RELIGIOUS AND MYSTICAL STATES: A NEUROPSYCHOLOGICAL MODEL

by Eugene G. d'Aquili and Andrew B. Newberg

Abstract. This paper first considers the current confusion in categorizing and even describing mystical states, including experiences of God, the Void, and lesser religious experiences. The paper presents the necessity of studying the neuropsychological substrate of such experiences both to understand them in greater depth and to help resolve scholarly confusion in this area. As a prelude to presenting a neuropsychological model, the basic principles of brain organization are reviewed, including hemisphericity; primary, secondary, and tertiary sensory receptive areas; their motor analogues; prefrontosensorial polarity; and the integration of limbic functioning into cortical activity. A neuropsychological model for mystical states is then presented in terms of differential stimulation and deafferentation of various tertiary sensory association areas, along with integration of various patterns of limbic stimulation.

Keywords: Absolute Unitary Being; associated areas; cultural elaboration, deafferentiation, ergotropic-trophotropic tuning; hemisphericity; limbic-cortical integration; mystical states; neuroepistemology; structural invariance; *Via Negativa*; *Via Positiva.*

The purpose of this paper is to contribute to the understanding of intense religious and spiritual experience in a more scientific form than one usually encounters; to present a theoretical neuropsychological model for the genesis of such experiences in terms of information we already possess about brain functioning; and to plead for further refinement of the model and for its empirical testing using new, noninvasive techniques.

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There is clearly a wide variety of deeply religious or mystical experience, ranging from the sense of the "wholly other" of the divine being to the Absolute Unitary Being (AUB) of many Eastern religions such as Buddhism and Hinduism (Otto 1970; Streng 1978). Steven Katz (1978) maintains that not only do mystical experiences differ in terms of the language of the culture in which they are embedded, but their very content is altered by the cultural experience the mystic brings to them. All of this presents a rather confused picture about what, if anything, mystical experiences may have in common across cultures and from person to person.

We propose that a neuropsychological analysis of mysticism, altered states of consciousness, and the experience of the Divine can bring some order out of the confusion. We will therefore present in this paper a theoretical model that we hope will contain general neuropsychological principles permitting an analysis of any kind of mystical experience. For the purpose of simplification, our initial attempt will be to explain AUB and thereafter, other mystical and religious states.

AUB is a state in which the subject loses all awareness of discrete limited being and of the passage of time, and even experiences an obliteration of the self-other dichotomy. In previous works, we have presented evidence that if AUB is experienced, accompanied by blissful positive affect, it is usually interpreted as the *unio mystica*, or the experience of God. If it is associated with neutral affect, it is more frequently interpreted impersonally as the Void or Nirvana of Buddhism, or as the Absolute of various philosophical disciplines.

We shall return to these and other mystical and religious states after we briefly review some well-known and basic principles of brain organization requisite to comprehending our explanatory model of such states.

PRINCIPLES OF BRAIN ORGANIZATION

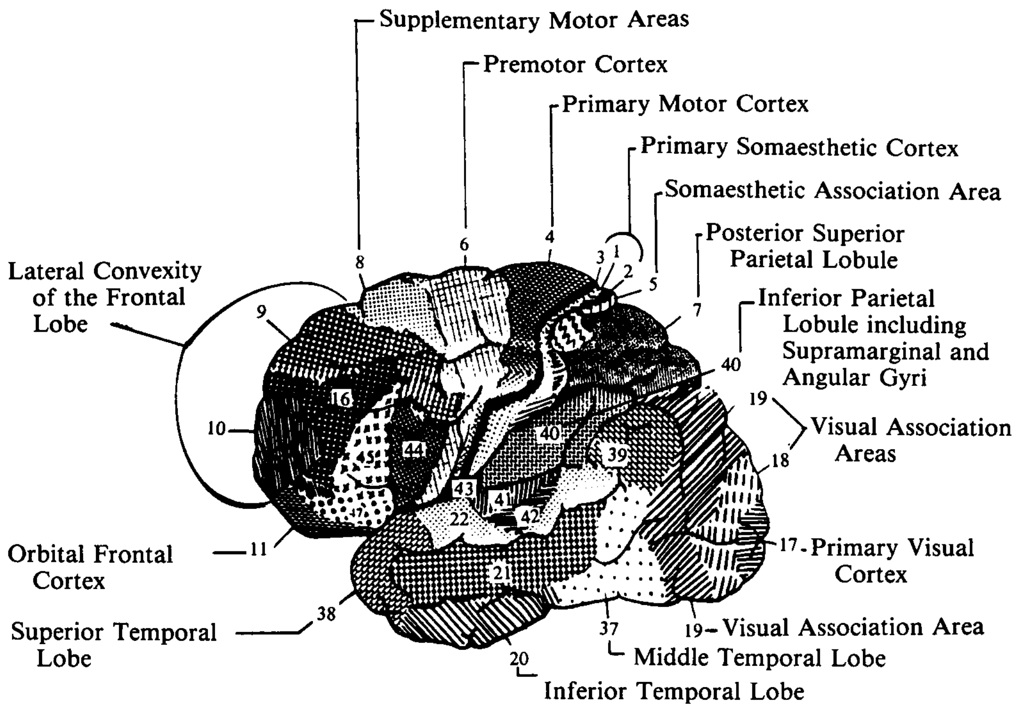
In the process of evolution, each hemisphere of the brain has developed its own peculiar mode of perceiving, processing, and experiencing information. The human cerebral cortex is arranged such that two potentially independent consciousnesses exist side by side (Gazzaniga and LeDoux 1978; Joseph 1982, 1988a, b; Levy 1983; Sperry 1966, 1982). For example, the right hemisphere is associated with nonverbal awareness of the environment; visual-spatial perceptual functioning; figure ground and stereopsis; facial recognition; the maintenance of the body image; and the perception, expression, and mediation of most aspects of emotionality. By contrast, the left hemisphere governs expressive speech; linguistic knowledge and thought; mathematical and analytical reasoning; and temporal-sequential and rhythmical aspects of consciousness. We will refer to two figures during our discussion of the anatomy and function of various areas of the brain. Figure 1 shows the lateral surface of the left cerebral hemisphere, with Brodmann's areas indicated. Figure 2 shows the structures of the limbic system.

Sensory input, for all modalities and for both hemispheres, has primary, secondary, and tertiary receptive areas. For example, the primary visual cortices (Brodmann's area 17) receive the raw input data from the eyes. The secondary visual cortex (areas 18 and 19) is responsible for the recognition and meaningfulness of the raw perceptual data registered in the primary cortex (Joseph 1990). Thus, for visual inputs to be perceived on a conscious level, at least some of the secondary cortex must be present and functioning properly.

In addition to the primary and secondary sense areas, there exist a number of areas in the brain where secondary association areas of different sense modalities overlap, yielding what has been referred to as tertiary association areas (Joseph 1990). These are the areas of the highest integration of sensory information, often involving direct cross-modal transfer of information between the senses (Joseph 1990). In this paper, we shall be concerned with a number of tertiary association areas, particularly on the right side.

The anterior or frontal structures of the brain, which primarily involve movement, are organized similarly to the sense receptive parts of the brain. Thus, there is a primary motor cortex for simple movements (Brodmann's area 4) and a secondary association area (Brodmann's area 6) responsible for more complex movements, particularly goal-oriented motor behavior (Joseph 1990). The remainder of the frontal lobe, including the supplementary motor area, the lateral convexity of the frontal lobe, and the orbital frontal cortex all represent a highly evolved tertiary motor system. In fact, these areas often transcend strictly motor operations and actually modulate and modify the functions of both the limbic system and the tertiary sensory areas (Fuster 1989). Some authors refer to the entire frontal tertiary complex as the "prefrontal cortex."

We must now turn to a brief consideration of the normal functioning of four tertiary association areas and to their relationship to the limbic system. We postulate that these areas, under certain conditions, may be involved in the genesis of various mystical states, the sense of the divine, and the subjective experience of God. These cortical regions are: the inferior temporal lobe (ITL); the inferior



PREFRONTAL CORTEX = {Supplementary Motor Area
Lateral Convexity of the Frontal Lobe
Orbital Frontal Cortex

Fig. 1. The lateral surface of the left cerebral hemisphere with Brodmann's areas indicated.

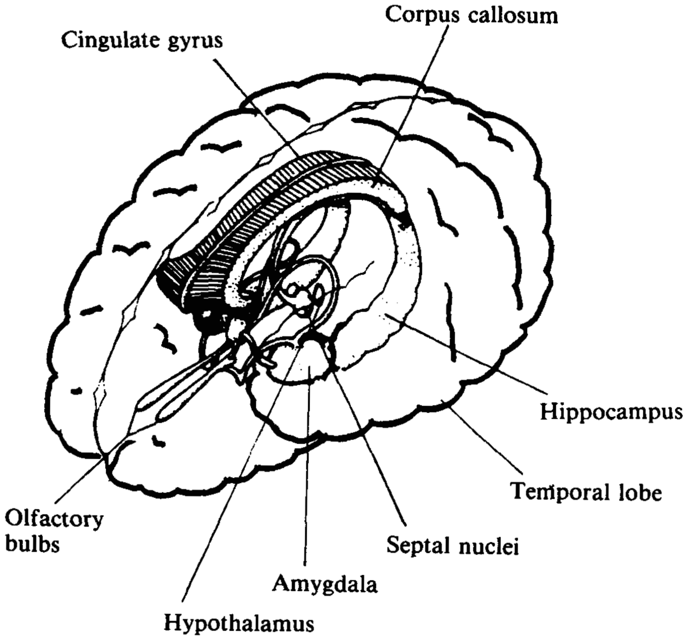


Fig. 2. Limbic system nuclei, superior-lateral aspect. From Marvin Schwarz, *Physiological Psychology*, 2nd ed., p. 9. Reprinted by permission of Prentice-Hall, Englewood Cliffs, N.J.

parietal lobule (IPL); the posterior superior parietal lobule (PSPL); and the prefrontal cortex.

The PSPL (area 7) is heavily involved in the analysis and integration of higher-order visual, auditory, and somaesthetic 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, 1980), can direct visual attention, become excited when certain objects are within grasping distance, and motivate and guide hand movements towards these objects.

There is some difference in function between the PSPL on the right and the PSPL on the left. Joseph (1990) 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 with regard to objects that may be directly grasped and manipulated. The fact that some neurons in the left

PSPL respond most to stimuli within grasping distance and other neurons respond most to stimuli just beyond the arm's reach led Joseph to postulate that the distinction between self and world may ultimately arise from the left PSPL's ability to judge these two categories of distance. 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 (Brodmann's area 20) 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 and Van Hoesen 1976; Kling, Lloyd, and Perryman 1987; Turner, Mishkin, Knapp 1980; Van Hoesen, Pandya, and Butters 1972). When such objects are detected from the PSPL, the ITL's visual form recognition neurons are activated, whereas those with wide nonspecific visual fields are inhibited. In this manner, objects of interest are detected and fixated upon.

The IPL (Brodmann's areas 40 and most of 39), located at the junction of the temporal, parietal, and occipital lobes and sometimes including the angular and supramarginal gyri, is an association area of association areas, and maintains rich interconnections with the visual, auditory, and somaesthetic association areas. This area is responsible for the generation of abstract concepts and relating them to words. 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, and Gross 1986; Burton and Jones 1976; Geschwind 1965; Jones and Powell 1970; Seltzer and Pandya 1978; Zeki 1982).

The limbic structures, which are very ancient phylogenetically, control the sensation, modulation, and expression of emotion. The medial structures of the hypothalamus, especially the ventromedial nucleus, seem to represent an extension of the parasympathetic nervous system into the brain stem (Joseph 1990, 91-98). The medial hypothalamic structures with the peripheral parasympathetic nervous system have been called the trophotropic (or energy conserving) system. In general, it is involved with the homeostasis of the organism, with vegetative functions, and with a subjective sense of quiescence.

In contrast, the lateral hypothalamic structures seem to be an extension of the sympathetic nervous system into the brain stem (Joseph 1990), and the entire system has been called the ergotropic (or energy expending) system. It is involved with "fight or flight" responses, with sensations of fear, or with the sensation of positive emotions ranging from moderate pleasure to bliss. Such pleasurable feelings can be generated by a number of areas within the lateral hypothalamus or adjacent areas, usually mediated, however, by the median forebrain bundle (Olds and Forbes 1981; Warranczynski and Stellar 1978).

The emotions generated by the hypothalamus whether positive or negative tend to be stimulus bound, and therefore die off very quickly when the stimulus is removed (Joseph 1990, 91–98). On the other hand, the emotional tone generated through the amygdala is not stimulus bound, and tends, to persist over time with a slow extinction curve (Joseph 1990, 98–104). The hippocampus does not seem to subserve the expression of emotion directly. Rather, it acts in a modulating and moderating fashion both on the amygdala and on the hypothalamus via interconnections with both. Thus, the hippocampus seems to prevent emotional extremes via rich and extensive interconnections with the prefrontal cortex, other neocortical areas, the amygdala, and the hypothalamus (Joseph 1990, 110–14). It seems that most of the prefrontal modulation of emotion is via the hippocampus and its connections both with the hypothalamus and the amygdala. The hippocampus also acts as a coordinating structure uniting elements from various secondary and tertiary association areas into complex memories (Joseph 1990, 114–15).

The prefrontal cortex is the only area that receives afferent fibers from all sensory modes, including olfaction, as well as from the multimodal (tertiary) association areas (Stuss 1986). The prefrontal cortex is involved in mediating concepts via its rich interconnections with the inferior parietal lobule (Luria 1980; Stuss 1986). The prefrontal cortex mediates images and complicated imaginal patterns via its connection with the rostral temporal cortex, especially the inferior temporal lobe (Fuster 1989; Stuss 1986). Also, and most importantly for our concerns here, the prefrontal cortex of each hemisphere is connected to the prefrontal cortex of the other by fibers running across the genu and rostrum of the corpus callosum (Stuss 1986).

In humans, the loss of the ability to concentrate is a characteristic feature of any prefrontal disorder, as is the loss of the ability to plan and to orient oneself to future behavior (Pribram and McGuinness 1975). Pribram (1981) has suggested that prefrontal processes may function to produce redundancy in otherwise novel sensorial space. Such processes have been shown to predominate in the right hemisphere and to be associated with dopaminergic systems (Tucker and Williamson 1984). The production of such redundancy seems to be essential to all attention-related functions of human consciousness.

Thus, patients with prefrontal lesions not only lose the ability to plan and orient themselves to future activity, but they also suffer a severe deficit in carrying out complex perceptual and conceptual tasks.

Patients with prefrontal disorders also exhibit flatness of affect and apathy, and they tend to have difficulty controlling emotion, especially if frontal-limbic connections are affected (Stuss and Benson 1986). Prefrontal deficits seem to indicate a general loss of global sensory integrative capacity with respect to supramodal control, planning, integration, and monitoring of activity and the effects of activity (Nauta 1971). To put it bluntly, a great part of what one sees with this disorder is a loss of will or of the capacity to form intention. If any part of the brain can be said to be the seat of the will or of intentionality, it is certainly the prefrontal cortex, especially the dorsal lateral convexity (Pribram 1971; Pribram and Luria 1973; Fuster 1989).

As we have noted in a previous work (Laughlin, McManus, and d'Aquili [1990] 1992), it seems that the role of the prefrontal cortex is twofold: it serves not only to implement "executive" programs when events in the environment become too complex for lower-order networks (Pribram and Luria 1973), but also to mediate the relationships between the Husserlian "pure ego" and the phenomenal world as constituted by sensorial structures presented by secondary and especially tertiary sensory association areas.

This discussion has finally brought us to that structure which mediates intense concentration, and thus is essential for all meditative practices: the prefrontal area, especially the lateral convexity. Let us consider what happens electrophysiologically during concentration of any sort, and especially during meditation.

A number of studies have shown that during sustained attention, the electroencephalogram (EEG) develops theta waves (3.5 to 7.5 Hz) in the prefrontal cortex. Mizuki (1983) showed a correlation between the amount of theta activity and the degree of concentration required for memorization, retention, and recall of material, with the intensity of theta activity increasing in the presence of distraction. Hirai (1974) demonstrated frontal theta activity among Zen practitioners during meditation. Thus, it seems clear that low amplitude theta activity is correlated with sustained attention or concentration (Pigeau 1985; Ishihara and Yoshii 1972; Schacter 1977).

Entirely different research by Green and Arduini (1954) showed that when experimental animals attended to, or attempted to fix, a novel stimulus in the environment, they produced slow-wave theta activity in the hippocampus. This would seem to suggest that attention or fixation generates theta activity not only in the prefrontal cortex, but also in the hippocampus. This indicates that the limbic system is always at least somewhat involved when there is any attention or concentration, even at lower levels of intensity. Grastyan, Lissak, Madarasz, and Donhoffer (1959) demonstrated this limbic involvement during situations in which both the cortex and the hippocampus were desynchronized (no theta activity in either). This desynchronization results in distractibility and hyperresponsiveness. The subject becomes overwhelmed, confused, and may orient towards and approach several different stimuli. Furthermore, attention, learning, and memory functions significantly decrease.

Although we have a great deal of data concerning the EEG correlates of concentration, even of intense concentration, we unfortunately have only one EEG reading taken when a subject experienced a near AUB experience (Corby 1978). The EEG record of this subject during meditation disclosed both large amounts of high-amplitude (up to 100 microV), alpha-range frequencies, and also large amounts of intermediate theta-range frequencies (up to 150 microV). Significantly, there were intermittent discrete bursts of theta-range frequencies of amplitudes up to 300 microV usually over the *prefrontal* and *parietal* areas. The association of high-amplitude theta bursts over the parietal as well as the prefrontal areas is particularly significant for the thesis we will present below.

One other aspect that is crucial to our neuropsychological model of mystical states is the concept of deafferentation. Deafferentation simply means that neural input into a structure within the nervous system is "cut off." This cutting off, which may be partial or total, can be caused by physical interruption such as by a destructive tumor or surgical cutting, or by "functional" deafferentation. Functional deafferentation can occur through inhibitory fibers from other nervous system structures. Thus, impulses from inhibitory fibers may actually block input into a neural structure. 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. Hoppe called this prevention of interhemispheric communication a "functional comissurotomy." There is similar evidence that intrahemispheric information transmission can be partially or totally prevented by impulses originating in the prefrontal cortex via the hippocampus (Green and Adey 1956; Nauta 1958; Joseph, Forrest, Fiducis, Como, and Siegal 1981).

When deafferentation of a structure occurs to a significant degree, the cells within that structure begin to fire either randomly, or more likely, according to the "internal logic" of that structure (Joseph 1990, 116–20). The ordered neural activity of that structure is no longer maintained by input from other parts of the brain.

Almost all of the examples of functional deafferentation that we know of originate in the prefrontal cortex and are therefore "willed" or "intended" by the subject. A good example is the intitial instruction for beginners in Theravada meditation and some Zen schools to remove all thoughts from their minds and concentrate only on their breathing. This is a rather simple instruction and one with which it is not very hard to comply. What we propose is happening on a neuropsychological level is the following: When the subject wills to banish all thoughts from the mind, impulses from the prefrontal cortex inhibit the transmission of information from the inferior parietal lobule to the PSPL. Since concepts and linguistic deep structure are generated in great part by the IPL (primarily on the left, but some on the right), the inhibition of information passing from the IPL to the PSPL effectively prevents words and concepts from entering the PSPL. To fully deafferent the PSPL from the secondary sensory association areas (as well as from the IPL) may take years of practice and intense concentration.

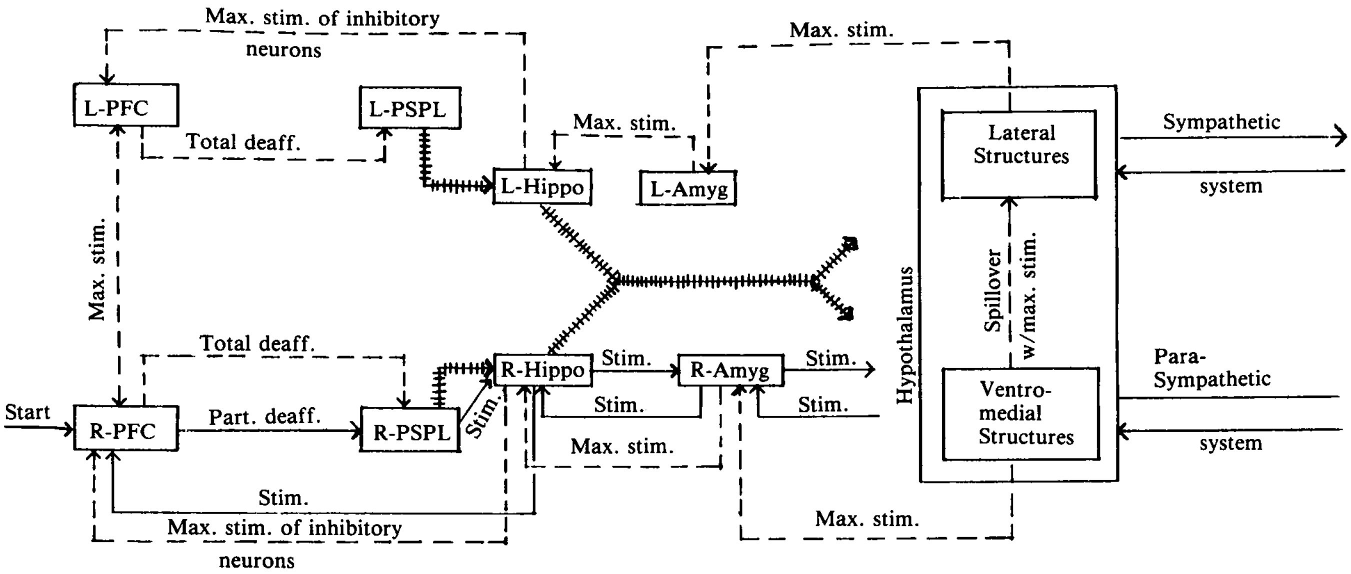
THE NEUROPHYSIOLOGICAL MODEL OF MYSTICAL EXPERIENCE

This finally brings us to the neuropsychological modelling of mystical or religious experiences, which is the central topic of this paper. From a pragmatic point of view, psychotherapists may be more interested in spontaneous mystical states rather than in those same states produced by various forms of controlled meditation. We shall briefly consider the issue of spontaneous religious experiences below. But from the point of view of systematically developing a theoretical neuropsychological model of such states, analysis of controlled meditation gives us our best entree to an understanding of these phenomena.

Passive Meditation — The Via Negativa. We are now ready to consider passive meditation and the state of Absolute Unitary Being which may arise from the patient and persistent pursuit of what was known in the Middle Ages as the *Via Negativa*. Figure 3 is a schematic representation of the neural events which, we propose, occur with this kind of meditation. One starts in the right prefrontal cortex with the will or intent to clear the mind of thoughts and words. As we have noted above, this may result in a partial deafferentation of the right posterior superior parietal lobule (PSPL) This partial deafferentation consists in the total blocking of input from the inferior parietal lobule, as well as the attempt not to pay attention to direct sensory input. Such further disattention probably also represents further deafferentation of the right PSPL. This partial deafferentation of the right PSPL likely results in stimulation of the right hippocampus via the very rich interconnections between the PSPL and the hippocampus. If, in addition, there is simultaneous direct stimulation of the right hippocampus from the right prefrontal cortex, then we get a powerful recruitment of stimulation of the right hippocampus, ultimately resulting in stimulation of the right amygdala's trophotropic centers. After the stimulation of the right amygdala reaches a certain threshold, we get stimulation from the right amygdala to the ventromedial portion of the hypothalamus, with a resultant stimulation of the peripheral parasympathetic system. This results in the subjective sensation first of relaxation, and eventually, of a more and more profound quiescence.

Not only is it likely for the right prefrontal cortex to stimulate the right hippocampus directly, but also, at every step along the way, stimulation may be reinforced by "leapfrogging" among various structures via numerous neural projections between many of them. Thus, the right hippocampus stimulates the amygdala, which, in turn, powerfully stimulates the ventromedial portion of the hypothalamus; but the right hippocampus also projects fibers directly to the ventromedial portion of the hypothalamus, resulting in a powerful recruitment of stimulation. So, we should keep this double and even triple leapfrogging stimulation effect from a single, original source in mind as we run through our model's schematic pathway.

In any case, most simply defined, a reverberating circuit is formed by impulses originating in the right prefrontal cortex, going to the right PSPL; to the right hippocampus; to the right amygdala; to the ventromedial structures of the hypothalamus; then back to the right amygdala; to the right hippocampus; and directly back to the right prefrontal cortex. Impulses go around and around this circuit, recruiting greater electrical activity. The system is accelerated by ever greater members of impulses originating in the right prefrontal cortex by continued meditation. This results in a progressive increase in the intensity of neural discharge until a maximum level is reached in the trophotropic-parasympathetic system. Reaching the maximum level results in spillover and almost instantaneous maximal stimulation of the ergotrophic-sympathetic system, as has been shown to occur in third-stage autonomic tuning (d'Aquili 1978). This maximal stimulation of both systems results in ecstatic and blissful feelings via intense stimulation of structures both in the lateral hypothalamus and in the median forebrain bundle.



PFC = Prefrontal Cortex
PSPL = Posterior-Superior Parietal Lobule
Hippo = Hippocampus

Amyg = Amygdala
Stim = Stimulation
deaff = deafferentation

Fig. 3. A schematic drawing of the neural events occurring during passive meditation—the *Via Negativa*. Meditator starts the R-PFC by "intending" to clear mind of thoughts
Plain Arrows ——→ initial neural paths forming a recurrent loop of progressively increasing intensity prior to spillover
Dashed Arrows – – –→ neural paths of maximal stimulation between spillover and the generation of AUB
Hatched Arrows ++++→ neural paths following AUB establishing either ergotrophic or trophotropic dominance while AUB lasts

Likewise, there is an almost instantaneous maximal feedback stimulation from the hypothalamus to the right and left amygdalas, to the right and left hippocampi, to the right and left prefrontal cortices. Maximal stimulation of these latter areas is powerfully and mutually reinforced by the stimulation of facilitatory impulses passing directly between the right and left prefrontal cortices (in both directions), via fibers passing through the genu and rostral portion of the corpus callosum. The maximal stimulation of both prefrontal cortices should almost instantly result in total deafferentation of both the left and right posterior-superior parietal lobules.

As noted earlier, the right PSPL is concerned with generating a sense of space and spatial coordinates (somaesthetic, visual, and to some extent auditory) in which to orient incoming stimuli. The total deafferentation of the PSPL cannot result in unusual or unmodulated visions, sounds, or tactile sensations, since the PSPL has no memory banks with previously stored sensations. Rather, its total deafferentation can only result in an absolute subjective sensation of pure space. But space has no conventional meaning except as a matrix in which to relate objects. We propose, therefore, that pure space arising from total deafferentation of the right PSPL is subjectively experienced as absolute unity or wholeness.

At the same instant that the right PSPL is totally deafferented, the left PSPL is likewise totally deafferented. We have presented some evidence earlier in this paper that the left PSPL may be intimately involved with the maintenance of the self-other or the self-world dichotomy. We propose that the total deafferentation of the left PSPL results in the obliteration of the self-other dichotomy at precisely the same moment that the deafferentation of the right PSPL generates a sense of absolute transcendent wholeness. All the events, from the moment of spillover in the hypothalamus with resultant maximal firing of both ergotropic and trophotropic systems to the total deafferentation of both the right and left PSPL, occur so rapidly as to be experienced by the subject as instantaneous.

We believe that this results in the subject's attainment of a state of rapturous transcendence and absolute wholeness which carries such overwhelming power and strength with it that the subject has the sense of experiencing absolute reality. This is the state of Absolute Unitary Being. Indeed, so ineffable is this state, that even the memory of it carries a sense of greater reality than the reality of our everyday world for those who experience AUB (as reported by a number of experiencers interviewed by us as well as reported in the world's mystical literature). The first part of the schematic drawing (figure 3), beginning with the will or intent to obliterate thoughts from the mind up to the moment of spillover in the hypothalamus (which involves the reverberating circuit described above), may take days, weeks, months, or even years of regular, disciplined meditation, depending on the aptitude of the subject. The events represented by the rest of this schematic drawing subsequent to the moment of spillover occur almost instantaneously.

There is still one further step before completing the explanation of figure 3. Please note the arrows going from both the right and left PSPL back to the hypothalamus. This is possible because, in this model, although both the right and left PSPL have been deafferented, they have not been deafferented. In other words, although no impulses can get into these structures, impulses can get out. The impulses arising from the totally deafferented right and left PSPL pass through fiber tracts primarily to the hippocampi, but also to other limbic structures. We believe that these impulses determine the steady state of the limbic system during the period of AUB. They either reinforce the initial ecstasy by ultimately reinforcing the lateral (ergotropic) hypothalamic discharge, or they switch balance from ecstasy to a deep and profound quiescence by allowing the ventromedial hypothalamic (trophotropic) structures to regain dominance.

If the first situation occurs, AUB is not only experienced initially as ecstasy, but the ecstasy is maintained throughout the period of contemplation. If the second situation occurs, then after the initial moments of ecstasy, AUB is experienced as a deep quiescent Void or Nirvana. We would suggest that the first situation tends to be interpreted personally (after the fact), as the immediate experience of or union with God. In the second case, the experience of AUB tends to be interpreted impersonally, as the peace and emptiness of the absolute ground of being.

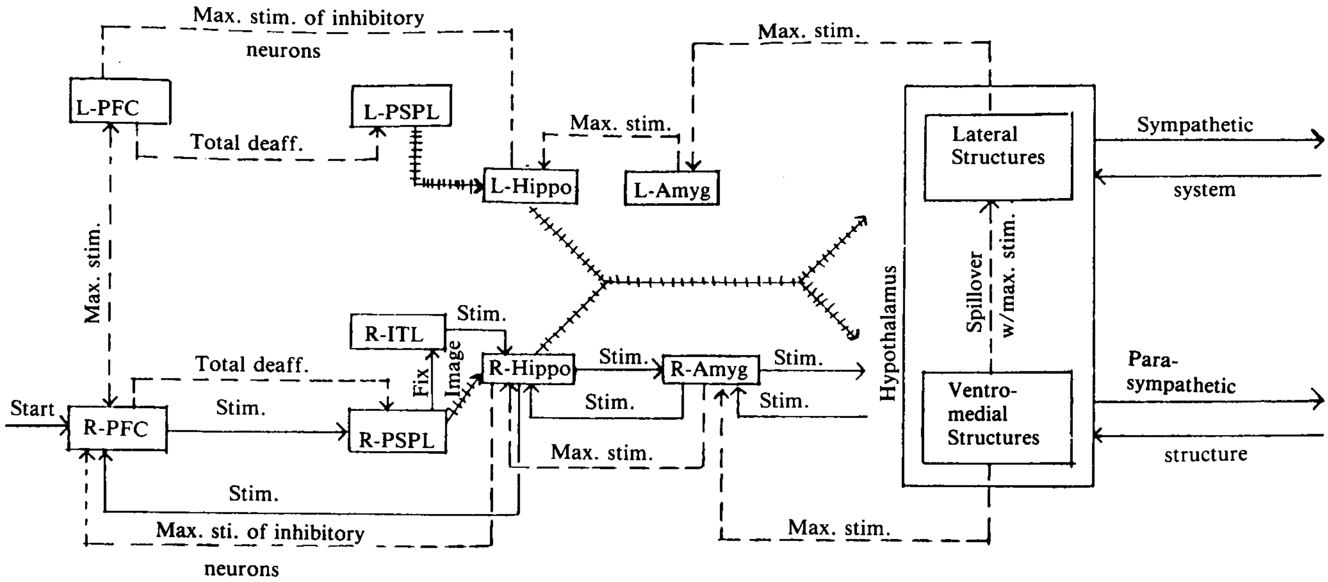
What is not clear is which variables result in one or the other affective state becoming stabilized during the AUB experience. It seems to be the case that most mature meditators who practice the *Via Negativa* tend to end up in the quiescent experience of AUB, which in our model represents the trophotropic state. Likewise, it is true that those who practice the *Via Positiva* (by intensely concentrating on an object or idea, described below) tend to end up with the ecstatic experience of AUB, which we would suggest is an ergotropic state.

So it may be that one ends up more or less according to the general mode in which one starts out. But this is by no means always true, and there seem to be many exceptions. Perhaps the socioculturally determined belief system of the meditator also has something to do with the outcome. In any case, much research needs to be done into why certain mystics experience AUB or the ground of being as active and personal, while others experience it as passive and impersonal.

Active Meditation — The Via Positiva. Figure 4 represents the hypothesized mechanism of active or absorptive meditation also known as the *Via Positiva*. Only the events up to the point of hypothalamic spillover are significantly different from the events illustrated in figure 3. From the point of hypothalamic spillover on, the events of both passive and active meditation are almost identical, with one significant exception (to be considered later). The *Via Positiva* begins by the subject's willing or intending not to clear the mind, but to focus either on a mental image or on an external physical object. Sometimes the image is a religious symbol, the meaning of which carries powerful emotional overtones, which help to stimulate the limbic system. But the object of meditation need not necessarily be a religious symbol. It could be something as mundane as a stone, a chair, or any other physical object.

The simplest case is when one chooses to focus upon a visual object of meditation in the external world with eyes open. In our model, impulses pass from the right prefrontal cortex of the willing or intending subject to the right PSPL. Note that in this case the impulses are facilitatory and stimulating, not inhibitory or deafferenting. It is the right PSPL that fixes an image presented by the inferior temporal lobe. If the meditator's eyes are open and the image originates in the retina, it is passed back through the visual system to the primary receptive area in the occipital lobe (Brodmann's area 17); then to the secondary association areas (Brodmann's areas 18 and 19), where it acquires essential functional associations; then it passes to the inferior temporal lobe, where it receives its most complex associations. The image is then fixed and attended to by the right PSPL.

If the subject intends to call forth an image from memory (whether it be an image of a physical object, a religious symbol, a past memory, or whatever), this would be effected by stimulatory impulses running from the right prefrontal cortex directly to the right inferior temporal lobe. This is the first step if the image is not originating from within the field of vision. Then, the right prefrontal cortex stimulates the right PSPL to fix the image and attend to it in a steady, highly focused manner. In any case, we postulate that continuous fixation on the image presented by the right inferior temporal lobe begins to stimulate the right hippocampus; the right hippocampus, in turn, stimulates the right amygdala; the right amygdala stimulates the lateral portions of the hypothalamus, generating a



PFC = Prefrontal Cortex
PSPL = Posterior-Superior Parietal Lobule
Hippo = Hippocampus

ITL = Inferior Temporal Lobe
Amyg = Amygdala
Stim. = Stimulation
deaff. = deafferentation

Fig. 4. A schematic drawing of the neural events occurring during active or absorptive meditation—the *Via Positiva*. Meditator starts the R-PFC by "intending" to focus on an image. Hence the first step from the R-PFC ⟶ R-PSPL is stimulation, not partial deafferentation (inhibition) as in Fig. 3.

Plain Arrows ⟶ initial neural paths forming a recurrent loop of progressively increasing intensity prior to spillover
Dashed Arrows – – – → neural paths of maximal stimulation between spillover and the generation of AUB
Hatched Arrows ┼┼┼┼→ neural paths following AUB establishing either ergotrophic or trophotropic dominance while AUB lasts

See text for an explanation of the lag time between the total deafferentation of the L-PSPL and that of the R-PSPL, creating the state of absorption prior to AUB characteristic of active meditation.

mildly pleasant sensation. Impulses then pass back to the right amygdala and hippocampus, recruiting intensity as they go along. The impulses then feed back to the right prefrontal cortex. Progressively intense concentration upon the object reinforces the whole system. Thus, a reverberating loop is established, similar to that in the *Via Negativa.*

In our model, the circuit continues to reverberate and to augment in intensity until the stimulation of the lateral hypothalamus (ergotropic system) becomes maximal, creating a "spillover" such that maximal stimulation of the ventromedial hypothalamus (trophotropic system) occurs simultaneously with the ongoing maximal stimulation of the ergotropic system. At this point, there would be maximal stimulation feedback through the limbic structures to the left and right prefrontal cortices. As in the system described by figure 3, this results in instantaneous maximal stimulation of the left prefrontal cortex, with immediate total deafferentation of the left PSPL.

The situation on the right side, however, is somewhat different in the case of active meditation. Although from the moment of spillover, there is also maximal limbic stimulation of the right prefrontal inhibitory system, you will note that there is already an ongoing and powerful stimulation system (*not* deafferenting) from the right prefrontal cortex to the right posterior-superior parietal lobule. This system has been reinforced by a constant feedback loop until the moment of spillover.

Therefore, the right prefrontal inhibitory system, although maximally stimulated, must fight against a preexistent, and very strong, facilitatory or stimulating system that is generated by fixating and focusing upon an object. Since the meditating subject still intends to focus in an ever more concentrated way on the object of meditation, this system continues to be reinforced even in the presence of ecstatic feelings generated by the limbic system and by a progressively stronger assertion of the inhibitory deafferenting system. Throughout the period of time in which there is conflict on the right side between facilitatory and inhibitory mechanisms, there has been total instantaneous deafferentation of the left PSPL.

Thus, the self-other dichotomy has been obliterated during a period of time, perhaps fairly long, in which the image still remains a focus of meditation. We would suggest that this is the period of time in which the subject feels absorbed into the object, or, as described by the subject, becomes one with the object. This period of meditation upon the object, during which the subject becomes one with the image, the symbol, or the event, may last for a relatively long period of time. The length of time depends upon the determination of the meditator to continue fixating upon the object and thus to reinforce the facilitatory stimulating system in opposition to the limbic system's maximal stimulation of the inhibitory nuclei of the right prefrontal cortex. Sooner or later, in the face of maximal ergotropic and trophotropic discharge, either the meditator surrenders, or possibly even against the subject's will, the inhibitory influences take over and total deafferentation of the right PSPL occurs. Since the left PSPL has already been totally deafferented, the sef-other dichotomy has been obliterated for some time.

Thus, the endpoint of the *Via Positiva* becomes the endpoint of the *Via Negativa*: maximal stimulation of the ergotropic and trophotropic systems with total deafferentation of the right and left PSPL, creating the experience of Absolute Unitary Being. The period of time from spillover to the final assertion of dominance of the inhibitory neurons in the right prefrontal cortex is the period of absorption of the meditator into the object of meditation.

Lesser Mystical States. With the mechanisms of the *Via Negativa* and *Via Positiva* explained, and in the context of what we have mentioned about the functions of several tertiary sensory association areas, it is now possible to gain some preliminary insight into the genesis of what we might term "lesser" (although extremely powerful) mystical states or religious experiences.

For example, the state which Jung and others refer to as numinosity can be described as a combination of the experience of both fear and exaltation, usually termed "religious awe," and almost always associated with religious symbols, sacred images, or "archetypal" symbols. When this occurs as a result of meditation, it probably begins with the meditator's intending or willing to focus intently on the stream of images as they come into and leave consciousness. We would suggest that this subjective state of free flow of consciousness is probably attained by prefrontal deafferentation of the inferior temporal lobe. Without modulating input, images from the memory bank of the inferior temporal lobe flow according to their own internal logic. They appear sometimes as simple representations of external reality, sometimes as monsters or gods composed of fragments of other images, and sometimes as "archetypal" symbols. If Jungian archetypes do in fact exist, it is probably through deafferentation of the inferior temporal lobe that they rise to consciousness.

Thus, the right prefrontal cortex would stimulate the parietal lobe to fix on and attend to, not any one object generated by the inferior temporal lobe, but the total functioning (imaginal flow) of the inferior temporal lobe as a deafferented unity. Such free-flowing activity of the inferior temporal lobe would powerfully stimulate the limbic system in very specific ways. It might stimulate parts of the lateral hypothalamus (via the hippocampus and amygdala) to generate a mild to moderate fear. At the same time, it might stimulate related parts of the lateral hypothalamus (also via the hippocampus and amygdala) to generate a concomitant feeling of exaltation.

We would suggest that in lesser religious states, we are not dealing with a system of maximal simultaneous ergotropic and trophotropic stimulation (as with the genesis of AUB). Rather, we believe that we are dealing with mild to moderate stimulation of certain neurocircuits of the lateral hypothalamus, which generate a mild to moderate fear accompanied by a sense of exaltation. This, then, is the complex often referred to as religious awe, probably because this unusual combination of emotions is generally associated with symbols or constructs generated by the inferior temporal lobe and identified as religious.

Otto's *Mysterium Tremendum et Fascinans* is the sense of the mighty and wholly other "Cause of All" filling the world. It is experienced by the subject as a mysterious and awesome presence. In our model, when this occurs as an effect of meditation, we are probably dealing with the deafferentation of those neural circuits within the inferior parietal lobule which generate the sense of causality in our ordinary processing of sensory input, and which we have termed in previous works the causal operator (d'Aquili 1978, 1982, 1983). Since these structures presumably act as an operator on sensory input and do not contain memory banks themselves, the deafferentation of the causal operator within the inferior parietal lobule would generate a subjective sense of reified causality. As with the case of the deafferented inferior temporal lobe (which generated the sense of numinosity), the deafferented causal operator generates the subjective sense of the Great Cause along with the same limbic discharges which comprise the sense of "religious awe."

We must note here that the sense of the *Mysterium Tremendum* and the sense of numinosity can also occur spontaneously, without meditation, and even in persons with no history or knowledge of meditation. We would hypothesize that the immediate and proximate triggers are what we have presented in our model: deafferentation of the inferior temporal lobe in the case of numinosity; and deafferentation of the causal operator (part of the inferior parietal lobule) in the case of the *Mysterium Tremendum*. What stimuli (external or internal) short of meditative concentration can trigger such sudden deafferentation and limbic stimulation is a subject for future empirical investigation.

We suspect that *spontaneous* intense religious experiences and perhaps near death experiences not generated by intended meditative practices begin with unusually stimulated hypothalamic-limbic structures. Whether these unusual hypothalamic-limbic trigger states occur because of an accumulation of certain life experiences or from other causes is as yet completely unknown. We strongly suspect, however, that the same reverberating circuits discussed above are set off, but in this case spontaneously, from the bottom up, as it were, instead of from the top down, as with intended meditation.

This paper does not claim to present a comprehensive model for the great variety of religious experiences that are known to exist. But the principle of selective stimulation and deafferentation of various brain structures accompanied by various patterns and degrees of intensity of limbic stimulation may hold the key to explaining most, if not all, religious experiences, and possibly the secret to the nature of aesthetic experiences as well.

PROVING THIS MODEL

In presenting this theoretical model of the neuropsychological mechanisms underlying various mystical or religious states, we have attempted to integrate current data regarding our understanding of brain function during these and related states. However, this model expands upon many of these ideas in order to explain the phenomenology of these experiences. It is certainly likely that there are parts of this model which will be proved incorrect, but it is our hope that many of the basic aspects of the model are indeed correct. Further, the ability in itself to describe mystical states from a neuropsychological perspective, whether the model proves accurate or not in all aspects, is an important step in understanding how the human brain relates to religious experience.

Since it is rare that the actual mystical or religious experience would occur at a predictable enough time and place in order to study it, proving this model will be quite difficult. The only possible way would be to identify a person who is well-practiced in meditation and to study this subject in the process of meditating. Some studies have been done in this manner. However, we would suggest that the more recent development of technologies such as positron emission tomography (PET) and magnetic resonance imaging (MRI) might be very useful in following brain function or cerebral blood flow during various aspects of meditation. This might allow us to observe selective stimulation of individual brain areas, such as the prefrontal cortex, the hippocampus, the amygdala, and the hypothalamus, as the person procedes towards maximal stimulation of these structures and actual higher-level mystical experience. The use of PET and MRI, with more traditional measures of electroencephalography and measures of sympathetic and parasympathetic tone, might help complete our understanding of the neurological functioning that occurs during mystical or religious experiences.

FINAL CONSIDERATIONS

The reader should be cautioned against using this model in a way that is too reductionistic. Even if subsequent testing with PET scanning and similar procedures should prove the model correct, either in whole or in significant part, it still raises significant neuroepistemological problems. To maintain that the reality of a person's "objective" experience of God is reducible to neurochemical flux and nothing more may be equivalent to maintaining that the person's experience of the "objective" reality of the sun, the earth, and the air we breathe is reducible to neurochemical flux.

The model presented in this paper of certain "absolute" esoteric states compared with "baseline" reality brings up questions about the fundamental nature of subjectivity, of objectivity, and of consciousness itself. We are currently considering in a systematic fashion the neuroepistemological implications of models such as those presented in this paper when compared with the known neuropsychological substrate of baseline consciousness. Already it appears that when one considers all the relevant criteria for the "reality" of the object of various states of consciousness, ordinary baseline consciousness can claim no priority or superiority of "objective reality" over certain mystical states of consciousness (at any rate, over hyperlucid ones such as AUB, the intense forms of near-death experience, and other vivid and highly integrated and *integrating* visions.) Any attempt to trivialize their ontological status by naive reductionism might be a serious misinterpretation of the true nature of these mystical experiences. We are only now embarking upon a scientific investigation of some of the most powerful experiences humans can attain. Perhaps we need to maintain an attitude of humility, rather than an arrogant presumption that our knowledge of neurophysiology can give us an intrinsic knowledge of the relationship between "reality" and consciousness, whether in its baseline or more esoteric forms.

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