

6

THE NEUROPSYCHOLOGY OF SPIRITUAL EXPERIENCE

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This chapter will consider the neuropsychology of religious and spiritual experience. An analysis of the neuropsychological basis of these experiences serves several important purposes: (a) to illuminate the biological roots of these experiences and provide new information regarding the function of the human brain, (b) to provide a new understanding of how and why these experiences have played such a significant role in human thought and history, and (c) to lead to an understanding of the relationship between these experiences and human health and psychological well-being.

Religious and spiritual experiences, such as meditation, prayer, and ritual, have been described in the biomedical, psychological, anthropological, and religious literature. Furthermore, there are a large number of studies which have already begun to examine the neuropsychological and physiological correlates of such experiences. It is likely that such experiences became possible with the evolution of various structures in the brain of early primates and eventually of *Homo sapiens*. The concatenation of "religiogenic" brain mechanisms in *H. sapiens* was accompanied historically by an explosion of religious traditions that have continued to permeate human societies since prehistoric times. In light of this evolutionary pattern, neurobiological and neuropsychological correlates of religious and spiritual experiences have begun to be identified. Furthermore, by considering other rele-

vant studies in neurobiology, a more complex model of neurophysiological events during religious and spiritual experience can be developed. More specifically, brain function can be considered in relation to its interconnection with other body physiology that can be mediated by the autonomic nervous system as well as the neuroendocrine system. A consideration of this relation between cognitive processes in the brain and the autonomic nervous system may yield a more complete understanding of a variety of spiritual experiences ranging from "awe" to intense unitary states. Thus, from the current literature, a foundation for the development of a neuropsychological model can be considered in order to guide future studies in the neurobiology of religious and spiritual experiences. In addition, the use of state-of-the-art brain imaging techniques, as well as other measures of brain activity, has been and will continue to be applied to investigate brain function during experiences such as meditation, prayer, and ritual experiences.

THE NEUROEVOLUTION OF SPIRITUAL EXPERIENCE

Evolution has led to the development of the complex neuronal connections that exist within the brain's cerebral hemispheres. The higher centers in the brain are also connected to the more primitive structures such as the limbic system. For the most part, the brain evolved its complexity to provide human beings improved abilities to delineate order in the external environment and to solve cognitive problems necessary for survival. In addition to purely cognitive aspects, the evolution of the brain led to human socialization. The ability to form family units, communities, and societies had a tremendous evolutionary advantage. The question is, How did these evolutionary changes in the brain lead to the development of spiritual experience, religion, and ritual?

The brain can be divided functionally into several primary cognitive functions (d'Aquili, 1978, 1983, 1986). We have previously referred to these functions as cognitive operators. Cognitive operators simply refer to the neurophysiological mechanisms that underlie certain broad categories of cognitive function. Thus, these operators do not exist in the literal sense but can be useful when considering overall brain function. The cognitive operators include abstraction of generals from particulars, the perception of causality in external reality, the perception of spatial or temporal sequences in external reality, and the ordering of elements of reality into causal chains giving rise to explanatory models of the external world whether scientific or mythical. Space does not permit us to describe in detail the neurophysiological substrates and neuroanatomical networks of all these operators. However, several operators require consideration.

The causal operator accounts for the causal sequencing of elements of reality as abstracted from sense perceptions (d'Aquili, 1978). This causal operator derives its function from the inferior parietal lobule in the left hemisphere, the anterior convexity of the frontal lobes, primarily in the left hemisphere, and their reciprocal neural interconnections (Luria, 1966; Pribram, 1973). The causal operator has

important relevance to the development of religious and spiritual experience (d'Aquili, 1978). This operator organizes any given strip of reality into what is subjectively perceived as causal sequences back to the initial terminus of that strip. In view of the apparently universal human trait of positing causes for any given strip of reality, we postulate that if the initial terminus is not given by sense data, the causal operator generates automatically an initial terminus. Western science refuses to postulate an initial terminus or first cause for any strip of reality unless it is observed or can be immediately inferred from observation. Under more usual (nonscientific) conditions the causal operator simply generates an initial terminus or first cause for a strip of reality. We are proposing that when no observational or "scientific" causal explanation is forthcoming for a strip of reality, gods, powers, spirits, or some other causative construct is automatically generated by the causal operator. Thus, the causal operator simply operates spontaneously on reality, positing an initial causal terminus when none is given.

If it is true that the causal operator necessarily analyzes reality, then human beings have no choice but to construct myths filled with personalized power sources to explain their world. The myths may be social in nature or they may be individual in terms of dreams, daydreams, or other fantasy aspects of the individual person. Nevertheless, as long as human beings are aware of the contingency of their existence in the face of what often appears to be a capricious universe, they must construct myths to orient themselves within that universe. Thus, they construct gods, spirits, demons, or other personalized power sources with whom they can deal contractually in order to gain control over a capricious environment.

A second operator that has particular significance regarding spiritual experience is the holistic operator. The holistic operator permits reality to be viewed as a whole or as a gestalt. This operator allows for the abstraction from particulars or individuals into a larger contextual framework. The holistic operator likely resides in the parietal lobe in the nondominant hemisphere, more specifically in the posterior superior parietal lobule and adjacent areas that have been found to be involved in generating gestalt understanding about both sensory input and various abstract concepts (Bogen, 1969; Gazzaniga & Hillyard, 1971; Levy-Agresti & Sperry, 1968; Nebes & Sperry, 1971; Sperry, Gazzaniga, & Bogen, 1969; Trevarthen, 1969). It is also interesting to note that this area sits adjacent to the area in the dominant hemisphere that provides the neuroanatomical substrate for logical-grammatical operations. Thus, the right parietal lobe is involved in a holistic approach to things and the left parietal lobe is involved in more reductionist processes. We will consider how the holistic operator, in addition to the causal operator, functions with regard to spiritual experience.

METHODS OF ATTAINING SPIRITUAL EXPERIENCES

In further considering a neuropsychological and neuroevolutionary approach to the study of religious and spiritual experiences, it is important to consider two ma-

major avenues toward attaining such experiences: group ritual and individual contemplation or meditation. A phenomenological analysis reveals that the two practices are similar in kind, if not in intensity, along two dimensions: (a) intermittent emotional discharges involving the subjective sensation of awe, peace, tranquillity, or ecstasy; and (b) varying degrees of unitary experience correlating with the emotional discharges just mentioned (d'Aquili & Newberg, 1993b). These unitary experiences consist of a decreased sense or awareness of the boundaries between the self and the external world (d'Aquili, 1986; d'Aquili & Newberg, 1993a, 1993b; Smart, 1958, 1967, 1969, 1978; Stace, 1961). The latter dimension can also lead to a sense of oneness between other perceived individuals, thereby generating a sense of community. At the extreme, unitary experiences can eventually lead to the abolition of all boundaries of discrete being, thus generating a state of what we have called absolute unitary being (AUB; d'Aquili & Newberg, 1993a, 1993b).

It should be noted that the experiences of group ritual and individual meditation have a certain degree of overlap such that each may play a role in the other. In fact, it may be that human ceremonial ritual actually provides the "average" person access to mystical experience (average in distinction to those regularly practicing intense contemplation such as highly religious monks). This by no means implies that the mystic or contemplative is impervious to the effects of ceremonial ritual. Precisely because of the intense unitary experiences arising from meditation, mystics are likely to be more affected by ceremonial ritual than the average person. Viewed dispassionately, one must conclude that ceremonial ritual, at its most effective, is an incredibly powerful technology whether for good or ill. Furthermore, because of its essentially communal aspects, it tends to have immeasurably greater social significance than meditation or contemplation. Although meditation and contemplation may produce more intense and more extended unitary states compared to the relatively brief flashes generated by group ritual, the former are almost always solitary experiences.

With regards to human ceremonial ritual, it is a morally neutral technology. Therefore, depending on the myth in which it is imbedded and which it expresses, ritual can either promote or minimize the structural aspects of a society and promote or minimize overall aggressive behavior. Utilizing Turner's concept of *communitas* (Turner, 1969) as the powerful unitary social experience usually arising out of ceremonial ritual, we can state that if a myth achieves its incarnation in a ritual that defines the unitary experience as applying only to the tribe, then the result is only the *communitas tribus*. It is certainly true that aggression within the tribe has been minimized or eliminated by the unifying experience generated by the ritual. However, this may only serve to emphasize the special cohesiveness of the tribe vis-à-vis other tribes. The result may be an increase in intertribal aggression even though intratribal aggression is diminished. The myth and its embodying ritual may, of course, apply to all members of a religion, a nation state, an ideology, all of humanity, and all of reality. Obviously, as one increases the scope of what is included in the unitary experience, the amount of overall aggressive behavior decreases. If indeed a ceremonial ritual were giving flesh to a myth of the

unity of all being, then one would presumably experience brief senses of *communitas omnium*. Such a myth-ritual experience approaches meditative states such as Bucke's (1961) cosmic consciousness or even AUB (d'Aquili & Newberg, 1993a, 1993b). However, such grand scope is, unfortunately, unusual for group ritual in human ethnographic experiences.

A NEUROPHYSIOLOGICAL REVIEW

Any understanding of the neuropsychological basis of spiritual experience necessarily requires at least a basic understanding of neurobiology. Therefore, it is helpful to consider here the neurobiological concepts that are particularly relevant to spiritual experience. We will consider some of the major anatomical and functional components of human neurobiology. Furthermore, we will try to build this review using a "bottom-up" approach, considering the more primitive evolutionary aspects first and finishing with the cerebral cortex.

THE AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system is responsible, in conjunction with the rest of the brain, for maintaining baseline bodily function. Thus, this system keeps us alive but also plays a crucial role in the overall activity of the brain as well as in the generation of fundamental emotions such as fear. The autonomic nervous system is traditionally understood to be composed of two subsystems, the sympathetic and parasympathetic systems (Joseph, 1990; Kandel & Schwartz, 1993). The sympathetic system subserves the so-called fight-or-flight response, the physiological basis of our adaptive strategies either to noxious stimuli or to highly desirable stimuli in the environment (Gellhorn, 1967; Gellhorn & Loofbourrow, 1963). The principal function of the sympathetic system is control of short-range adaptation to events in the environment. It initiates and carries out action directed either at acquiring or avoiding stimuli of survival interests to the animal. The sympathetic system mediates the expenditure of vital resources, increasing heart rate and blood pressure, increasing muscle efficiency, dilation of the pupils of the eye, erection of body hair, ejaculation, and increased respiration (Gellhorn, 1967; Gellhorn & Loofbourrow, 1963; Joseph, 1990; Kandel & Schwartz, 1993). Since all these functions are involved in the expenditure of the body's energy and metabolism, the total of the sympathetic system with its associated brain structures has been called the ergotropic system (Lex, 1979).

The parasympathetic system, on the other hand, is responsible for maintaining homeostasis (Gellhorn, 1967; Gellhorn & Loofbourrow, 1963; Kandel & Schwartz, 1993). It regulates physiological maintenance activities and vegetative functions, such as growth of cells, digestion, relaxation, and sleep. Parasympathetic functions include a storage of vital resources, decrease of heart rate and blood pressure, collection of waste products, penile erection, and slowing of res-

piration (Gellhorn, 1967; Gellhorn & Loofbourrow, 1963; Joseph, 1990; Kandel & Schwartz, 1993). Since all these functions are involved with the conservation of body energy and the maintenance of baseline metabolism, the total of the parasympathetic system with its associated brain structures has been called the trophotropic system (Lex, 1979).

The ergotropic and trophotropic systems have often been described as "antagonistic" to each other, but they can be complementary to each other under certain conditions. Normally, the increased activity of one tends to produce a decreased activity in the other. Thus, each system is designed to inhibit the functioning of the other in most circumstances. During normal waking consciousness, the specific balance between these two systems helps to characterize our baseline emotional state that we bring to the world, i.e., whether we are "uptight" or "laid-back." However, studies have shown that if either system is driven to its maximal capacity, one can induce "reversal" or "spillover" phenomena (Gellhorn & Keily, 1972). This spillover phenomenon occurs when continued stimulation of one system to maximal capacity begins to produce activation responses (rather than inhibitory) in the other system.

We have proposed, in a previous work (d'Aquili & Newberg, 1993b), four basic categories of ergotropic/trophotropic events and their sensorial concomitants which may occur during extraordinary phases of consciousness. The hypertrophotropic state, in which trophotropic activity is exceptionally high, may result in extraordinary states of quiescence. This activity can occur during normal sleep but may occur during deep meditation, prayer, or other related activities. In extreme form, a hypertrophotropic state may result in vivid, hyperlucid hallucinations via activation of the hippocampus. It is known that stimulation of the hippocampus, as well as the amygdala, can result in fully formed visual and auditory hallucinations (Halgren, Babb, & Crandel, 1978; Horowitz, Adams, & Rutkin, 1968). In addition, there may be an experience of oceanic tranquillity in which no thought or fantasy intrudes upon consciousness and no bodily sensations are felt. The hyperergotropic state occurs when ergotropic activity is exceptionally high. This results in an extraordinary stage of unblocked arousal and excitation and is associated with keen alertness and concentration in the absence of superfluous thought and fantasy (Czikszenmihalyi, 1975).

The next two autonomic states involve hyperactivation of one system with spillover into excitation of the other system. Thus, the hypertrophotropic state with ergotropic eruption is the state in which trophotropic activity is so extreme that spillover occurs and the ergotropic system becomes activated (Gellhorn & Kiely, 1972). In the case of meditation, a person begins by activating the trophotropic system. As the hypertrophotropic state creates a sense of oceanic bliss, the ergotropic eruption results in the experience of a sense of a tremendous release of energy. The mediator may experience one of the so-called "active" blisses or energy rushes. The hyperergotropic state with trophotropic eruption occurs when ergotropic activity is so extreme that spillover occurs and the trophotropic system becomes activated. This may be associated with the experience of an orgasmic,

has extensive interconnections with many parts of the brain through which it is able to monitor and determine which sensory stimuli are of motivational significance to the animal (Steklis & Kling, 1985). This includes the ability to discern and express even quite subtle social-emotional nuances such as love, affection, friendliness, fear, distrust, and anger. In addition to emotional and motivational functioning, the amygdala is also involved in attention, learning, and memory. Although the function of the amygdala is complex, it is becoming clear that the amygdala has primarily an ergotropic function, particularly in the lateral part (Chapman et al., 1954; Mark, Ervin, & Sweet, 1972; Ursin & Kaada, 1960). However, it does have some trophotropic functions as well.

The final structure of the limbic system that requires discussion is the hippocampus, which is shaped like a telephone receiver and is located slightly behind the amygdala. A number of investigators have assigned a major role to the hippocampus in information processing, including memory, new learning, cognitive mapping of the environment, attention, and some orienting reactions. The hippocampus is greatly influenced by the amygdala, which in turn monitors and responds to hippocampal activity (Joseph, 1990). The amygdala also acts to relay certain forms of information from the hippocampus to the hypothalamus. Thus, the hippocampus and amygdala complement each other and interact in regard to attention and generation of emotionally linked images as well as in regard to learning and memory. The hippocampus also partially regulates the activity in another structure that connects the autonomic nervous system to the cerebral cortex called the thalamus (Joseph, 1990). Since the thalamus is a major relay between a variety of brain structures, the hippocampus can sometimes block information input to various neocortical areas via the thalamus. It is important to note that while the amygdala may enhance information transfer between neocortical regions, the hippocampus usually tends to do the reverse. Through interconnections with the amygdala and the hypothalamus, in addition to other parts of the brain, the hippocampus can inhibit activity in these areas, thus preventing emotional extremes (Redding, 1967). This ability to inhibit the transfer of information from one region to another, in addition to its control over emotional responses, is very important in generating certain experiences such as mystical phenomena.

TERTIARY ASSOCIATION AREAS

Returning to the cerebral cortex, with its structures involved in higher cognitive, sensory, and emotional functioning, we note that there are four tertiary association areas that integrate neuronal activity from various other areas in the brain (Joseph, 1990; Kandel & Schwartz, 1993). These cortical regions are the inferior temporal lobe (ITL), the inferior parietal lobule (IPL), the posterior superior parietal lobule (PSPL), and the prefrontal cortex (PFC).

The PSPL is heavily involved in the analysis and integration of higher order visual, auditory, and somesthetic information. Through the reception of auditory and visual input, the PSPL is also able to create a three-dimensional image of the

body in space (Lynch, 1980). Some cells in the PSPL, exerting "command" functions (Montcastle, 1976; Montcastle, Motter, & Anderson, 1980), can direct visual attention, become excited when certain objects are within grasping distance, and can motivate and guide hand movements toward these objects. There is some difference in function between the PSPL on the right and the PSPL on the left. It has been observed that the right parietal lobe appears to play an important role in generalized localization and the sense of spatial coordinates per se, whereas the left PSPL exerts influences in regard to objects that may be directly grasped and manipulated (Joseph, 1990; Kandel & Schwartz, 1993). That some neurons in the left PSPL respond most to stimuli within grasping distance and other neurons respond most to stimuli just beyond arms reach led Joseph (1990) to postulate that the distinction between self and world may ultimately arise from the left PSPL's ability to judge these two categories of distances. Thus, it seems probable that the self-other dichotomy is a left PSPL function that evolved from its more primitive division of space into the graspable and the nongraspable.

The ITL neurons scan the entire visual field so as to alert the organism to objects of interest or motivational importance through its interconnections with the limbic nuclei (Herzog & Van Hoesen, 1976; Kling et al., 1987; Turner, Mishkin, & Knapp, 1980; Van Hoesen, Pandya, & Butters, 1972). When such objects are detected from the PSPL, the ITL's visual form recognition neurons are activated, and the neurons with wide nonspecific visual fields are inhibited. In this manner, objects of interest are detected and fixated upon. Brain imaging studies using position emission tomography (PET) have also shown that the ITL and PSPL are involved in the visual perception and learning of complex geometric patterns (Roland, 1995).

The IPL is located at the confluence of the temporal, parietal, and occipital lobes. The IPL is an association area of association areas and maintains rich interconnections with the visual, auditory, and somesthetic association areas. This area is responsible for the generation of abstract concepts and relating them to words (Joseph, 1990). It is also involved in conceptual comparison, automatic ordering of conceptual opposites, the naming of objects and categories of objects, and, in general, higher order grammatical and logical operations (Bruce, Desimone, & Gross, 1986; Burton & Jones, 1976; Geschwind, 1965; Jones & Powell, 1970; Seltzer & Pandya, 1978; Zeki, Symonds, & Kaas, 1982).

DEAFFERENTATION

One other aspect of brain function that may play an important role in spiritual experience is the ability of certain brain structures to block input into other structures. This blocking of input into a brain structure is called deafferentation. There is much evidence of such phenomena arising from natural (i.e., stroke or neuronal degeneration) or induced lesions in various parts of the brain (Baron et al., 1986; Gilbert & Peterson, 1991; Jeltsch, et al., 1994; Kataoka, Hayakawa, Kuroda, Yuguchi, & Yamada, 1991). Deafferentation of a brain structure also can occur via

the activity of inhibitory fibers from other nervous system structures. For example, Hoppe (1977) has shown that one hemisphere can be prevented from knowing what is occurring in the opposite hemisphere by suppressive actions of the frontal lobes. There is similar evidence that intrahemispheric information transmission can be partially or totally prevented by impulses originating in the prefrontal cortex and passing via the hippocampus (Green & Adey, 1956; Joseph, Forrest, Fiducis, Como, & Siegal, 1981; Nauta, 1958).

When a brain structure that ordinarily processes input has been deafferented to a significant degree, the structure is required to extract meaning from its own random neural activity. Such meaning takes the form of the intrinsic function of that structure (Joseph, 1990). Thus, a deafferented area of the brain that normally functions to analyze visual input will tend to interpret any neural activity as visual input resulting in a visual hallucination as occurs in patients with cortical blindness. Deafferentation via inhibitory mechanisms from other brain structures may ultimately give rise to various components of spiritual experiences.

A NEUROPHYSIOLOGICAL MODEL FOR THE SPIRITUAL CONTINUUM

It appears that there are a variety of spiritual experiences which, although they seem to be fundamentally different, actually have a similar neuropsychological and neuroevolutionary origin and therefore lie along the same spiritual continuum. Frederick Streng (1978) notes,

The term mysticism has been used to refer to a variety of phenomena including occult experience, trance, a vague sense of unaccountable uneasiness, sudden extraordinary visions and words of divine beings, or aesthetic sensitivity. For our purposes, we will narrow the definition to: an interior illumination of reality that results in ultimate freedom. Ninian Smart has correctly distinguished mysticism in this sense from "the experience of a dynamic external presence." (p. 142)

Smart (1958, 1967, 1969, 1978) has further argued that certain sects of Hinduism, Buddhism, and Taoism differ markedly from prophetic religions, such as Judaism and Islam, and from religions related to the prophetic-like Christianity in that the religious experience most characteristic of the former is "mystical," whereas that most characteristic of the latter is "numinous."

Somewhat similar to Smart's distinction between mystical and numinous experiences is that of W. B. Stace (1961), who distinguishes between what he calls extrovertive mystical experiences and introvertive mystical experiences. Stace characterizes these respectively as follows:

Extrovertive mystical experiences

1. The Unifying Vision—all things are one
2. The more concrete apprehension of the One as an inner subjectivity, or life, in all things

3. Sense of objectivity or reality
4. Blessedness, peace, etc.
5. Feeling of the holy, sacred, or divine
6. Paradoxicality
7. Alleged by mystics to be ineffable

Introvertive mystical experiences

1. The Unitary Consciousness; the One, the Void; pure consciousness
2. Nonspatial, nontemporal
3. Sense of objectivity or reality
4. Blessedness, peace, etc.
5. Feeling of the holy, sacred, or divine
6. Paradoxicality
7. Alleged by mystics to be ineffable

Stace then concludes that characteristics 3–7 are identical in the two lists and are therefore universal common characteristics of mystical experiences in all cultures, ages, religions, and civilizations of the world. However, it is characteristics 1 and 2 in which the distinction is made between extrovertive and introvertive mystical experiences in his typology. One can see the similarity between Stace's extrovertive mystical experience and Smart's numinous experience and between Stace's introvertive mystical experiences and Smart's mystical experience proper.

A neurobiological analysis of mysticism and other spiritual experiences might clarify some of the issues regarding mystical and spiritual experiences by allowing for a typology of such experiences based on the underlying brain functions. In terms of the effects of ceremonial ritual, we, along with other colleagues, have proposed that rhythmicity in the environment (i.e., visual, auditory, or tactile) drives either the ergotropic or trophotropic system to maximal capacity with the possibility of spillover and simultaneous activation of the other system creating unusual subjective states (d'Aquili, 1983; d'Aquili and Newberg, 1993a, 1993b). For the most part, this neurophysiological activity occurs as a result of the rhythmic driving of ceremonial ritual. This ultimately results in a progressive deafferentation of certain parts of the right PSPL (which, the reader will recall, is the neurobiological basis of the holistic operator), creating an increasing sense of wholeness progressively more dominant over the sense of the multiplicity of baseline reality. Ceremonial ritual may be described as generating these spiritual experiences from a bottom-up approach since it is rhythmic sounds and behaviors of the ritual that eventually drive the ergotropic and trophotropic systems. It should also be mentioned that the particular system initially activated (ergotropic or trophotropic) depends on the type of ritual. Rituals themselves might therefore be divided into "slow" and "fast" rituals. Slow rituals might involve calm, peaceful music and soft chanting to generate a sense of quiescence via the trophotropic system (d'Aquili & Newberg, 1993b). Fast rituals might utilize rapid or frenzied danc-

ing to generate a sense of heightened arousal via the ergotropic system (d'Aquili & Newberg, 1993b).

However, activation of the holistic operator (the right PSPL and adjacent structures) and the attainment of ecstatic and blissful unitary states can also be achieved via other mechanisms. For example, meditation approaches the situation from the opposite direction from ceremonial ritual and highly rhythmic behavior (d'Aquili & Newberg, 1993a, 1993b). Thus, meditation appears to utilize a top-down mechanism using cognitive/emotional activity to drive the ergotropic/trophotropic system to maximum activation. This appears to occur via a complex mechanism of neural interactions.

A detailed mechanism for the neurophysiological basis of meditative experiences has been previously described (d'Aquili & Newberg, 1993a, 1993b). However, it may be helpful to review some of the major components of that model in order to develop a better understanding of the spiritual continuum. One form of meditation begins with the subject willing or intending to focus either on a mental image or on an external physical object. In our model, impulses pass from the right PFC to the PSPL via the thalamus, which functions as a relay. These impulses are correlated with the person subjectively focusing their attention on a visual object. This object is presented by the ITL, which is subsequently spatially oriented by the PSPL.

We postulate that continuous fixation on the image presented by the right ITL begins to stimulate the right hippocampus, which in turn stimulates the right amygdala. The result is a stimulation of the lateral portions of the hypothalamus generating a mildly pleasant sensation. Impulses then pass back to the right amygdala and hippocampus, recruiting intensity as they go along. This then feeds back to the right PFC, reinforcing the whole system with progressively intense concentration upon the object. Thus, a reverberating loop is established.

In our model, the circuit continues to reverberate and to augment in intensity until the stimulation of the hypothalamic ergotropic centers (lateral part) reaches maximum, thus leading to a spillover such that maximal stimulation of the hypothalamic trophotropic centers (medial part) occurs. At this point, there would be maximal stimulation feedback through the limbic structures to both the left and right PFCs. This results in instantaneous maximal stimulation of the left PFC, with immediate total blocking of input into the left PSPL tending to obliterate the self-other dichotomy. In the right hemisphere, even though from the moment of spillover there should be likewise maximal limbic stimulation of the right PFC which should generate total deafferentation of the right PSPL, there is already an ongoing, powerful stimulation system from the right PFC to the right PSPL. This stimulation has been reinforced by a constant feedback loop going through the right ITL (the neurophysiological basis of "focusing on an object").

Therefore, the inhibitory ability of the right PFC, although at maximum, must fight against a preexistent and very strong facilitatory or stimulating system that is generated by fixating and focusing on the original object. Since the meditating

subject is still intending to focus on the object of meditation, this system continues to be reinforced even in the presence of ecstatic feelings generated by the limbic system and the progressively stronger activity of the inhibitory system. Throughout the period of time when there is conflict in the right hemisphere between facilitatory and inhibitory mechanisms there has been total instantaneous blocking of input into the left PSPL. Thus, the self-other dichotomy has been obliterated during a period of time, perhaps fairly long, when the image still remains a focus of meditation. We suggest that this is the period of time when the subject feels absorbed into the object or describes a sense of becoming one with the object of meditation. Eventually, in the face of maximal ergotropic and trophotropic activity, either the meditator surrenders or, possibly even against his or her will, the inhibitory influences take over and total blocking of input into the right PSPL occurs. Since the left PSPL has already been totally blocked, the self-other dichotomy has been obliterated for some time. Thus, the endpoint of the meditation is maximal stimulation of the ergotropic and trophotropic systems with total blocking of input into both the right and left PSPL, creating the experience of AUB. The period of time from spillover to the final assertion of dominance of the inhibitory neurons of the right prefrontal cortex is the period of absorption of the meditator into the object of meditation.

Regarding a comparison of ceremonial ritual with meditation, the end result can be the same in both situations (d'Aquili and Newberg, 1993a, 1993b). In other words, both methods can result in simultaneous activation of the ergotropic and trophotropic systems with concomitant deafferentation of the left and right PSPL. This results in the experience of bliss and ecstasy as well as in profound unitary states. It should be noted that AUB is unlikely to occur in ceremonial ritual since it is very difficult to maintain the level of rhythmic activity necessary for the continued driving of the ergotropic system to result in simultaneous maximal activity of both the ergotropic and trophotropic systems. However, ceremonial ritual still can result in powerful unitary experiences.

In terms of a spiritual continuum, unitary states play a crucial role. While it is clearly difficult to define what makes a given experience spiritual, the sense of having a union with some higher power or fundamental state seems an important part of spiritual experiences. To that end, this union helps reduce existential anxiety as well as provides a sense of control over the environment (d'Aquili, 1978; Smart, 1967, 1969). The bottom line in understanding the phenomenology of subjective religious experience is to understand that every religious experience involves a sense of the unity of reality at least somewhat greater than the baseline perception of unity in day to day life (d'Aquili, 1986). This is another way of saying that a more intense application of the holistic operator to incoming stimuli, over and above its baseline function, coupled with the limbic or emotional stimulation that accompanies such increased functioning, results in experiences which are usually described as religious or spiritual. Whatever the mechanism for the increased functioning of the holistic operator may be, whether it is an external rhythmic driver,

profound meditation, extreme fasting, or other physiological alterations, the bottom line is activation of the holistic operator with accompanying experiences of increased unity over multiplicity.

AUB is a state of ultimate unity and is described in the mystical literature of all the world's great religions. When a person is in this state he or she loses all sense of discrete being and even the difference between self and other is obliterated. There is no sense of the passing of time, and all that remains is a perfect timeless undifferentiated consciousness. However, it is important to realize that the limbic system is intimately involved in the perception of these experiences (Saver & Rabin, 1997). Thus, when such a state is suffused with positive affect there is a tendency to describe the experience, after the fact, as personal. Such experiences are often described as a perfect union with God (the *Unio mystica* of the Christian tradition) or else the perfect manifestation of God in the Hindu tradition. When such experiences are accompanied by neutral affect they tend to be described, after the fact, as impersonal. These states are described in concepts such as the abyss of Jacob Boeme, the void or nirvana of Buddhism, or the absolute of a number of philosophical/mystical traditions. There is no question that whether the experience is interpreted personally as God or impersonally as the absolute, it nevertheless possesses a quality of transcendent wholeness without any temporal or spatial division whatsoever.

We have postulated that these rare states of AUB are attained through the "absolute" functioning of the holistic operator (d'Aquili, 1982; d'Aquili and Newberg, 1993a, 1993b). As described in the previous model, the neurological substrate for the holistic operator involves the function of the right PSPL. However, during AUB, not only would there be absolute functioning of the holistic operator but also there would be an intense activity of structures in the left cerebral hemisphere associating with that wholeness the intense consciousness of the reflexive ego associated with normal left hemispheric functioning. Thus, the experience of AUB is not a vague sense of undifferentiated wholeness but one of intense consciousness.

We propose, however, that even in more ordinary perceptions, whenever the sense of wholeness exceeds the sense of multiplicity of parts or of discrete elements in the sensorium, there is an affective discharge via the right brain-limbic connections that Schwartz, Davidson, and Maer (1975) have shown to be of such importance. This tilting of the balance toward an increased perception of wholeness, depending on its intensity, can be experienced as beauty, romantic love, numinosity or the religious awe described by Smart, religious exaltation in the perception of unity in multiplicity (described by Stace as extrovertive mystical experience), and eventually various trance states culminating in AUB.

We propose that the spiritual continuum is based on the activation of the holistic operator with the subsequent experience of greater senses of unity within the sensorium. As there is an increasing sense of unity, there is the perception of ever greater approximations of a more fundamental reality (d'Aquili, 1986). Furthermore, the more the holistic operator functions in excess of a state of balance with

the analytic functions of the left hemisphere, the stronger will be the associated emotional charge. Thus, in any perception, such as a piece of music, a painting, a sculpture, or a sunset, there is a sense of meaning and wholeness which transcends the constituent parts. In aesthetic perceptions such as those just described, this transcendence is slight to moderate. We would locate the overarching sense of unity between two persons in romantic love as the next stage in this spiritual continuum. The next stage is characterized as numinosity or religious awe and occurs when the holistic operator functions with a degree of intensity which generates a very marked sense of meaning and wholeness extending well beyond the parts perceived or well beyond the image generated but in a "wholly other" context. Both Otto (1970) and Smart (1969) have described this experience in detail. It is often considered (rather incorrectly we believe) to be the dominant Western mystical experience. It is experienced when an archetypal symbol is perceived or when certain archetypal elements are externally constellated in a myth. As we move from numinosity along the continuum—that is, as the function of the holistic operator increasingly overwhelms synthetic perception—we reach the state of religious exaltation which Bucke (1961) has called cosmic consciousness. This state is characterized by a sense of meaning and wholeness extending to all discrete being whether subjective or objective. The essential unity and purposefulness of the universe is perceived as a primary datum despite the perception and knowledge of evil in the world. During this state, there is nothing whatsoever that escapes the mantle of wholeness and purposefulness. However, this state does not obliterate discrete being, and it certainly exists within a temporal context. This roughly corresponds to Stace's extrovertive mystical experience.

PROOF OF THE MODEL

Clearly, one of the most important aspects of a study of spiritual experiences is to find careful, rigorous methods for empirically testing hypotheses. One such example of empirical evidence for the neurophysiological basis of the spiritual continuum described previously comes from a number of studies which have measured neurophysiological activity during states in which there is activation of the holistic operator. Meditative states comprise perhaps the most fertile testing ground because of the predictable, reproducible, and well-described nature of such experiences. Studies of meditation have evolved over the years to utilize the most advanced technologies for studying neurophysiology.

Originally, studies analyzed the relationship between electrical changes in the brain (measured by electroencephalography) and meditative states. Corby, Roth, Zarcone, and Kopell (1978) showed that during meditation, proficient practitioners had increased alpha and theta amplitudes compared to baseline. These changes were associated with increased autonomic activation. Banquet (1972) found an increased intensity of a frontal alpha pattern during the early stages of meditation. Later stages of meditation were characterized by bursts of theta waves on elec-

troencephalography (EEG) associated with short shallow breathing and the disappearance of tonic electromyographic activity. Another study found hemispheric asymmetries in alpha and beta activity associated with meditation (Benson, Malhotra, Goldman, Jacobs, & Hopkins, 1990). Unfortunately, EEG is limited in its ability to distinguish particular regions of the brain that may have increased or decreased activity.

For this reason, recent studies of meditation have utilized brain imaging techniques such as single photon emission computed tomography (SPECT) and PET. Future studies may also use functional magnetic resonance imaging. There are limitations of each type of technique for the study of meditation. It is important to ensure that the technique is sensitive enough to measure the changes. Also, each of these techniques may interfere with the normal environment of meditation. For this reason, we have performed our initial studies with SPECT, which measures changes in cerebral blood flow.

Our initial data of highly proficient meditators (Newberg, Alavi, Baime, & d'Aquili, 1997a; Newberg, Alavi, Baime, Mozley, & d'Aquili, 1997b) showed significant increases in brain activity in the region comprising the PFC consistent with focusing attention during meditation. We have also observed significant decreases of activity in the area of the PSPL possibly consistent with deafferentation of the PSPL. Interestingly, there was also a strong inverse correlation between activity in the PFC and in the PSPL. This might indicate that the more active the PFC, the more the PSPL is deafferented. These results, although preliminary, are consistent with the model for the neurophysiological basis of meditative experiences presented in this chapter, a model that was developed prior to these imaging studies. Furthermore, our results corroborate an earlier PET study of meditation that showed an increased frontal:occipital ratio of cerebral glucose metabolism (Herzog et al., 1990/1991). However, more studies, using improved methods, will be necessary to further elucidate the neuropsychology of meditation and spiritual experiences. That the underlying neurophysiology of extreme meditative states can be considered at all allows for the conceptualization of many other spiritual experiences that lie along the spiritual continuum. Different spiritual experiences might be explained using the previously mentioned physiological mechanisms. They can be derived from either a top-down or bottom-up approach; either way, they eventually activate the holistic operator via the PSPL and ultimately generate their emotional value via activation of the limbic system and autonomic nervous system.

CONCLUSION: SPIRITUAL EXPERIENCE IN PSYCHOLOGICAL PRACTICE

In this section, using a neurophysiological analysis of spiritual experiences, we consider how these experiences impact clinical practice. Western society has historically emphasized the importance of causality, technological advances, and empiricism. It is from these values that Western medicine, psychiatry, and psycholo-

gy have developed. We propose that regardless of the connotation of the concept of spirituality in Western society, mystical and meditative experiences are natural and probably measurable processes that are and can be experienced by a diversity of people of different races, religions, and cultures. Those having spiritual experiences can have a variety of neuropsychological constitutions.

In addition, it is important for clinicians to be sensitive and knowledgeable regarding spiritual and philosophical beliefs (Worthington, McCullough, & Sandage, 1996). Professionals need to be capable of distinguishing normal, healthy spiritual growth from psychopathology. It is hoped that some of the neurophysiological analysis described previously might allow for a distinction between normal spiritual experiences and pathological states. Such a distinction might depend on the ergotropic/trophotropic balance created by the experience or by the alterations in the functioning of the brain structures subserving the holistic or causal operators. However, the fact that spiritual experiences have an effect on autonomic function as well as other cortically mediated cognitive and emotional processes suggests that such experiences not only affect the human psyche but also may be utilized to assist in the therapy of various disorders.

Studies have demonstrated that prayer and meditation can improve both physical and psychological parameters (Carson, 1993; Kabat-Zinn, Lipworth, & Burney, 1985; Kaplan, Goldenberg, & Galvin-Nadeu, 1993; Worthington et al., 1996). The more the underlying neurophysiological correlates of spiritual experiences are understood, the more such experiences can be analyzed and utilized in clinical practice. Therefore spiritual experience can be very useful in clinical psychological and psychiatric practice. Furthermore, clinicians themselves can be instrumental in helping their patients with personal and spiritual growth by discussing various meditative and/or spiritual practices and encouraging patients to approach these practices in an unambiguous manner. According to Rowan (1983), a humanistic psychologist, "[the self] is the missing link between the psychological and the spiritual. And it offers a safe way into the difficult and apparently dangerous realms of mysticism" (p. 24). Therefore, it seems natural that spiritual experiences, such as those encountered in meditation and prayer, could become an adjunct to Western therapeutic practices and that developing oneself spiritually could become an important part of psychosocial development.

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