion. Trends in Cognitive Science. 4:29-34.
- Barrett, J., Richert, R. & Driesenga, A. (2001) God's beliefs versus mother's: The Development of nonhuman agent concepts. Child Development 72:50-65.
- Bauman, M. & Kemper, T. (1985) Histoanatomic observations of the brain in early infantile autism. Neurology 35:866-874.
- Bear, D. (1979) Temporal lobe epilepsy. Cortex 15:357-384.
- Beard, A. (1963) The schizophrenia-like psychoses of epilepsy, II: Physical aspects. British Journal of Psychiatry 109:113-129.
- Beit-Hallahmi, B. & Argyle, M. (1997) The psychology of religious behavior, belief, and experience. London: Routledge.
- Ben-Amos, P. G. (1994) The promise of greatness. In T. Blakely, W. van Beek & D. Thomson (eds.), Religion in Africa. Portsmouth, NH: Heinemann.
- Blackmore, S. (1999) The meme machine. Oxford: Oxford University Press.
- Boyer, P. (1994) The naturalness of religious ideas. Berkeley: University of California Press.
- Bowlby, J. (1969) Attachment and loss, vol. 1. Attachment. New York: Basic Books.
- Burkert, W. (1996) Creation of the sacred. Cambridge, MA: Harvard University Press.
- Cahill, L., Prins, B., Weber, M. & McGaugh, J. (1994) Beta-adrenergic activation and memory for emotional events. Nature 371:702-704.
- Chase, P. & Dibble, H. (1987) Middle Paleolithic symbolism. Journal of Anthropological Archaeology 6:263-296.
- Chomsky, N. (1986) Knowledge of language. New York: Praeger.
- Corcoran, R., Mercer, G. & Frith, C. (1995) Schizophrenia, symptomatology and social inference: Investigating "theory of mind" in people with schizophrenia. Schizophrenia Research 17:5-13.
- Crooke, W. (1907) The native races of Northern India. London: Archibald Constable.
- Cunningham, J. & Sterling, R. (1988) Developmental changes in the understanding of affective meaning in music. Motivation and Emotion 12:399-412.
- d'Aquili, E. (1986) Myth, ritual, and the archetypal hypothesis. Zygon 21:141-160.
- d'Aquili, E. & Newberg, A. (1998) The neuropsychological basis of religions, or why God won't go away. Zygon 33:187-201.
- d'Aquili, E. & Newberg, A. (1999) The mystical mind. Minneapolis: Fortress Press.
- d'Azevedo, W. (1973) Mask makers and myth in Western Liberia. In A. Forge (ed.), Primitive art and society. London: Oxford University Press.
- Damasio, A. (1994) Descartes' error. New York: Avon Books.

- Darwin, C. (1965[1872]) The expression of the emotions in man and animals. Chicago: University of Chicago Press.
- Deardoff, J. (2001) Mom wins asylum for son with autism. Chicago Tribune, February 21.
- DeLong, G. (1992) Autism, amnesia, hippocampus, and learning. Neuroscience and Behavioral Reviews 16:63-70.
- Dewhurst, K. & Beard, A. (1970) Sudden religious conversions in temporal lobe epilepsy. British Journal of Psychiatry 117: S497-S507.
- Douyon, E. (1966) L'examen au Rorschach des voudouisants Haitiens. In R. Prince (ed.), Trans and possession states. Montreal: R.M. Bucke Memorial Society.
- Durkheim, E. (1995[1912]) The elementary forms of religious life. New York: The Free Press.
- Ekman, P. (1992) An argument for basic emotions. Cognition and Emotion 6:169-200.
- Eliade, M. (1964) Myth and reality. London: Allen & Unwin.
- Ellsworth, P. (1991) Some implications of cognitive appraisal theories of emotion. K. Strongman (ed.) International Review of Studies of Emotion, vol. 1. New York: John Wiley.
- Erikson, E. (1963) Childhood and society, 2<sup>nd</sup> ed. New York: Norton.
- Feuerbach, L. (1972[1843]) The fiery book. Garden City, New York: Anchor Books.
- Fodor, J. (1974) The language of thought. Cambridge, MA: MIT Press.
- Freed, S. & Freed, R. (1964) Spirit possession as an illness in a North American village. Ethnology 3:152-197.
- Freud, S. (1990[1913]) Totem and taboo. New York: Norton.
- Gellhorn, E. & Kiely, W. (1972) Mystical states of consciousness. Journal of Nervous and Mental Disease 154:399-405.
- Geschwind, N. (1983) Interictal behavioral changes in epilepsy. Epilepsia 24 (suppl. 1):S23-S30.
- Gloor, P., Olivier, A., Quesney, F., Andermann, F. & Horowitz, S. (1982) The role of the limbic system in experiential phenomena of temporal lobe epilepsy. Annals of Neurology 12:129-144.
- Goldfarb, W. (1964) An investigation of childhood schizophrenia. Archives of General Psychiatry 11:620-634.
- Greeley, A. (1975) The sociology of the paranormal. London: Sage.
- Guthrie, S. (1993) Faces in the clouds. New York: Oxford University Press.
- Hauser, M. (2000) What do animals think about numbers? American Scientist 88:144-151.
- Hay, D. (1990) Religious experience today. London: Mowbray.
- Hirschfeld, L. & Gelman, S., eds. (1994) Mapping the mind. New York: Cambridge University Press.
- Hooker, C., Roese, N. & Park, S. (2000) Impoverished counterfactual thinking is associated with schizophrenia. Psychiatry 63:326-335
- Horton, R. (1963) The Kalabiri Erkin society. Africa 33:94-114.
- Hugdahl, K. (1996) Cognitive influences on human autonomic nervous function. Current Opinion in Neurobiology 6:252-258.
- Hume, D. (1956[1757]) The natural history of religion. Stanford: Stanford University Press.
- Hustig, H. & Hafner, R. (1990) Persistent auditory hallucinations and their relationship to delusions and mood. Journal of Nervous and Mental Disease 178:264-267.
- Irons, W. (1996) Morality, religion, and human nature. In W.M. Richardson & W. Wildman (eds.) Religion and science. New York: Routledge.
- James, W. (1902) The varieties of religious experience. London: Longmans.
- Jausen, A. (1948[1907]) Coutumes des Arabes au pays de Moab. Paris: Adrien-Maisonneuve.
- Joseph, R. (2001) The limbic system and the soul. Zygon 36:105-136.
- Johanson, D. & Edgar, B. (1996) From Lucy to language. New York: Simon and Schuster
- Kanner, L. (1943) Autistic disturbances of affective contact. The Nervous Child 2:217-250.
- Karagulla, S. & Robertson, E. (1955) Physical phenomena in temporal lobe epilepsy and the psychoses. British Medical Journal 1:748-752.
- Kelley, M. (1958) The incidence of hospitalized mental illness among religious sisters in the United States. American Journal of Psychiatry 115:72-75.

- Keltner, D., Ellsworth, P. & Edwards, K. (1993) Beyond simple pessimism: Effects of sadness and anger on social perception. Journal of Personality and Social Psychology 64:740-752.
- Kent, G. & Wahass, S. (1996) The content and characteristics of auditory hallucinations in Saudia Arabia and the UK. Acta Psychiatrica Scandinavica 94:433-437.
- Kierkegaard, S. (1955[1843]) Fear and trembling and the sickness unto death. New York: Doubleday.
- Kilson, M. (1972) Ambivalence and power. Journal of Religion in Africa 4:171-177.
- Kirkpatrick, L. (1998) God as a substitute attachment figure. Personality and Social Psychology Bulletin 24:961-973.
- Klüver, H. & Bucy, P. (1939) Preliminary analysis of function of the temporal lobe in monkeys. Archives of Neurology 42:979-1000.
- Knight, N., Atran, S., Barrett, J. & Ucan Ek', E. (2001) Understanding the mind of God: Evidence from Yukatek Maya children. Paper presented at the Annual Meeting of The Society for the Scientific Study of Religion, Columbus, OH, October.
- Knight, R. & Grabowecky, M. (1995) Escape from linear time: Prefrontal cortex and conscious experience. In M. Gazzaniga (ed.), The cognitive neurosciences; Cambridge, MA: MIT Press.
- Larkin, A. (1979) The form and content of schizophrenic hallucination. American Journal of Psychiatry 136:940-943.
- LeDoux, J. (1993) Emotional memory systems in the brain. Behavioural Brain Research 58:69-79.
- Leiris, M. (1958) La possession et ses aspects theatraux chez les Ethiopiens. Paris: Plon.
- Leslie, A. & Frith, U. (1987) Metarepresentation and autism. Cognition 27:291-294.
- Leslie, A. & Frith, U. (1988) Autistic children's understanding of seeing, knowing, and believing. British Journal of Developmental Psychology 6:315-324.
- Lester, T. (2002) Supernatural selection. Atlantic Monthly, February 8.
- Leventhal, H. & Scherer, K. (1987) The relationship of emotion to cognition. Cognition and Emotion 1:3-28.
- Lewis, I. (1971) Ecstatic religion. Harmondsworth, UK: Penguin.
- Lorenz, K. (1996) The natural science of the human species. Cambridge, MA: MIT Press.
- Lotter, V. (1966) Epidemiology of autistic conditions in young children, 1: Prevalence. Social Psychology 1:124-137.
- Lowie, R. (1924) Primitive religion. New York: Boni and Liveright.
- Ludwig, A. (1965) Witchcraft today. Diseases of the Nervous System 26:288-291.
- Lynch, J. (1980) The functional organization of posterior parietal association cortex. Behavioral and Brain Sciences 3:485-499.
- McGaugh, J., Cahill, L., Parent, M., Mesches, M., Coleman-Mesches, K. & Salinas, J. (1995) Involvement of the amygdala in the regulation of memory storage. In J. McGaugh, F. Bermudez-Rattoni & R. Prado-Alcala (eds.), Plasticity in the central nervous system. Hillsdale, NJ: Erlbaum.
- McReady, N. (2002) Adrenergic blockers shortly after trauma can block PTSD. Clinical Psychiatry News, February.
- Mineka, S., Davidson, M., Cook, M. & Keir, R. (1984) Observational conditioning of snake fear in rhesus monkeys. Journal of Abnormal Psychology 93:355-372.
- Munkur, B. (1983) The cult of the serpent. Albany: State University of New York Press.
- Nesse, R. (1999) Evolution of commitment and the origins of religion. Science and Spirit 10:32-36.
- Newberg, A., d'Aquili, E. & Rause, V. (2001a) Why God won't go away. Ballantine.
- Newberg, A., Alavi, A., Baime, M., Pourdehand, M., Santanna, J. & d'Aquili, E. (2001b) The measurement of cerebral blood flow during the complex cognitive task of meditation. Psychiatry Research: Neuroimaging 106:113-122.
- Norenzayan, A. & Atran, S. (2002) Cognitive and emotional processes in the cultural transmission of natural and nonnatural beliefs. In M. Schaller & C. Crandall (eds.), The psychological foundations of culture. Hillsdale, NJ: Lawrence Erlbaum.
- Oulis, P., Mavreas, V., Mamounas, J. & Stefanis, C. (1995) Clinical characteristics of auditory hallucinations. Acta Psychiatrica Scandinavica 92:97-102.

- Panksepp, J. (1995) The emotional source of “chills” induced by music. Music Perception 13:171-207.
- Passingham, R. (1993) The frontal lobes and voluntary action. Oxford: Oxford University Press.
- Persinger, M. (1983) Religious and mystical experiences as artifacts of temporal lobe function. Perceptual and Motor Skills 57:1255-1262.
- Persinger, M. (1984) Striking EEG profiles from single episodes of glossolalia and transcendental meditation. Perceptual and Motor Skills 58:127-133.
- Persinger, M. (1987) Neurophysiological bases of God beliefs. New York: Praeger.
- Persinger, M. (1997) “I would kill in God’s name,” Role of sex, weekly church attendance, report of a religious experience, and limbic liability. Perceptual and Motor Skills 71:817-818.
- Phillips, M. & David, A. (1995) Facial processing in schizophrenia and delusional misidentification. Schizophrenia Research 17:109-114.
- Pressel, E. (1974) Umbanda trance and possession in Sao Paulo, Brazil. In F. Goodman, J. Henney & E. Pressel (eds.), Trance healing and hallucination. London: Wiley.
- Rappaport, R. (1979) Ecology, meaning, and religion. Berkeley: Atlantic Books.
- Rappaport, R. (1999) Ritual and religion in the making of humanity. Cambridge, UK: Cambridge University Press.
- Ratey, J. & Johnson, C. (1998) Shadow syndromes. New York: Bantam Doubleday.
- Redfield, R. & Villa Rojas, A. (1934) Chan Kom: A Maya village. Chicago: University of Chicago Press.
- Reina, R. (1966) The law of the saint. Bobbs-Merrill.
- Rosch, E., Mervis, C., Grey, W., Johnson, D., & Boyes-Braem, P. (1976) Basic objects in natural categories. Cognitive Psychology 8:382-439.
- Rudavsky, S. (1991) The secret life of the Neanderthal. Omni 14:42- 44, 55-56.
- Sackville-West (1943) The eagle and the dove. London: Michael Joseph.
- Schmidt, L. & Trainor, L. (2001) Frontal brain electrical activity (EEG) distinguishes valence and intensity of musical emotions. Cognition and Emotion 15:487-500.
- Slater, E. & Beard, A. (1963) The schizophrenia-like psychoses of epilepsy. I, V. British Journal of Psychiatry 109:95-112, 143-150.
- Smith, A. (1993[1776]) An inquiry into the nature and causes of the wealth of nations. Oxford: Oxford University Press.
- Sperber, D., Premack, D. & Premack, A., eds. (1995) Causal cognition. Oxford: Clarendon Press.
- Spilka, B., Brown, G. & Cassidy, S. (1992) The structure of religious mystical experience. International Journal for the Psychology of Religion. 2:241-257.
- Stern, D. 1985. The interpersonal world of the infant. New York: Basic Books.
- Stern, E. & Silbersweig, D. (1998) Neural mechanisms underlying hallucinations in schizophrenia. In M. Lenzenweger & R. Dworkin (eds.), Origins and development of schizophrenia. Washington, DC: American Psychological Association.
- Suddendorf, T. (1999) The rise of the metamind. In M. Corballis & S. Lea (eds.), The descent of mind. New York: Oxford University Press.
- Theresa, Saint of Avila (1930) Interior castle. London: Thomas Baker.
- Thomas, L. & Cooper, R. (1978) Measurement and incidence of mystical experience. Journal for the Scientific Study of Religion 17:433-437.
- Tinbergen, N. (1951) The study of instinct. London: Oxford University Press.
- Trainor, L. & Trehub, S. (1992) The development of referential meaning in music. Music Perception 9:455-470.
- Turner, V. (1969) The ritual process. New York: Aldine.
- Wahass, S. & Kent, G. (1997) A comparison of public attitudes in Britain and Saudia Arabia towards auditory hallucinations. International Journal of Social Psychiatry 43:175-183.
- Walker, S. (1972) Ceremonial spirit possession in Africa and Afro-America. Leiden: Brill.
- Warner, R. (1977) Witchcraft and soul loss. Hospital and Community Psychiatry 28:686-690.

- Watanabee, J. & Smuts, B. (1999) Explaining ritual without explaining it away. American Anthropologist 101:98-112.
- Weber, M. (1946) The Protestant sects and the spirit of capitalism. In From Max Weber: Essays in sociology, trans. and ed. C. Wright Mills & H. Gerth. New York: Oxford University Press.
- Wellman, H. (1990) The child's theory of mind. Cambridge, MA: MIT Press.
- Wheeler, M., Stuss, D. & Tulving, E. (1997) Toward a theory of episodic memory: The frontal lobes and autoiogenic consciousness. Psychological Bulletin 121:331-354.
- Whitehead, H. (1988[1921]) The village gods of South India. Madras: Asia Education Services.
- Wilson, D.S. (2002) Darwin's cathedral. Chicago: University of Chicago Press.
- Wimmer, H. & Perner, J. (1983) Beliefs about beliefs. Cognition 13:103-128.
- Woods, M. (1913) Was the Apostle Paul an epileptic? New York: Cosmopolitan Press.
- Worthington, E., Kuru, T., McCullough, M. & Sandage, S. (1996) Empirical research on religion and psychotherapeutic processes of outcomes. Psychological Bulletin 19:448-487.
- Yap, P. (1960) The possession syndrome. Journal of Mental Science 106:114-137.
- Zisook, S., Byrd, D., Kuck, J. & Jeste, D. (1995) Command hallucinations in outpatients with schizophrenia. Journal of Clinical Psychiatry 56:462-465.

**Table 1. Three stories with matching events used to prime feelings of religiosity:  
Neutral (uneventful), Death (stressful), Religious (prayer scene)**

	<b>Neutral</b>	<b>Death</b>	<b>Religious</b>
1	A mother and her son are leaving home in the morning	A mother and her son are leaving home in the morning	A mother and her son are leaving home in the morning
2	She is taking him to visit his father's workplace	She is taking him to visit his father's workplace	She is taking him to visit his father's workplace
3	The father is a laboratory technician at Victory Memorial Hospital	The father is a laboratory technician at Victory Memorial Hospital	The father is a laboratory technician at Victory Memorial Hospital
4	They check before crossing a busy road	They check before crossing a busy road	They check before crossing a busy road
5	While walking along, the boy sees some wrecked cars in a junk yard, which he finds interesting	While crossing the road, the boy is caught in a terrible accident, which critically injures him.	While walking along, the boy sees a well-dressed man stop by a homeless woman, falling on his knees before her, weeping.
6	At the hospital, the staff are preparing for a practice disaster drill, which the boy will watch	At the hospital, the staff prepares the emergency room, to which the boy is rushed.	At the hospital, the boy's father shows him around his lab. The boy listens politely, but his thoughts are elsewhere.
7	An image from a brain scan machine used in the drill attracts the boy's interest.	An image from a brain scan machine used in a trauma situation shows severe bleeding in the boy's brain.	An image from a brain scan that he sees reminds him of something in the homeless woman's face.
8	All morning long, a surgical team practices the disaster drill procedures	All morning long, a surgical team struggles to save the boy's life.	On his way around the hospital, the boy glances into the hospital's chapel, where he sees the well-dressed man sitting alone.
9	Make-up artists are able to create realistic-looking injuries on actors for the drill.	Specialized surgeons are able to re-attach the boy's severed feet, but can not stop his internal hemorrhaging.	With elbows on his knees, and his head in his hands, the man moves his lips silently. The boy wants to sit beside him, but his father leads him away.
10	After the drill, while the father watches the boy, the mother leaves to phone her other child's pre-school.	After the surgery, while the father stays by the dead boy, the mother leaves to phone her other child's pre-school	After a brief tour of the hospital, while the father watches the boy, the mother leaves to phone her other child's pre-school.
11	Running a little late, she phones the pre-school to tell them she will soon pick up her child.	Barely able to talk, she phones the pre-school to tell them she will soon pick up her child.	Running a little late, she phones the pre-school to tell them she will soon pick up her child.
12	Heading to pick up her child, she hails a taxi at the number nine bus stop	Heading to pick up her child, she hails a taxi at the number nine bus stop.	Heading to pick up her child, she hails a taxi at the number nine bus stop.

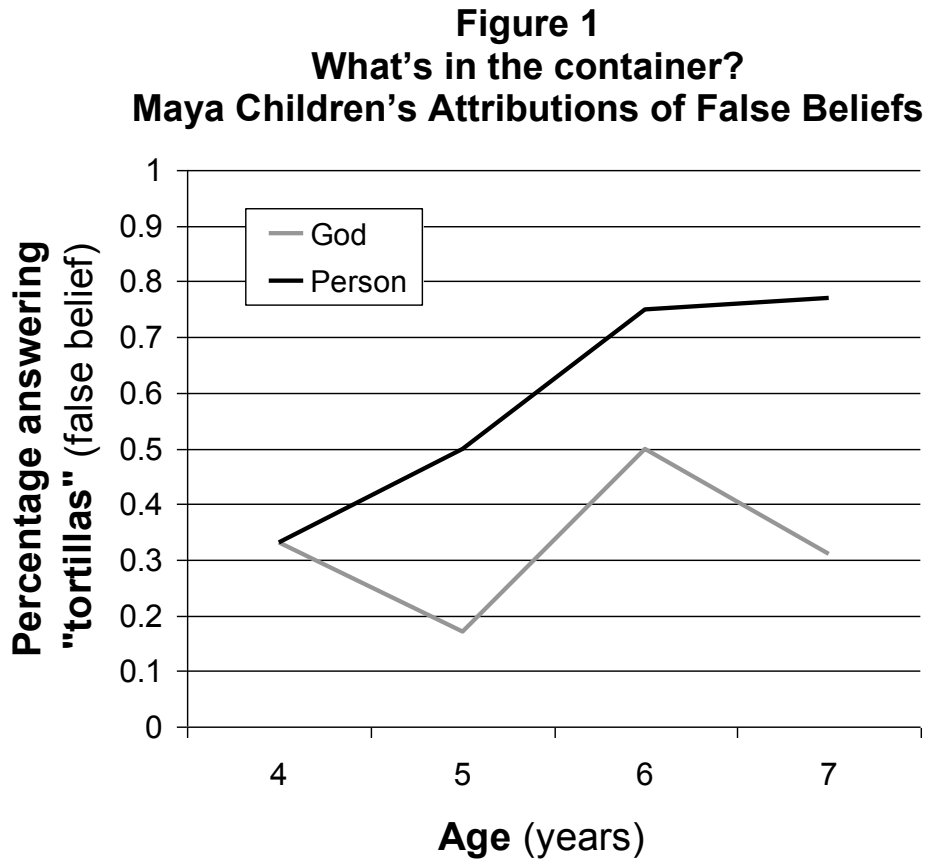


Fig. 1. Percentage of Yukatek Maya children's attributions of false beliefs to God and persons by age.



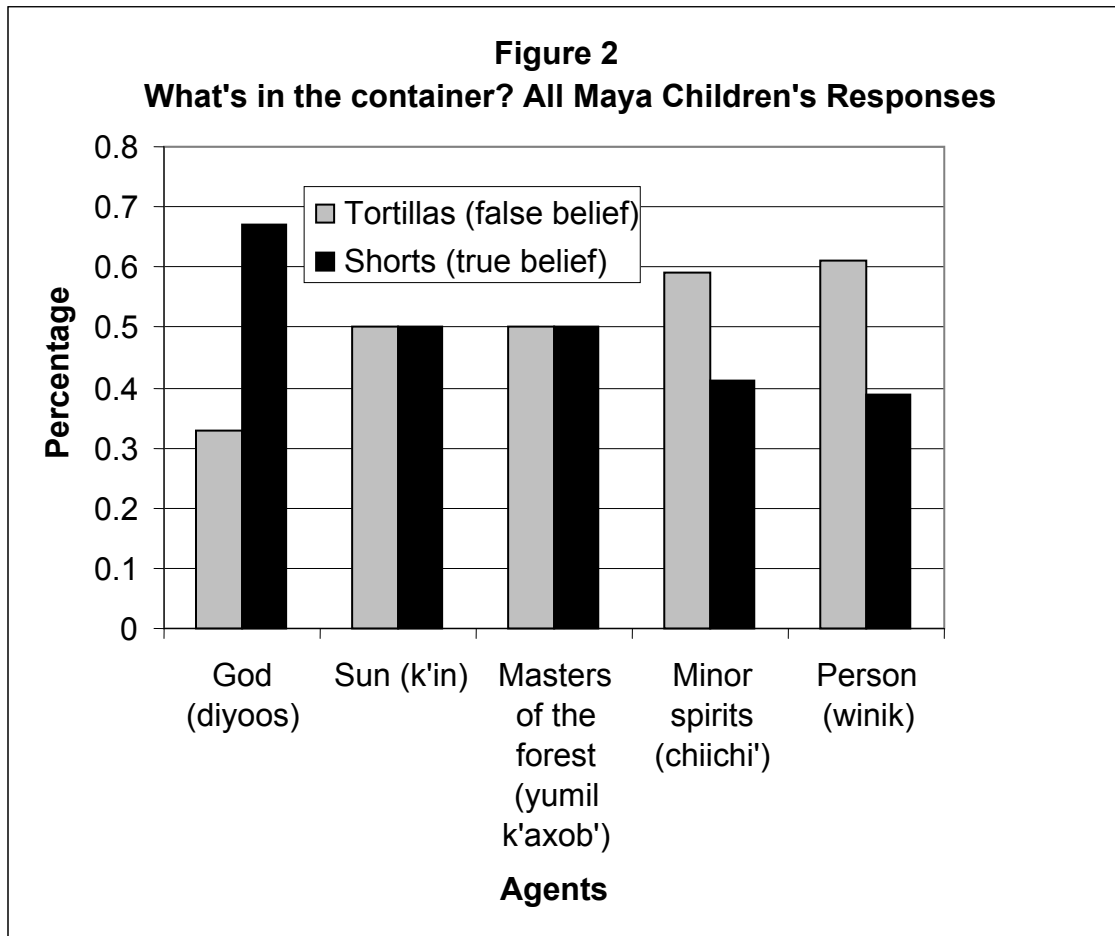


Fig. 2. Percentage of responses by all age groups of Yukatek Maya children attributing false beliefs or true beliefs to persons and various supernatural agents.

**Figure 3**  
**The God that prayer groups were praying to exists**

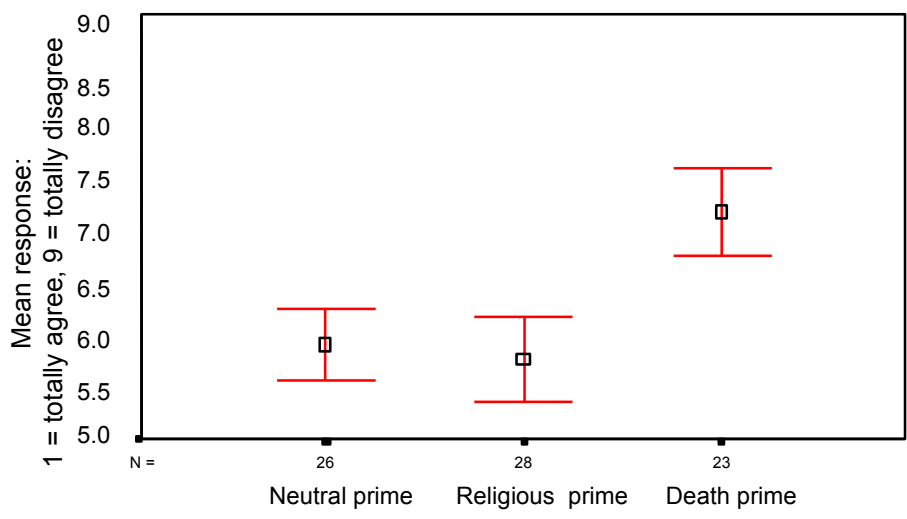


Fig. 3. Strength of belief in God's existence after priming (neutral, religious or death) and then reading a newspaper article about effects of prayer on pregnancy (vertical bars represent margin of error at  $p = .05$ )

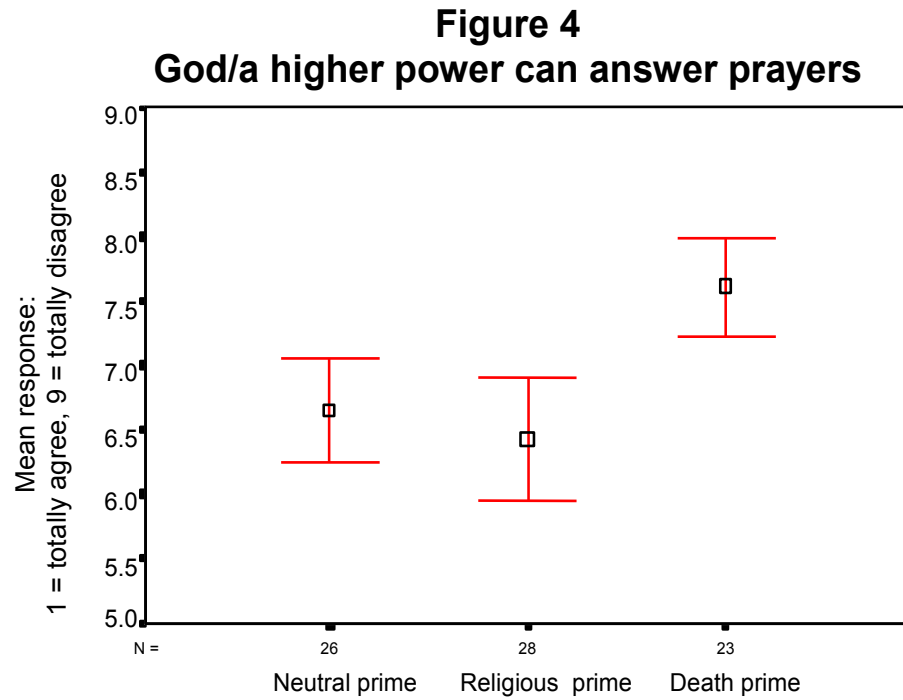


Fig. 4. Strength of belief in supernatural power after priming (neutral, religious or death) and then reading a newspaper article about effects of prayer on pregnancy (vertical bars represent margin of error at  $p = .05$ )