Articles

THE MOTIVATIONAL ORIGINS OF RELIGIOUS PRACTICES

by Patrick McNamara

Abstract. I hypothesize that people engage in religious practices, in part, because such practices activate the frontal lobes. Activation of the frontal lobes is both intrinsically rewarding and necessary for acquisition of many of the behaviors that religions seek to foster, including self-responsibility, impulse and emotion modulation, empathy, moral insight, hope, and optimism. Although direct tests of the hypothesis are as yet nonexistent, there is reasonably strong circumstantial evidence (reviewed herein) for it. Recent brain-imaging studies indicate greater anterior activation values and increased blood flow to frontal sites during prayer and meditation. Regular prayer is positively correlated with better overall mental health. Religiosity is correlated with higher levels of self-monitoring, empathy, and moral insight and other positive behaviors and negatively correlated with depression and impulsive and risky behaviors. Independent data show that self-monitoring, empathy, hope, and moral insight are all selectively associated with intact frontal function, whereas depression, impulsiveness, and drug and alcohol abuse are associated selectively with frontal dysfunction. If religious practices do indeed preferentially activate and stimulate development of the frontal lobes, (a) religious practices should be considered as possible adjuncts for some patients in treatment for mental health disorders, and (b) the frontal lobes (rather than the temporal lobes) should be considered the major brain site that supports the core components of religious experience.

Keywords: catecholamines; dopamine; executive functions; frontal lobes; localization; neuropsychology; religious cognition; reward systems.

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[*Zygon*, vol. 37, no. 1 (March 2002).]
 ISSN 0591-2385

Why do people engage in religious practices? For some the answer is simple: People participate in religious practices because they (the religious people) are ignorant and superstitious. For others (like myself) such an explanation (denigration of religious people as ignorant and superstitious) is not a scientific hypothesis at all and, in any case, does not fit the facts (actually most religious people are neither ignorant nor superstitious). It, furthermore, does not explain religion's persistence or religion's beneficial effects on the individual or the group. Although it is certainly true that religion has been associated with negative practices and effects, such as intolerance and violent fanaticism, it, like virtually any other behavioral phenomenon, exhibits both positive and negative associations. We therefore need a theory of religion that can account for both its positive and negative effects.

Theoretically, religion's positive effects must outweigh its negative effects if we are to explain its persistence from the time of its appearance among the shamans of the stone age up to the modern era. We need to understand religion's beneficial effects if we are to understand its overall nature and role in human culture. Many influential theories of religion's "payoff" point to social cohesion as its major positive function (for example, Durkheim [1912] 1976; Girard 1977). Fewer and perhaps less-influential theories of religion's positive function have pointed to individual socialization, integration, and autonomy (Allport 1950; Hartmann 1958; Beit-Hallahmi and Argyle 1997; Batson, Schoenrade, and Ventis 1993). It is to this latter class of theories of religion that I hope to contribute, arguing that (a) religious practices do indeed help to promote development of individuals who are characterized by compassionate service to others as well as individual wholeness, integrity, and autonomy; (b) they accomplish their goal of producing mature, autonomous, and generative individuals by stimulating development of the prefrontal cortex and its associated executive cognitive functions (ECFs), and (c) this ability to stimulate the frontal lobes also helps to explain religion's negative effects (such as rigidity in belief systems, intolerance, and fanaticism), because stimulation of frontal systems is associated with the core neurobiologic mechanisms of addiction and its associated cognitive distortions.

The Hypothesis

I hypothesize that people engage in religious practices, in part, because such practices activate the frontal lobes and help them to acquire ECFs. By religious practices I mean religious rituals such as prayer, religiously oriented meditation, devotional worship, attendance at liturgical or ritual celebrations, and study of scripture (see Table 1). ECFs are valued because they are cognitive prerequisites of maturity, prosocial behaviors, abstract reasoning ability, generativity, and personal autonomy. Although direct tests of the hypothesis are as yet nonexistent, there is reasonably strong

circumstantial evidence for it. The concrete signs that religious practices are having their intended effects include enhanced moral sensibilities, greater internal freedom, greater self-control, deeper insight into self and others, empathy and compassion for others, generativity, and prosocial behavior in general. These are all mental processes and behaviors that have been linked to activation of neurocognitive networks in the frontal lobes. Thus, it is reasonable to suppose that the hypothesis would find some support if tested. With regard to negative effects of religiosity, such as fanaticism and intolerance, I suggest that stimulation of frontal circuits (this time the mesocortical dopamine circuits) is involved, because repetitive stimulation of these circuits with drugs that selectively stimulate the mesocortical dopaminergic terminals sets up addictive patterns of thought and behavior. A brief review of the available evidence for these conjectures follows. I begin with a short discussion of my assumed theoretical orientations and what I mean by religious practices.

Theoretical and Methodological Assumptions

1. RELIGIOUS PRACTICES ARE THOSE CULTURAL PRACTICES THAT INDUCE RELIGIOUS EXPERIENCES. I assume a neutral stance with regard to the possible transcendent source of the urge to engage in religious practices. I further assume that any social or cultural practice that reliably produces a religious experience is a religious practice. I therefore need to define *religious experience*, and here I rely on W. J. Wildman and L. A. Brothers's recent treatment of the topic (1999). For Wildman and Brothers religious experiences are a subset of a broader range of "ultimacy experiences" (UE)—roughly those experiences that point to ultimate concerns and elicit our most intense cognitive-emotional-spiritual engagement/commitment. Wildman and Brothers use a number of sources—first-person accounts, phenomenological analyses, the judgments of experts in religious discernment, neural and psychological correlates, and the wisdom of generations as captured in the theological, ethical, and spiritual literatures—to identify the distinguishing characteristics of UEs. Focusing on the characteristics of religious experiences, they note that such experiences can be discrete (short-term, single-instance) experiences or extended (long-term) experiences. Elements of discrete UEs include sensory alterations, self-alterations, a sense of supernatural presence, and cognitive and emotional changes. Elements of extended UEs include existential potency, social engagement, transformation of character, and transformation of beliefs. When experiences are associated with a number of these markers of discrete and/or extended UEs, in the context of a socially or normatively defined "religious" practice, and when the experiences are further associated with emotional engagement or commitment as defined by Wildman and Brothers, we are likely dealing with authentic religious experiences. The essential

point here is that what most people would call a religious *practice* is typically associated with what most people would call a religious *experience* and that these experiences can be reasonably well defined using Wildman's and Brothers's criteria. I focus in this paper on the religious practices listed in Table 1 because they satisfy the criteria and are what most people in the West would call religious practices.

2. THE PREFRONTAL CORTEX (A) CONTAINS INTRINSIC-REWARD CIRCUITS IMPORTANT IN THE NEUROBIOLOGY OF ADDICTION AND SPECIALIZES IN BOTH (B) EXECUTIVE COGNITIVE FUNCTIONS AND (C) SKILLS OF SOCIAL INTELLIGENCE. BECAUSE OF THESE SPECIALIZATIONS, THE PREFRONTAL CORTEX (RATHER THAN THE TEMPORAL CORTEX) SHOULD BE CONSIDERED THE MAJOR BRAIN SITE THAT SUPPORTS THE CORE COMPONENTS OF RELIGIOUS COGNITION. I assume a model of frontal functions that suggests that its major specializations are (a) predicting appetitive rewards, (b) supporting executive cognitive functions, and (c) supporting social cognition. Given a, b and c, I further assume that the frontal lobes eventually (over normal ontogenetic development) specialize in religious cognition and behaviors. Supporting evidence for each of these assumptions follows.

(a) Stimulation of the Frontal Lobes is Intrinsically and Potently Rewarding. The frontal lobes are densely innervated by dopaminergic (DA) fibers originating in the Ventral Tegmental Area (VTA) and the Substantia Nigra (SN). The nigrostriatal system indirectly influences the frontal lobes through the basal ganglia. The mesocortical system originates in the VTA and terminates in the ventral striatum, amygdala, nucleus accumbens, and frontal lobes. This latter mesocortical system is crucially important for understanding human behavior as its stimulation appears to be intrinsically rewarding. All addictive substances, for example, appear to derive their addicting properties from their abilities to potently stimulate this frontal dopaminergic system. Dopamine neurons of the VTA and SN have long been associated with the reward and pleasure systems of the brain. Virtually all of the known addictions (including cocaine, heroin, amphetamines, alcohol, food, and sex) exert their addictive actions, in part, by prolonging the influence of dopamine on target neurons (Koob 1992; Wise and Bozarth 1987). VTA DA neuron responses appear to be necessary for facilitating formation of associations between stimuli that predict reward and behavioral responses that obtain reward (Schultz et al. 1995). The orbital frontal cortex integrates the most complex level of associations of reinforcement with both stimuli and responses (Rolls 1998). In summary, stimulation of dopaminergic terminals in the mesolimbic-frontal systems constitute the substrate for a most potent reward and reinforcing system.

(b) and (c) The Prefrontal Cortex Specializes in Both Executive Cognitive Functions and Skills of Social Intelligence. Social intelligence involves the ability to act wisely in social situations and appears to depend on the frontal lobes. Sociocognitive abilities linked to the frontal lobes include perspective taking, interpersonal problem solving, relationship maintenance, moral judgment, and social-pragmatic communication (Eisenberg and Harris 1984; Hogarty and Flesher 1999; Worden 1998). Executive cognitive functions are, broadly, those functions that relate to cognitive activity involving the planning, initiation, maintenance, and adjustment of nonroutine, goal-directed behaviors. Commonly seen clinical manifestations of ECF deficits include disinhibition, amotivational syndrome, depressive affect, cognitive inflexibility, behavioral rigidity, "theory of mind" impairments (in which the individual fails to ascribe intentional states, or attributes of mind, to others), distractibility, and impaired abstract reasoning. ECFs are considered a special category of cognitive functions, because ECF impairments are usually selectively associated with prefrontal-lobe dysfunction. When prefrontal dysfunction occurs, one or more ECFs are selectively affected while other (higher) cognitive functions such as language, memory, visuospatial perception, and praxis are spared.

The connection between ECFs and religious practices has been made before. With some irony, P. Rabbit recently pointed out how congruent are recent concepts of the ECFs of the frontal lobe with formal theological criteria for commission of a serious sin:

> The minimal functional processes involved in the commission of a mortal sin (taking the Roman Catholic framework) are awareness of the self as the intending perpetrator of the act; recognition of the unpleasant implications of the act for others by possession of a theory of Mind; recognition of its moral repulsiveness by possession of a theory of the Mind of God; an ability to simultaneously represent alternative acts and their possible outcomes in working memory in order efficiently to choose between them; conscious formulation of a well-articulated plan to perform the act successfully; self-initiation and execution of sequences of appropriate actions to consummate this plan during which recognition of personal culpability is maintained by continuous self-monitoring; recognition of attainment of the vile goal state and an intention to use what has been learned in its pursuit to perform it again if opportunity occurs. Clearly only the central executive can sin. (Rabbit 1997, 2)

Whether or not a "central executive" exists, ECFs clearly do exist, and people need them to engage in any freely chosen path of behavior. Rabbit's tongue-in-cheek list of ECFs that are required in commission of a mortal sin—self-awareness, empathy, theory of mind, working memory, planning, self-initiation or will, goal-directedness, and so forth—are all functions that have been shown to depend on the prefrontal lobes. I review the evidence for this claim below.

In Table 1 are laid out some possible (speculative) relations of influence between specific religious practices and ECFs and social skills. At this

Table 1. Possible relations of religious practices to executive functions and social intelligence

Religious practice	Executive functions	Social skills
communal worship/ services	Sensitivity to social context	prosocial behaviors, interpersonal problem solving, modulation of social emotions
cultivation of altruistic orientation	perspective-taking, mental simulation	empathy, moral insight, detection of deception
meditation and contemplation	resistance to interference, working memory, attentional control	will, goal-directedness, optimism, hope
prayer and private devotions (theistic orientation)	theory of mind (core components)	attributions of agency to others, social communication of affect, "collaborative coping"
spiritual exercises, self-examen, life review	introspection, insight, attentional control, episodic memory retrieval	self-awareness/autonomy, "centeredness"
communal and private study of spiritual texts, communal-liturgical recitations of sacred texts	meaning construction	belief fixation
participation in sacred rituals, initiation rites	meaning and identity construction, stress-induced activation of frontal circuits	
repetitive prayers/ chants	mental concentration, trance, ecstasy	relaxation
sacred and liturgical music	all of the above	"inspiration," will, social solidarity

point these relationships are merely suggestions for potential routes of causation. None of the proposed relationships has yet received any direct empirical confirmation. I assume (a) that the relationships will hold most obviously for developing children and adolescents and (b) that repetitive participation in the given religious practice promotes development of several associated ECFs and social skills. Again, these proposed relationships are only possibilities. Lines of influence are undoubtedly multiple, even though the table emphasizes simple or singular lines of influence.

In what follows I summarize the circumstantial evidence in favor of the hypothesis. This is accomplished in three sections: (1) a review of the evidence that the frontal lobes support the religion-related ECFs and so-

cial skills listed in Table 1, (2) empirical evidence that the frontal lobes are physiologically activated when people engage in religious practices, and (3) evidence that religiosity is associated with acquisition of the relevant social skills and ECFs.

The Frontal Lobes Support Religion-Related ECFs and Social Skills

Some knowledge of anatomy is helpful for understanding the literature about functions of the frontal lobe, so I begin with a short synopsis of relevant frontal anatomy.

Frontal Lobe Anatomy and Function. The frontal lobes increase in size and connectivity with both phylogenetic and ontogenetic development (Fuster 1989). They are never fully myelinated (functional) before the adult years. They comprise primary motor cortex, as well as premotor, supplementary motor, and prefrontal areas. All of these areas send inhibitory efferents onto their sites of termination (suggesting executive control of lower functions). The prefrontal areas are further subdivided into two large functional regions—the orbitofrontal and the dorsolateral regions. Dorsolateral and orbitofrontal lesions are each associated with a specific variety of "higher-order" functional deficits that will be discussed further on. In brief, the dorsolateral prefrontal syndrome is characterized primarily by deficits related to functions of planning, working memory, and abstract reasoning. There is an increased vulnerability to cognitive interference or a failure of inhibitory mechanisms that screen out irrelevant stimuli. The orbitofrontal syndrome is characterized by dramatic personality changes involving disinhibition of emotional and prepotent responses and drives.

Prosocial Behaviors of Empathy and Moral Insight. All religions claim to promote prosocial behavior, and it must be said that improved empathy and moral insight can be acquired via religious practices such as participation in communal services and cultivation of an altruistic orientation. Fundamental to the ability to engage in moral choice, empathy, and prosocial behaviors in general is the ability to delay gratification of one's own impulses. If individuals can derive real benefits (e.g., a larger "return" later) by learning to inhibit current appetitive responses, natural selection should favor those individuals with the ability to delay gratification of impulses. One of the most disabling impairments associated with traumatic brain injury (which affects primarily the prefrontal cortex) is loss of the ability to delay gratification of prepotent or previously rewarded responses (Schnider and Gutbrod 1999). Relaxed inhibitory control over appetitive and sexual drives leads to inappropriate social behaviors that prevent the patient from returning to full functional independence. The child's acquisition of the

ability to delay gratification of impulses develops in tandem with maturation of the frontal lobes (Samango-Sprouse 1999). In adults prefrontal lesions are often associated with ECF deficits and disinhibition of drives and aggression (Benson and Blumer 1975; Pincus 1999; Schnider and Gutbrod 1999; Fuster 1989).

Empathy and perspective-taking. Some models of moral development posit a central role for the capacity for fellow feeling, or *empathy and sympathy*. Emerging empathy and sympathy and the other social emotions constitute prerequisites for mature moral behavior (Hoffman 2000) and probably depend on the frontal lobes (Grattan et al. 1994). Having a "theory of mind" allows one to impute mental states (thoughts, perceptions, and feelings) not only to oneself but also to other individuals and thereby to take the perspective of another. This, to some extent, involves empathy and supports development of sympathy. Humphrey (1983) and others (Worden 1998, for example) suggest that theory-of-mind abilities and this empathic kind of awareness evolved in human beings because they were tools that successfully predicted the behavior of others. The best strategists in the human social game would be those who could use a theory of mind to empathize accurately with others and thereby be able to predict what the others would do in any given situation and to detect deception by others. It would be interesting to see how persons high in "religiosity" perform on theory-of-mind tasks and on detecting deception. We know that "intrinsic" religious persons do score well on measures of empathy (Watson et al. 1994). The frontal lobes are crucial for all of these abilities (Grattan et al. 1994; Worden 1998).

One way to show the role of the frontal lobes in supporting these prosocial behaviors is to investigate neuropsychological correlates of antisocial behavior. Sociopaths are by definition antisocial individuals, and the evidence for prefrontal dysfunction in these individuals is accumulating rapidly (Damasio, Tranel, and Damasio 1991a, b). Sociopaths typically exhibit an inability to empathize with others or form lasting personal commitments, and a marked degree of impulsiveness. While they may appear charming, they evidence serious deficits in expression of the social emotions (love, shame, guilt, empathy, and remorse). On the other hand, they are not intellectually handicapped and are skillful manipulators of others (McCord 1983; Davison and Neale 1994). What little evidence exists suggests that sociopathy is associated with orbitofrontal dysfunction (Damasio, Tranel, and Damasio 1991a; Smith, Arnett, and Newman 1992). Dorsolateral function, however, is preserved and would explain the lack of intellectual deficit in these individuals.

The more violent forms of antisocial behavior are also associated with frontal deficits. In their review of the literature on neuroimaging in violent offenders, S. Mills and A. Raine (1994) concluded that frontal-lobe dysfunction is associated with violent offending. Raine and his colleagues

(1994), for example, found that violent offenders (twenty-two subjects accused of murder) evinced significantly lower glucose metabolic activity levels in the medial and lateral prefrontal cortex, relative to controls. T. McAllister and T. Price (1987) found that 60 percent of psychiatric patients with prefrontal cortical pathology displayed disinhibited social behaviors, and 10 percent displayed violent outbursts. R. Heinrichs (1989) showed that the best predictor of violent behavior in a sample of forty-five neuropsychiatric patients was a prefrontal lesion.

Will, Planning, Goal-directedness, Optimism, and Hope. Virtually all patients with evidence of prefrontal dysfunction perform poorly on tests of planning and goal-oriented behaviors (Fuster 1989). T. Shallice and P. Burgess (1991), for example, asked three patients with prefrontal dysfunction caused by head injury to perform a set of tasks designed to mimic the errands a person might have to run on a Saturday morning. The patients were given detailed written instructions so as to eliminate memory problems. All three patients failed to carry out the tasks or experienced great difficulty in their endeavors. Patients with lesions in the supplementary motor area of the prefrontal cortex evince significant deficits in initiation of behavior, and lesions in adjacent areas are also associated with deficits in will, agency, and voluntary behaviors (Goldberg 1987; Passingham 1995). Patients report that they are capable of responding but have no will to do so and therefore remain silent. A simple verbal test of initiation is known as the verbal-fluency test. Most patients with evidence of prefrontal dysfunction perform poorly on verbal-fluency paradigms.

Resistance to interference is a prerequisite for focused, goal-directed, concentrated mental processing. Goal-directed, purposive cognitive processing is not possible for an individual who is incapable of resisting interference from other, competing goals. Retaining information in short-term memory is possible only if that information is not immediately displaced by competing interfering stimuli. Frontal inhibitory processes allow us to ignore irrelevant stimuli and to attend to relevant stimuli (Oscar-Berman, McNamara, and Freedman 1991; Dagenbach and Carr 1994). It is crucial for concentration and deliberative thought. No sustained attention to a single train of thought is possible if one's thought is constantly falling prey to distractors. Concentration requires the ability to ignore or screen out distracting and irrelevant information. The bare ability to hold something in one's mind (as in the religious practice of focused meditation) requires the ability to resist displacement of that mental object by some other mental object. Patients with frontal lesions perform poorly on tests of the ability to resist interference (Oscar-Berman, McNamara, and Freedman 1991).

Optimism and hope. Although I know of no direct studies that link hope to frontal systems, there is abundant evidence that links prefrontal

dysfunction with depression and loss of hope (Starkstein and Robinson 1991; Royall 1999). Patients with primary depression perform poorly on tests of frontal function, and ECF impairment is evident in these patients. Regional cerebral-blood-flow studies have demonstrated a reduction in blood flow to frontal systems in depressed patients (Baxter, Schwartz, and Phelps 1989).

Theory of Mind, Attributions of Agency. Agency, voluntary action, and intentionality depend in part on neurocognitive networks in the frontal lobes (Barkley 1997; Benson and Blumer 1975; Fuster 1989; Goldberg 1987; Leslie 1996; Passingham 1995). When human persons postulate a god or pray to a god, they are attributing certain cognitive properties to that god—among them, the property of possessing a mind. In order to be capable of attributing mind to others or to a god, however, the pray-er must possess these properties of mind him- or herself. The so-called Theory of Mind Module (ToMM; see Baron-Cohen 1995 for review) depends in part on orbitofrontal sites. Baron-Cohen (1998) cites two blood-flow studies that implicated orbitofrontal sites in ToM processes. Impairments in ToM processes have been documented in certain types of autistics and in antisocial psychopaths (Baron-Cohen 1995). The impairments in both cases have been linked to orbitofrontal-lobe dysfunction but are associated, of course, with varying manifestations of the underlying disorder.

Self-awareness, Autonomy, Identity, Memory. To the extent that religious cognition involves computations on agency, theory of mind, emotional processing, and belief fixation, it must also involve self-awareness. Certainly, most religions claim to improve self-awareness. M. A. Wheeler, D. T. Stuss, and E. Tulving (1997) have reviewed the literature on deficits in self-awareness and concluded that the frontal lobes are crucial for self-awareness. Patients with frontal lobotomies are the clearest example of impairment in the sense of self after frontal damage. Families of these patients often reported that they could no longer contact the real self of the patient who had had the surgery (Weingarten 1999). Right-frontal activation has recently been associated with experience of the self itself (Craik et al. 1999). Right-frontal sites were activated whenever subjects processed or memorized materials referring to the self.

Interestingly, the right-frontal cortex appears to be intimately involved in memory as well (Wheeler, Stuss, and Tulving 1997). Memory is clearly crucial to any enduring sense of identity and self. As Wheeler, Stuss, and Tulving (1997) have pointed out, the act of recall or remembering really involves an experience of the self. Episodic memory or conscious recollection always involves personal consciousness, and to the extent that recall leaves out this sense of self, conscious recollection will not emerge. The information will be "there" but not available on demand for the subject. In a review of Positron Emission Tomographic studies on episodic encod-

ing and retrieval processes, Wheeler, Stuss, and Tulving (1997; see also Nyberg, Cabeza, and Tulving 1996) conclude that episodic retrieval is associated with increased blood flow in the right-frontal cortex with no increased blood flow in the left-frontal cortex, whereas episodic encoding is associated with the opposite pattern, that is, increased blood flow in the left-frontal cortex and no increased flow in the right-frontal cortex. The researchers call this set of findings HERA (for *hemispheric encoding/retrieval asymmetry*). The right-frontal involvement, apparently, represents only retrieval set or retrieval mode—not actual retrieval of information itself. The right-frontal activation can be obtained even when subjects attempt but fail to retrieve items from memory. Actual episodic retrieval, or at least retrieval involving visual images, is associated with activation of posterior (parietal and occipital) cortical sites. Without efficient memory-retrieval mechanisms, many spiritual practices (such as the examen and the life review) would be impossible to perform. Conversely, the memory practice involved in attempts to perform an examen and life review probably improves the efficiency of episodic memory-retrieval strategies.

Belief-fixation and Meaning Construction. Processes of belief-fixation and meaning construction are central to religious cognition and can be studied neuropsychologically. Once again the frontal lobes play a crucial role. People differ in their openness to foreign or incompatible belief systems. At one extreme are the tiny class of temporal-lobe epileptics who experience "multiple conversion syndrome" (Dewhurst and Beard 1970) in which differing religious ideas are consecutively adopted as one's own without regard to internal consistency or relevance. These temporal-lobe epileptics experience excessive electrical discharges in their temporal lobes and may therefore overactivate frontal systems in an attempt to inhibit chronic temporal activation. At the other extreme of the belief-fixation continuum are persons who are closed to "foreign" ideas of any kind and resist acquisition of any new beliefs at all. These are usually individuals with rigid personality structures. Rigidity in personality structure has been linked to catecholaminergic and frontal dysfunction (Hubble and Koller 1995; McNamara et al. 1995; Cloninger 1987).

Persons with right-frontal-lobe deficits, for example, may often cling to an erroneous belief no matter how much evidence to the contrary is available (see papers in Christodoulou 1986). In Othello syndrome, for example, the patient is convinced of the infidelity of the spouse, and no amount of evidence to the contrary (often presented by a despairing family) will shake the belief. Patrick McNamara and R. Durso (1991) showed that the delusional belief system in one patient with Othello's syndrome was associated with catecholaminergic dysfunction in the frontal lobe. Theorists analyzing these syndromes usually suggest a disconnection between frontal and temporal lobes such that mnemonic information from

temporal sites cannot be integrated with control processes in the frontal lobe. In general, meaning is constructed by integrating information held in long-term memory (in posterior sites) with executive control and retrieval processes in the frontal lobes. In order to persist, beliefs must protect themselves from the effects of interference or countervailing evidence. This protection probably depends on insulating the belief from evaluation by (anteriorly located cortical) insight systems.

Summary of Section. We have now established why people would want to preferentially activate the frontal lobes. Such activation involves fundamental dopaminergic-dependent reward systems and ECF systems. Frontal activation is a prerequisite for development of various ECF-related functions that are crucial for personal autonomy, self-regulation, moral insight, and intellectual creativity. Prosocial behavior, including the ability to produce behaviors appropriate to the social context, depends on frontal functions. Empathy, fellow feeling, and compassionate sympathy appear to depend crucially on frontal activation. The list could go on, but I think it is reasonable to conclude from the foregoing that the frontal lobes appear to mediate those capacities and functions that uniquely define us as mature and free human persons.

It is not surprising then that human cultures throughout the world and throughout history have developed practices that promote development of the frontal lobes: there is no other way to develop a fully responsible and capable human being. Among these cultural practices the techniques of choice have been religious practices. But is there any evidence that religious practices actually do activate frontal networks?

Do Religious Practices Preferentially Activate the Frontal Lobes?

The evidence is sparse and mostly circumstantial, because no one has actually tried to study effects of religious practices on frontal-lobe activation patterns. Nevertheless, there is some suggestive data: Eugene G. d'Aquili and Andrew B. Newberg (1993) reviewed a number of studies that apparently established a link between sustained attention associated with the practice of meditation and electroencephalographic (EEG) theta waves above the prefrontal cortex. The EEG data therefore suggests that sustained meditation results in activation of prefrontal networks. Newberg et al. (1997) later confirmed these EEG data using single photon emission computed tomography (SPECT) imaging techniques. Regional cerebral-blood-flow changes were studied in six highly experienced meditators while they meditated. Results demonstrated significantly increased blood flow to the inferior frontal and dorsolateral-prefrontal cortical regions while subjects engaged in "intense meditation."

Religiosity is Associated with Better Acquisition of ECFs

In a review of the literature on mental effects of prayer, E. L. Worthington, T. A. Kurusu, M. E. McCullough, and S. J. Sandage (1996) summarized a number of studies relevant to the issue of effects of religious practices on mental functions associated with the frontal lobes. Use of prayer, for example, was correlated with indices of hope and with subjective well-being—at least in religiously committed subjects. Prayer appeared to be a very common coping method for persons in distress whether they described themselves as religious or not. J. S. Levin and H. Y. Vanderpool (1987), in a meta-analysis of twenty-eight studies of the relation between religiosity and subjective well-being and health, found that religiosity correlates positively with subjective sense of well-being and other measures of health. C. D. Batson, P. Schoenrade, and W. L. Ventis (1993) found that persons who scored high on measures of intrinsic (as opposed to extrinsic) religiosity tended to score better on measures of overall mental health than their nonreligious counterparts. P. J. Watson, R. W. Hood, R. J. Morris, and J. R. Hall (1984) found significant and positive correlations between measures of intrinsic religiosity and empathy. In their review of effects of religiosity on individuals who rate themselves as religious or who participate in religious practices, B. Beit-Hallahmi and M. Argyle (1997) found that, relative to nonreligious controls, religiosity (particularly intrinsic religiosity) was associated with increases in subjective happiness, health, mental health, and altruism and with decreases in some forms of sexual behavior as well as rates of suicide. In their review of effects of religiosity on mental health, J. S. Levin and L. M. Chatters (1998) found that religiosity is usually associated with better mental health.

Objections to the Hypothesis. Perhaps the most obvious objection to the hypothesis discussed here is that there are persons who do not engage in religious practices yet whose frontal lobes seem to be functioning satisfactorily. I have no doubt that that is true. I do not claim that religious practices are the only methods available to us to stimulate development of the frontal lobes. I do believe, however, that use of religious practices is the traditional method.

A second objection is that religion cannot be the only way to develop frontal functions—other forms of socialization probably work just as well. This is, of course, an open question. I know of no data that directly compare effects of religious practices to, say, educational exposure to a good teacher with reference to rates of maturation of the frontal lobes. Once again my main point is that religious practices have been the traditional method for creating mature and responsible individuals.

A third objection to my hypothesis is that I link religiosity primarily with the frontal lobes when it has traditionally been ascribed to the temporal or parietal lobes (Bear and Fedio 1977; Persinger 1987; d'Aquili and Newberg 1993; Ramachandran et al. 1997). But most of the evidence for a role of the temporal lobes in religious experience stems from observations of the behaviors of a tiny subset of temporal-lobe epileptics who exhibited the interictal behavioral syndrome (Geschwind 1983). The syndrome included hyperreligiosity as one of its signs. For example, M. A. Persinger (1983) argues that temporal-lobe transients (TLTs) or microseizures that emanate from deep within the temporal lobes give rise to religious experiences and related experiences such as out-of-body experiences, space-time distortions, and intense meaningfulness. These microseizures elicit powerful experiences because they activate neighboring structures such as the amygdala (important for emotion), the hippocampus (vital for attention and memory), and adjacent limbic structures. Persinger does not consider the possibility that TLTs that induced overactivation of deep temporal structures would elicit a powerful inhibitory response from the frontal lobes and that therefore the behaviors associated with TLTs are due to frontal-lobe activation patterns. In addition, neither the temporal nor the parietal lobes support the kinds of executive functions (such as self-monitoring, working memory, self-regulation, empathy, agency or will, resistance to interference, hope, and optimism) that all religions purport to create. On the other hand, as Persinger and others have suggested, given the long-term memory and the language-related functions of the temporal lobes, they probably do play some role in religious cognition (for suggestive roles see Ramachandran et al. 1997; Wildman and Brothers 1999)—particularly, in my view, in meaning construction.

D'Aquili and Newberg (1993), more than any other scholars, have explored possible neuropsychologic models of religious experience. They very sensibly assume that all of the major association areas of the cortex generate some aspect of the total religious experience. They assume, for example, that the temporal lobes attach meaning and significance to events and thus are central to eliciting the profound adherence to religious frameworks. Unfortunately, they then speculate that hyperstimulation of the organism leads to "deafferentation" of posterior parietal sites. This deafferentation leads to dissolution of self-other boundaries and related experiential phenomena. But deafferented states (such as brachial-avulsion injuries or amputations of limbs) usually lead to profound sensory disturbances, including agonizing and chronic pain states. Nevertheless, the parietal lobes must play some role in generation of religious experiences, although I know of no concrete suggestions as yet.

Religious Practices and Alternatives. If I am correct in my claim that religious practices have been the traditional methods for socialization (and

frontal-lobe maturation), then discarding religious practices in favor of other socialization practices such as modern educational instruction may actually be dangerous. If the modern alternatives to religion do not have the same effects on frontal maturation as do traditional religious rites and practices, society will eventually find itself populated with persons who cannot tap the full range of frontal functions, including the ECFs and related prosocial behaviors.

Conclusion

Because activation of the frontal lobes is both intrinsically rewarding and necessary for the acquisition of many of the behaviors that religions seek to foster, including personal responsibility, impulse and emotion modulation, empathy, moral insight, hope, and optimism, I have argued that religious practices probably effectively activate frontal circuits. Recent brain-imaging studies indicate greater anterior activation values and increased blood flow to frontal sites during prayer and meditation. Engaging in religious practices is correlated with higher levels of mental health, subjective well-being, self-monitoring, empathy, moral insight, and other positive behaviors and negatively correlated with depression and impulsive and risky behaviors. If religious practices do indeed effectively activate frontal physiological systems and associated cognitive functions, (a) religious practices should be considered as possible adjuncts in treatment of mental health disorders for some patients who are open to religion, and (b) the frontal lobes (rather than the temporal lobes) should be considered the major brain site that supports the core components of religious experience.

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