

# THE MYTH-RITUAL COMPLEX: A BIOGENETIC STRUCTURAL ANALYSIS

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*Abstract.* The structuring and transformation of myth is presented as a function of a number of brain "operators." Each operator is understood to represent specifically evolved neural tissue primarily of the neocortex of the brain. Mythmaking as well as other cognitive processes is seen as a behavior arising from the evolution and integration of certain parts of the brain. Human ceremonial ritual is likewise understood as the culmination of a long phylogenetic evolutionary process, and a neural model is presented to explain its properties. Finally, the mechanism by which ritual is used to resolve the antinomies of myth structure is explored.

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The thesis of this paper is that the generation of myth, its structure and transformations, as well as the resolution of the myth problem via ceremonial ritual are derived from the functioning of neural structures, which evolved and became progressively elaborated because of the adaptive advantage they conferred on their bearers. For our purposes we shall refer to such organization of neural tissue as neural operators. Each operator shall be considered as having a specific functional capacity accounting for one of the operations of the neocortex of the brain. Thus each structure or connected set of structures which forms a single operator will be viewed as an independent functional unit.

We shall proceed, first, by describing the probable neuroanatomical structures of the major cognitive operations involved in generating myth. Second, we will present a model which derives the nature and

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necessity of myth formation from certain of these operations as well as from the neurobiology underlying the transformations of the surface structure of myths. Third, we will present a model based on recent neurophysiological research that explains the resolution of mythic antinomies by the integration of ritual behavior into myths.

#### COGNITIVE STRUCTURES, OPERATORS, AND THEIR NEURAL SUBSTRATES

A cognitive structure may be defined as all the possible primary logical or affective relationships which obtain between elements comprising a single semantic domain. For example, the set of all cognitive elements which together comprise the semantic field of social organization and all their possible relationships comprise the "social organization" structure. Thus certain myth themes also would be a cognitive structure. By this definition, a structure is an abstract entity. Generally speaking, no individual possesses the total structure encoded within his central nervous system, usually because all the possible cognitive elements which theoretically comprise the semantic domain of the cognitive structure have not been "fed into the computer" so to speak. It certainly is true that any individual does not possess within consciousness the totality of the structure (even if the person perchance possesses *all the elements* of the set), simply because his or her conscious understanding of, for example, the myth of the solar hero necessarily relates the elements in a given way. This must exclude the other potential ways of relating the elements from stable or structural consciousness under normal conditions. It is important to realize, however, that any given individual can, under the proper circumstances, rearrange the elements of the structure bringing to consciousness alternate surface manifestations of the deep structure. This rearranging of elements of a semantic domain may or may not represent a stable configuration upon which behavior is based. It is only the *stable structural reorganizations* that we refer to when we speak of a transformation of cognitive structure. The relationship of structural reorganizations—transformations—to mythology will be discussed below.

The very existence of cognitive structures such as myth themes presupposes the ability of an organism to abstract dimensions of meaning from the universe, by which one can define the set of elements contained within a semantic field. Such abstraction is performed by what we have termed cognitive operators. To understand the generation of myth we must understand the function of cognitive operators.

When we use the term "cognitive operator," we are using the term "operator" analogously to the way it is used in mathematics. For example, a mathematical operator can be looked upon as the means by which

certain mathematical elements are made to relate to one another in specific ways. Similarly, a cognitive operator represents a neural structure which processes sensory input by relating various elements in ways specific to that operator. For the purposes of this discussion we will describe six operators in their simplest forms: (1) the *holistic operator* permits reality to be viewed as a whole or as a gestalt; (2) the *causal operator* permits reality to be viewed in terms of causal sequences of abstract elements; (3) the *abstractive operator* permits the formation of a general concept from the perception of empirical individuals; (4) the *binary operator* permits the extraction of meaning by ordering abstract elements into dyads involving varying degrees of polarity so that each pole of the dyad derives meaning from contrast with the other pole (this operator is particularly important in the generation of myth); (5) the *formal quantitative operator* permits the abstraction of quantity per se from the perception of empirical individuals, generating arithmetic and mathematics; and (6) the *value operator* permits an affective valence to be assigned to various elements of perception and cognition.<sup>1</sup>

We shall now present an anatomical model for each of these six operators, based on recent neurophysiological research. In terms of each model we shall attempt to localize these operators in terms of specific neuroanatomical structures. This permits a consideration of the morphological evolution of these structures in a phylogenetic perspective.

Recent experiments with animals, as well as observations of humans who have had their corpus callosum and anterior commissure sectioned to prevent the interhemispheric spread of epilepsy, have strongly supported the early clinical observations of neurologists that the parietal lobe on the *nondominant* side of the brain is intimately involved in the perception of spatial relations. Indeed most of the recent evidence indicates that this perception is of a holistic or gestalt nature. It is of more than passing interest that specific areas on the opposite or *dominant* side (specifically the angular gyrus) are related to the performance of mathematical operations. Other areas on this side are involved in the performance of certain basic logical-grammatical operations, particularly the perception of opposites and the ability to set one object over against another to emphasize its full semantic properties.<sup>2</sup> These and other basic logical-grammatical functions are related to areas of the parietal lobe adjacent to the angular gyrus and proximate to the anterior margin of the occipital lobe on the dominant side.<sup>3</sup> N. Geschwind has called this area the inferior parietal lobule. Lesions of this area in humans prevent the generation of antonyms as well as the use of the comparative degree of adjectives.<sup>4</sup> In short, such lesions prevent the formation of abstract dyadic oppositions or

polarities. This is a function basic to human cognition, one which we will consider below in relation to the generation of myths.

The inferior parietal lobule is comprised of the supramarginal and angular gyri as well as certain adjacent areas. It can best be visualized as the area of overlap between the somaesthetic, visual, and auditory association areas. As an association area of association areas, it allows for direct transfer across sensory modalities without involvement of the limbic or affective system. It is as if three computer systems, one for each of the three major sensory modalities mentioned, were hooked into each other and the information from each became available to all. Such a complex system allows classes of objects to be set up which are vastly more inclusive than any classificatory system possible within each individual sensory modality.

That this area of the brain may subserve conceptualization became powerfully supported by the evidence of Geschwind in his now classic monograph "Disconnection Syndromes in Animals and Man."<sup>5</sup> Soviet researchers refer to roughly the same area as simply the parieto-occipital area, and A. R. Luria also notes that it is intimately involved in the formation of basic logical-grammatical categories.<sup>6</sup> Luria and others have shown that destruction of parts of this area of the brain inhibits the use of the comparative degree of adjectives: a person is not able to be set off one object against another in one-to-one comparison. Therefore, such statements as "larger than," "smaller than," "better than," and so on, become impossible for patients with lesions in portions of this area. Furthermore, such patients are not able to name the opposite of any word which is presented to them. Although not conclusive, this kind of evidence indicates that the inferior parietal lobule on the dominant side not only may underlie conceptualization but may be responsible for the human proclivity for abstract antinomous or binary thinking, which underlies the basic structure of myth.

Such considerations lead us to postulate that the formal quantitative, binary, and abstractive operators can be localized to the dominant hemisphere, roughly in the area that Geschwind calls the inferior parietal lobule. If one wished to risk a greater specificity, one could ascribe the formal quantitative operation primarily to the angular gyrus, the binary operator to the supramarginal gyrus, and perhaps the abstractive operator to a region somewhat more occipital. However, we must bear in mind that these areas are intimately interconnected and might more profitably be viewed as a single region, as Geschwind proposes.<sup>7</sup>

The point is that it is probably no coincidence that those neural structures which appear to generate gestalt spatial perception on the nondominant side are homologous, in terms of the "geography" of

the brain, to those structures on the dominant side which underlie mathematical, logical, and grammatical relationships. It is certainly no news that mathematical operations appear to derive from the quantification of spatial properties. It is our contention that basic logical-grammatical operations are likewise so derived. If one considers the holistic perception of spatial relationships as the more primitively evolved or more basic function of the parietal lobe, one could easily postulate that this has been preserved or even elaborated in man on the nondominant side. Modification on the contralateral or dominant side has been in the opposite direction, that is, breaking down the spatial gestalt into various composite units and relationships.

This goes along with our contention that the evolution of humanity is most characteristically marked by the evolution of analytic cognitive processes; this permitted the evolution of abstract thought and problem solving, of which myth formation and resolution is a prime example. Such analytic processes most probably involved a modification and elaboration of the more basic gestalt operations in what we now call the nondominant side into the analytic functions which we associate with the dominant hemisphere of the brain. Such elaboration of function, and probably also of microstructure, is just that, namely, a modification of more primitive functions. The analytic functions of the dominant side do not arise *de novo* but are intimately related to the more primitive operations preserved on the nondominant side.

Thus one can postulate that the parieto-occipital area on the dominant side developed not so much to perceive spatial relationships in their total configuration but rather to perform the operation we now call the division of space into coordinate axes. G. Ratcliff has confirmed the findings of L. Franco and R. W. Sperry, G. Cohen and N. Butters et al. that the ability to rotate images (and axes) has evolved in humans as a function of the parietal and parieto-occipital regions on the nondominant side.<sup>8</sup> The ability to mentally rotate images and axes is the first step in the spatial breakdown necessary for quantitative analysis, which evolved in the homologous areas on the dominant side. Furthermore, the elaboration of function on the dominant side generates the capability of defining axes in terms of the polar termini of each axis. In this second operation one can perceive the basis of conceptual dyadic opposition beginning to derive from the evolution of an analytic perception of space.

We have proposed the loci of the analytic operations (i.e., binary, abstractive, and formal quantitative operators) to reside in various areas of the parietal lobe on the dominant side. Similar evidence leads us to localize the synthetic or holistic operator in the parietal region of the nondominant side.<sup>9</sup> As noted earlier, this operator permits the percep-

tion of reality as a whole or single perceived unity. As we shall see later, the function of the parietal lobe on the nondominant side (i.e., the holistic operator) becomes crucially important as a means of resolving the antinomies of myth, and the most important mechanism activating the holistic operator is ceremonial ritual.

There is considerable neurophysiological evidence that the ordering of events in time or more properly into a temporal sequence (since time may have no ontological reality outside the neural events which constitute the perception of it) is a result of the reciprocal interrelationship between the anterior convexity of the frontal lobe on the dominant side and the inferior parietal lobule via evolved fiber tracts.<sup>10</sup> It has long been known that the anterior portions of the frontal lobes, particularly on the dominant side, are involved in ordering not only sequential movement but also perceptual and cognitive elements in both space and time. We have attempted to show elsewhere that this basic temporal ordering of conceptual material underlies the faculty of abstract causal thinking.<sup>11</sup> This view is consistent with clinical data which confirm that lesions of the anterior convexity of the frontal lobe and/or its connection with the inferior parietal lobule interfere drastically with causal thinking. The implications of W. Grey Walter's work on the relationship of the contingent negative variation (CNV) to anticipated causal behavior involving abstract causal sequencing tends to confirm the importance of the frontal lobes in the process of abstract causal thinking.<sup>12</sup> Furthermore, the research of M. N. Livanov, N. A. Gavrilova, and A. S. Aslanov indicates a correlation of biopotentials of the frontal cortex with mental activity involving causal sequencing.<sup>13</sup> This further supports the position that the areas of the frontal lobes, particularly the anterior frontal convexity, are intimately related to processing information in terms of what we have called abstract causality. Thus, we would locate the causal operator in the interrelationship of the anterior convexity of the frontal lobe on the dominant side and the inferior parietal lobule.

The value operator resides in the interconnections of the neocortex with the limbic system. Considerable evidence beginning with J. W. Papez implicates the limbic system as the modulator of emotions.<sup>14</sup> The connections between the neocortex and the limbic system for visual and tactile learning have been demonstrated by M. Mishkin, J. Sunshine and M. Mishkin, and B. Jones and M. Mishkin.<sup>15</sup> Thus, for example, for visual learning they have demonstrated a sequential hierarchy of structures involving the striate, prestriate, inferior temporal, and ventromedial frontotemporal regions. These areas act as links mediating the neocortical-limbic pathway for visual-affective associations. These and similar neocortical-limbic connections for other sensory modalities

ties, we have collectively called the value operator. The value operator attaches an affective valence to various cognitions and perceptions thereby powerfully enriching them.

It appears that, phylogenetically, with the evolution of the inferior parietal lobule, the anterior convexity of the frontal lobes, and their reciprocal interconnections humans began to develop as "culture bearers" and "myth makers." It is interesting that ontogenetically these areas of the brain are the last to myelinate, and their myelination corresponds with the development of J. Piaget's formal operations and the perfection of linguistic ability. We are not claiming these areas are the sole explanations for spoken language. Other areas of the brain needed to evolve as well in order for spoken language to develop. But these areas (anterior convexity of the frontal lobe, the inferior parietal lobule and their interconnections) appear to be involved in the critical elements of myth structuring, that is, in conceptualization, abstract causal thinking, and abstract antinomous thinking.

#### COGNITIVE STRUCTURES

At this point one can see that cognitive operators—or, if one wishes to be more precise, the neural structures which operate on quanta of experience to organize them in specific ways—produce what we have called cognitive structures such as myth themes. Cognitive structures are simply the subjective manifestation of ways in which reality is organized by the operators. In other words, depending on which operator is functioning, the world is perceived in terms of synthetic unity, abstract causal relationships, relationships of binary opposition, and so on.

We must emphasize that in ordinary day-to-day cognitive functioning all these operators function in concert, each relating its function to that of the others in order to abstract maximal meaning from experience. In other words, the brain operates as a functional unit. The predominant function of any single operator to the exclusion of the others is a rare event, although as we shall see it is not altogether impossible.

These operators allow us to propose that the most sophisticated mathematical, logical, or grammatical operation can ultimately be reduced to the simplest spatial and spatio-temporal analysis, which itself can be understood as an evolutionary elaboration of the more gestalt operation of the nondominant hemisphere of the brain.

Consequently we would argue that the apparent multiplicity of relationships between elements of a cognitive structure such as a myth theme can be reduced to a relatively small list of ultimately basic analytic relationships including (1) inside-outside, (2) above-below,

(3) left-right, (4) in front-behind, (5) all-nothing, (6) before-after, and (7) simultaneous-sequential. These relatively few basic spatio-temporal relationships can be enriched by combining them with affective or emotional valence. Thus, "within" is usually identified with good and "without" with bad, "above" with good and "below" with bad, "right" with good and "left" with bad, "in front" with good and "behind" with bad, "all" with good and "nothing" with bad, and so on. These affective valences are *not* absolute and the reverse of any of them may occur. It is interesting however to note how frequently the relationships just mentioned do in fact culturally receive the affective valence stated. We feel there is a reason for this association which involves issues of simple preservation. For example, "above" is usually safer than "below" and is therefore good; "within" is usually safer than "without" and is therefore good. Nevertheless we must reiterate that these associations are not absolute and the reverse associations can theoretically occur and occasionally, in fact, do occur.

Instead of embarking on the impossible task of listing all the possible complex relationships that can exist between elements of a cognitive structure, we have chosen rather to attempt to reduce them to a handful of simple spatio-temporal relationships. We feel it can be practically demonstrated that all complex relationships (whether they be mathematical, local, or grammatical) can be reduced to either one or a combination of the basic spatio-temporal relationships we have just considered. This is true with respect to all relationships with the single exception of the category to which we have already briefly alluded, namely, affective or emotional relationships. These latter represent feeling states and are of crucial importance since they, in one way or another, enter into moral and value judgments and underlie the emotional impact of myths. On the most primitive level they can be resolved into whether a stimulus is positive or aversive for an organism. Simply put, that which provides either immediate or delayed gratification is good; that which the organism experiences as unpleasurable or not conducive to survival is bad. As with the spatio-temporal relationships the basic affective relationships can be elaborated into a number of subtle feeling states and can be related to perception and cognition in various ways. The neurophysiological substrate for such affective-cognitive-perceptual linkages is the numerous connections alluded to above which exist between various limbic structures and either the secondary sensory association areas (in the case of perceptions) or the inferior parietal lobule (in the case of cognitions).

Thus far we have attempted to delineate the basic classes of relationships—spatial, temporal, and affective—which obtain between elements of a cognitive structure such as a myth theme. We have



presented theoretical neurophysiological models for the evolution of such relationships. All this brings us to the problem of transformation of cognitive structures. As we have noted above, the transformation of cognitive structures presents the rearrangement of the relationships of cognitive elements and underlies the various mutations of the surface forms of myths.

#### THE NEUROBIOLOGY OF TRANSFORMATIONS

The issue of the biological base of transformations within a structural system is one which has received little or no attention by structuralists whether they be anthropologists (e.g., C. Lévi-Strauss), linguists (e.g., N. Chomsky), or developmental psychologists (e.g., Piaget). Before we consider the problem however, we must attempt to unravel some of the confusion concerning the concept of transformation itself. This confusion arises from the concept's being used in the contexts of various systems, all which purport to be structuralist in a general sense. Thus, for biologists who deal generally with "open structures," the concept of transformation often means replacing one set of elements (A) with another set of elements (B), with a one-to-one correspondence obtaining between a given element in set A and a given element in set B. Thus they will often speak of subjective perceptions as transformations of incoming sensory stimuli. In a theoretical vein psychoanalysts use the same meaning of transformation in the replacement of elements of cognition and affect with a totally different set of elements resulting in the symbology of dreams and fantasy material. This is not the sense in which we are considering transformation here.

A second meaning of transformation is best exemplified by the sense given to the word by Lévi-Strauss.<sup>16</sup> The elements of a structure are invariant. The meaning of transformation is associated only with the rules for their recombination. Structures understood in this sense are closed systems; the meaning of transformation here is the polar opposite of the sense just given for open systems. This sense of the word "transformation" is more in keeping with what we are attempting to understand in this paper, but we would dispute the Lévi-Straussian position that such transformations occur within completely closed structures.

A third, more comprehensive meaning of transformation is the one most often suggested by developmental psychologists. In this sense more complex cognitive structures such as myth themes (in which are embedded potential models of the world) evolve from simpler structures. More specifically, developmental psychology is viewed as the progressive elaboration of a series of nesting structures of increasing complexity. The relationship of the more complex to the less complex

structures involves rules of transformation which include: (1) possible alteration or substitution of one element for another as in the case of the fully open structures; (2) addition of new elements of content which were not previously present in the simpler structures; and (3) specific rules of reorganization of all the elements of content such as is conveyed in the Lévi-Straussian understanding of transformation.

Such a complex system of transformation allows for the classical Piagetian model of nesting structures, which often has been described as the form of the simpler structure becoming the content of the more complex. Recent evidence suggests that the human capacity to organize data in terms of nesting or hierarchical structures may involve the inferior frontal convolution known as Broca's area.<sup>17</sup> It has been known for some time that the syntactic structure of language is organized by this area of the brain, and it has been presumed that the nesting structures which generate language in Chomsky's model likewise reside in this area. What is exciting about this new evidence is that it seems to indicate the inferior frontal convolution on the dominant side may be generally responsible for any organization of thought into hierarchical structures (not just for linguistic organization). Such a structural system may be called a "semiclosed" system. We choose to call such structures *semiclosed* because we feel this term emphasizes the fact that they are highly stable neural and cognitive systems, not easily changed, but not absolutely and permanently fixed in either an ontogenetic or a phylogenetic sense, as the Lévi-Straussian model would seem to imply.

The major question with which we are concerned here is, given the principal cognitive elements contained within a semantic field (structure of a myth in this case) and given a number of possible relationships between each dyad of the cognitive elements (the possible relationships being generated by the neural structures which we have discussed above), why is it that any given set of relationships in fact obtains and under what circumstances will these relationships change? This last question can be reformulated: under what circumstances does the surface manifestation of a structure (myth) undergo a transformation?

Considering the work of Lévi-Strauss and his followers, as well as the findings of a number of cognitive psychologists, it seems not only that structures such as myths are composed of relationships between dyads of cognitive elements, such relationships setting one element off against another for semantic clarity, but furthermore that the relationships *themselves* can be grouped into dyads involving the opposing of spatial, temporal, or affective relationships we have considered above, such as up-down, left-right, before-after, or good-bad.<sup>18</sup> Thus, every pair of relationships involves three or four cognitive elements: four cognitive elements if each pole of the two relationships is separate, or

three elements if one cognitive element is common to two polar dyads. One of the few ways in which the work of cognitive psychologists and of anthropologists such as Lévi-Strauss can be made to make sense is if we postulate that it is inherent within the machinery of the brain to relate the cognitive elements of a structure (again in this case a myth) in such a way that for every pair related by one aspect of a relationship such as "up" *at least* one other pair must be related by the opposite relationship such as "down."<sup>19</sup> Furthermore, one must postulate that these relations obtain in such a way that, if the elements related by "up" are changed so that they are now related by "down," then at least some of the elements formerly related by "down" must now become related by "up"—unless, of course, the reciprocal change would result in nonsense. If one does not postulate some such system of reciprocal change attendant upon transformation, one simply cannot explain, for example, the almost algebraic neatness of Lévi-Strauss's famous solution of the problem of affective valence between son-father and sister's son-mother's brother.<sup>20</sup>

Note that, according to the postulate of reciprocal change, such change is operative only when it involves a new surface structure that has meaning. Certain combinations can obviously involve nonsense. It would appear at this point that we are invoking the subjective entity of meaning to be the constraint within which basic neurophysiological processes operate. If this were true, then the phenomenon would be dependent upon the epiphenomenon, and we would be reduced to absolute idealism. On the contrary, we affirm the physicalistic perspective that those constellations of relationships between cognitive elements of a structure which we consider meaningful possess the quality of "meaningfulness" simply because they are the subjective manifestations of inherently stable relationships within the neural microstructure. The locus of such relationships probably resides in various configurations of postsynaptic slow wave potentials. The very stability of the overall constellation of relationships and of the neural events which generate them is precisely what we mean when we state that a given surface manifestation of structure is meaningful. Meaningfulness, therefore, derives from the stability of neural connections. This stability, in turn, derives from the selection of certain combinations of neural configurations as being adaptive and thus conducive to survival. It is only in this sense of the word meaning that we will say that meaning imposes constraints upon the postulate of reciprocal change during a transformation. Thus any given cognitive (and by extension social) structure is limited in the number of its possible transformations not by the theoretical total of all the permutations generated by the postulate of reciprocal change but rather to a number which represents a subset of that total set, that is, those possible transformations which also are

meaningful subjectively or, in other words, those which have adaptive properties and represent a high degree of isomorphism with the external world.

The answer to why any given constellation (surface structure) of relationships among elements of a semantic field (myth) is present and stable at all at a given time is simply because it is adaptive psychophysiologicaly for an individual or socio-ecologically for a group. It is the environment, therefore, which ultimately imposes the constraints that define exactly which surface manifestation of a deep structure will obtain, either cognitively or socially, at any given time. It is change in the environment, ultimately, which causes a disconfirmation of a given surface structure as representing the external world and which permits a change in one or more relationships between cognitive elements. Once one change takes place the entire system becomes rearranged according to the postulate of reciprocal change; a number of possible configurations are generated until one which is more adaptive to the circumstances becomes fixed (either for the individual or for the group). It seems to us that when Anthony Wallace speaks of maze-way resynthesis what he is essentially talking about is the rearrangement of relationships between multiple dyads (usually under the influence of intense limbic arousal) of a superordinate structure involving the relationship of the individual to the universe as a whole.<sup>21</sup> Thus, maze-way resynthesis can be seen as a transformation of the most encompassing superordinate cognitive structure under conditions of intense stress. It is a testimony to the stability of cognitive structures that only the most severe stresses, the most intense states of limbic arousal, are able to facilitate the transformation of important superordinate structures.

We must deny the charge that has often been made that biogenetic structuralism tends to ignore the influence of the environment. As we have seen it is the environment and only the environment which is responsible for both the content of cognitive elements which comprise structures such as myth and for the fixing of a given constellation of relationships between cognitive elements at any point in time. Furthermore, it is the environment which ultimately governs the time when either an individual cognitive structure or a social structure (which can be seen as the social projection of a cognitive structure) will undergo transformation.

#### RESOLUTION OF THE MYTH PROBLEM COGNITIVELY AND RITUALLY

For the purpose of this discussion we shall consider a myth as performing two distinct but related functions. First, a myth presents a problem of ultimate concern to a society. This problem is always presented in antinomous form in the surface structure, that is, in terms of jux-

taposed opposites such as life-death, good-evil, and heaven-hell.<sup>22</sup> Second, once the existential problem is presented in the myth, it is solved by some resolution or unification of the seemingly irreconcilable opposites which constitute the problem. As we shall see, the most meaningful resolution of the problem presented in the surface structure of a myth is usually achieved by expressing the myth in the form of ceremonial ritual.

The ability to structure a mythic problem and its resolution involves the operators we have discussed, especially the abstractive, causal, binary, and holistic operators. In other words, myths, first, are couched in terms of named categories of objects which we call concepts or ideas and which serve as the elements of the surface structure. Second, myths, like all other rational thoughts, involve causal sequences. Third, myths involve the orientation of the universe into multiple dyads of polar opposites. Fourth, the resolution of the problem presented by these antinomies is accomplished most effectively by ritual.

As I have proposed in previous papers, human beings have no choice but to construct myths to explain their world.<sup>23</sup> 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. This is inherent in the obligatory functioning the neural structures or operators we have considered above. Since it is highly unlikely that human beings will ever know the first cause of every strip of reality observed, it is highly probable that we will always generate gods, powers, principles, or other entities as first causes to explain what we observe. Indeed we cannot do otherwise. Myth problems therefore are structured either socially or individually, primarily according to the analytic and verbal mode of consciousness of the dominant hemisphere. Myth problems involve the codification of unexplained reality in terms of antinomies or polar oppositions such as good-evil, change-permanence, and so on, and in terms of causal explanatory sequences.

Thus far we have only presented a neural model explaining the mechanism and necessity for structuring input from the external world into causal sequences and mythic antinomies, that is, into dyadic structures of ultimate existential concern to humanity. The second aspect of myth is to resolve these antinomies and hence to solve the problem. Such solutions are exemplified by the cognitive resolution of the god-man antinomy by a solar hero, a Christ figure, or a divine king. These resolutions are effected by a subtle shift in cognitive dominance from the major hemisphere to the minor hemisphere of the brain. The

cognitive functions we have been considering up to now (conceptualization, abstract, causal thinking, and antinomous thought) represent the evolution of major hemisphere function. As we have noted in previous sections, the minor hemisphere is related to gestalt perceptions, that is, to the perception of incoming sensory input as a whole rather than as a string of associated elements. We propose that the cognitive assimilation of logically irreconcilable polar opposites presented in the myth structure—such as god and man in a solar hero or a Christ figure—represents a shift of predominating influence from the major hemisphere to a predominant influence of the minor hemisphere, which allows the antinomies to be perceived as a cognitive unity. Thus, for example, the concepts of a Christ figure or a solar hero represent cognitive solutions within the myth to the problem presented by the basically antinomous myth structure. Although this is undoubtedly so, we feel that classical structuralists have tended to overemphasize the resolution in terms of the internal dialectic of structures. We contend that the only resolutions which are psychologically powerful to both individuals and groups are those which have an aspect of existential reality. We will attempt to show in what follows that such a powerfully affective resolution arises primarily from ritual and rarely from a cognitive fusion of antinomies alone, although such a cognitive fusion may be a necessary precursor in human religious ritual.

Religious ritual aims at existentially uniting opposites in an effort to gain control over an essentially unpredictable universe. The ultimate union of opposites is that of contingent and vulnerable humanity with a powerful, possibly omnipotent, force. In other words, we propose that humanity and superhuman power are the ultimate poles of much mythic structure, and that this polarity is the basic problem ritual must resolve existentially. Side by side with this basic antinomy are usually other correlative antinomies which frequently must be resolved according to the specific myth before the basic god-man antinomy can be resolved. Such polar opposites include heaven-hell, sky-earth, good-bad, left-right, strong-weak, as well as an almost endless series of other polarities recurring in human myths. Before we consider what it is about ritual that allows such a powerfully affective union of mythic poles, let us first consider why it is that human beings tend to act out their myths at all.

There is some evidence that whatever is present in one neural system tends to be present in other neural systems, even if its manifestation in other systems is inhibited. For our purposes here we shall consider five major neural systems: visual, auditory, tactile, conceptual-cognitive, and motor. Thus, for example, it has been known for some time that whatever is heard tends to be repeated. In normally functioning indi-

viduals the actual physical repetition of whatever is heard is inhibited by mechanisms within the frontal lobe leaving only an internal repetition within our heads. When the frontal inhibitory mechanisms are released in certain pathological states, the phenomenon of echolalia occurs in which individual obligatorily repeat whatever they hear. Likewise there is an inbuilt tendency to have a representation in the motor system of whatever movement appears in the visual system. As one might suspect such imitation is ordinarily inhibited in fact, except in a few pathological conditions in which the patient exhibits echopraxia. Such individuals necessarily perform any action they see. In a recent article in *Science* T. M. Field et al. demonstrated this visual-motor connection in the imitation by neonates of facial expressions presented to them.<sup>24</sup> The auditory motor connection is seen in the rare condition of *latah* in which the patients obligatorily obey whatever they hear.

For the purposes of this paper we are interested in the cognitive-verbal-motor connection. The motor manifestation of cognitive-verbal expression is ordinarily inhibited. However it tends to break through in normal individuals when we "talk with our hands." I propose there is a powerful inbuilt mechanism encouraging us to act out our thoughts. This proclivity is especially powerful when our thoughts and words form a learned, closed cognitive system as in the recitation of a myth. Because of the reciprocal representation of the content of the major neural systems, human beings are naturally disposed to act out their myths, but not by using ordinary motor behavior. They usually choose some form of rhythmic motor behavior. This propensity to enact a myth in rhythmic motor form is responsible for the myth-ritual complex. Humans reach far into their evolutionary past and graft an ancient motor behavior onto the product of their neocortexes, that is, myth. Why should we do so? The answer lies in the consideration of the nature of ritual behavior itself.

At this point one must ask what is meant by ritual behavior. We define ritual behavior as a sequence of behavior which (1) is structured or patterned; (2) is rhythmic and repetitive (to some degree at least), that is, tends to recur in the same or nearly the same form with some regularity; (3) acts to synchronize affective, perceptual-cognitive, and motor processes within the central nervous system of individual participants; and (4), most particularly, synchronizes these processes among the various individual participants. G. H. Manley has considered in some detail this synchronizing function of ritual in the black-headed gull.<sup>25</sup> From the work of M. W. Schein and E. B. Hale with the domestic turkey, N. Tinbergen with three-spined sticklebacks and queen butterflies, and J. S. Rosenblatt with cats—it appears there is something

about the repetitive or rhythmic emanation of signals from a conspecific which generates a high degree of arousal of the limbic system of the brain.<sup>26</sup> With respect to this rhythmic quality of ritual, K. Lorenz notes: "The display of animals during threat and courtship furnishes an abundance of examples, and so does the culturally developed ceremonial of man. The deans of the university walked into the hall with a 'measured step'; pitch, rhythm and loudness of the Catholic priests chanting during mass are all strictly regulated by liturgic prescription. The unambiguity of the communication is also increased by its frequent repetition. Rhythmical repetition of the same movement is so characteristic of very many rituals, both instinctive and cultural, that it is hardly necessary to describe examples."<sup>27</sup>

V. J. Walter and W. G. Walter as well as E. Gellhorn and W. F. Kiely have shown that such repetitive auditory and visual stimuli can drive cortical rhythms and eventually produce an intensely pleasurable, ineffable experience in humans.<sup>28</sup> Furthermore, Gellhorn and Kiely cite evidence that such repetitive stimuli can bring about simultaneous intense discharges from both the human sympathetic and parasympathetic nervous systems.<sup>29</sup> When one considers the evidence taken from the literature on animal studies together with the limited studies that have been done on humans, one can infer that there is something about repetitive rhythmic stimuli which may, under proper conditions, bring about the unusual neural state of simultaneous high discharge of both autonomic subsystems. In reaching this state three stages of tuning of the sympathetic-parasympathetic subsystems are recognized. In the first stage, reactivity in one system increases while at the same time it decreases in the other system. If augmented reactivity of the sensitized system continues, the second stage of tuning is reached after stimuli exceed a certain threshold; at this point not only is inhibition of the nonsensitized system complete, but also stimuli which usually elicit a response in the nonsensitized system instead evoke a response in the sensitized system. Behaviors resulting from this second stage of tuning are termed reversal phenomena. If stimulation continues beyond this stage, increased sensitization can lead to a third stage in which the reciprocal relationship fails and simultaneous discharges in both systems result.

Normally, either the sympathetic or the parasympathetic system predominates, and the excitation of one subsystem normally inhibits the other. In the special case of prolonged rhythmic stimuli, it appears that the simultaneous strong discharge of both autonomic systems creates a state of stimulation of the median forebrain bundle generating not only a pleasurable sensation but, under proper conditions, a sense of union with conspecifics and a blurring of cognitive bound-



aries. We suggest that such driving of the autonomic subsystems by rhythmic stimuli powerfully activates the holistic operator allowing various degrees of gestalt perception. The simplest paradigm to explain the situation in humans is the feeling of union that occurs during orgasm. During orgasm, as during other states we shall consider later, there is intense simultaneous discharge from both the autonomic subsystems.

Hence, we are postulating that the various ecstasy states, which can be produced in humans after exposure to rhythmic auditory, visual, or tactile stimuli, produce a feeling of union with other members participating in that ritual. In fact, the oneness of all participants is the theme running through the myth of most human rituals. It is probably the sense of oneness and the vagueness of boundaries which are experienced at certain nodal points in ritual which allow the symbol to be experienced as that for which it stands itself. The fusion of symbols and their referents at various points in human religious ritual is undoubtedly accomplished by the general feeling of oneness or unity which obtains when a ritual triggers the holistic operator. Although it is very difficult to extrapolate from humans to animals, it is probable that some sort of analogous affective state is produced by rhythmic, repeated ritual behavior in other species. This state may vary in intensity, but it always has the effect at least of unifying the social group.

Put simply, there is increasing evidence that rhythmic or repetitive behavior synchronizes the limbic discharges (i.e., the affective states) of a group of conspecifics. It can generate a level of arousal which is both pleasurable and reasonably uniform among the individuals so that necessary group action is facilitated. We must note at this point that we have said nothing about the communication aspect of this rhythmic signaling. There is a great body of evidence that many of these rhythmic stimuli serve as communications, and the position of most ethologists is that rhythmicity evolved in lower animal species in the service of communication. However, many ethologists maintain that the rhythmicity evolved an autonomous effect of its own separate from its signaling function. Thus, Lorenz states: "Both instinctive and cultural rituals become independent motivations of behavior by creating new ends or goals towards which the organisms strive for their own sake. It is in their character of independent motivating factors that rituals transcend their original function of communication and become able to perform their equally important secondary tasks of controlling aggression and of forming a bond between certain individuals."<sup>30</sup>

Let us see how the recent discoveries of differential hemispheric functioning, discussed earlier in this paper, fit into this line of thinking. Permit me to recapitulate in two or three sentences the recent dis-

coveries concerning the functions of the nondominant hemisphere. What is new is the discovery that the so-called nondominant or minor hemisphere has extremely important nonverbal, nonanalytic functions. First, it is related to the perception of visual-spatial relationships. Over and above this, there is good evidence that it perceives the world not in terms of discrete entities but in terms of gestalts, or nondiscrete, holistic perceptions. The perception of wholeness or unity which this hemisphere controls is extremely important to this discussion as we have seen. Furthermore, there is evidence that the minor hemisphere may be chiefly responsible for creative or artistic ability.

J. Levy and C. Trevarthen are obtaining evidence that in the normally functioning individual both hemispheres operate in solving problems via a mechanism of reciprocal inhibition controlled at the brainstem level.<sup>31</sup> Put simply, the world is approached by a rapid alternation pattern of functioning of each hemisphere. In other words, one hemisphere is flashed on and then turned off, the second flashed on and then turned off, the first flashed on again, and so on, in rapid alternation. The rhythm of this process, and whether one side or the other tends to predominate in this process, may account for various cognitive styles—from the extremely analytic and scientific to the extremely artistic and synthetic. There is some evidence reviewed by B. Lex that this duality of cerebral functioning may parallel the duality of autonomic functioning which we have just considered.<sup>32</sup>

Actually, it is easier conceptually to integrate the two modes of consciousness into a more general duality of patterning within the central nervous system. Lex does this by utilizing Hess's model of an energy-expending or ergotropic system and an energy-conserving or trophotropic system operating in a complementary fashion within the human organism. In this model, the ergotropic system consists of not only the sympathetic nervous system, which governs arousal states and fight or flight responses, but also any energy-expanding process within the central nervous system. Conversely, the trophotropic system includes not only the parasympathetic peripheral nervous system, which governs basic vegetative and homeostatic functions, but also any central nervous system process which maintains the baseline stability of the organism. Thus, the ergotropic-trophotropic model represents an extension to the central nervous system of sympathetic-parasympathetic peripheral nervous functioning. Further extending this model, we can identify the minor or nondominant hemisphere with the trophotropic or baseline energy state system and the dominant or major hemisphere, which governs analytical verbal and causal thinking, with the ergotropic or energy-expending system.

Alteration in the tuning of these systems from the peripheral autonomic level to the cerebral level has been offered as an explanation

for various altered states of consciousness by a number of investigators, including E. Gellhorn, Gellhorn and W. F. Kiely, and R. E. Ornstein.<sup>33</sup> These investigators present evidence that at maximal stimulation of either the trophotropic or ergotropic system there is, as it were, a spillover into the opposite, complementary system. It has been postulated that the rhythmic activity of ritual behavior supersaturates the ergotropic or energy-expending system to the point that not only is the trophotropic system simultaneously excited by a kind of spillover but, on rare occasions, may achieve nearly maximal stimulation of the trophotropic system as well so that, briefly at least, both systems are intensely stimulated. The positive, ineffable affect which this state produces was alluded to above.

In humans we propose that, concomitant with the simultaneous stimulation of the lower aspects of both systems, their cerebral representations, that is, both hemispheres of the brain, also may function simultaneously. Cognitively, this is manifested by the presentation of polar opposites by the analytic hemisphere (i.e., the presentation of a problem to be solved in terms of the myth structure) and the simultaneous experience of their union via the excitation or stimulation of the minor hemisphere, specifically the holistic operator. This could explain the often reported experience of the resolution of unexplainable paradoxes by individuals during certain meditation states on one hand or during states induced by ritual behavior on the other. In one of the few experiments carried out in any kind of controlled manner on the experiences of meditation, A. J. Deikman notes that one of the phenomena common to all subjects is what appears to be simultaneity of conflicting perceptions during relatively advanced meditation states:

The subjects' reports indicated that they experienced conflicting perception. For example, in the third session, subject B stated, about the vase, "it certainly filled my visual field" but a few minutes later stated "it didn't fill the field by any means." In the seventh session referring to the landscape he commented, "... a great deal of agitation . . . but it isn't agitating . . . it's . . . pleasurable." In general, subjects found it very difficult to describe their feelings and perceptions during the meditation periods—"it's very hard to put into words," was a frequent comment. This difficulty seemed due in part of the difficulty in describing their experience without contradictions.<sup>34</sup>

It appears that during certain meditation states and ritual states, logical paradoxes or the awareness of polar opposites as presented in a myth appear simultaneously both as antinomies and as unified wholes. This experience is coupled with the intensely affective, oceanic experience which has been described during various meditation states as well as at certain modal points of ritual. During intense meditative experiences, such as yogic ecstasy and the *unio mystica* of the Christian tradi-

tion, the experience of the union of opposites, or *conjunctio oppositorum*, is expanded to the experience of the total union of self and other, or, as it is expressed in the Christian tradition, the union of the self with God.

Ritual is always performed to solve a problem presented by and to the verbal analytic consciousness. The problem may be between good and evil, life and death, or the disparity between God and man. The problem may be as simple as the disparity between man and a capricious rain god or as subtle as the disparity between man's existential contingent state and the state of an all-knowing, all-powerful, unchangeable ground of being. In any case, the problem is presented in the analytic mode which involves ergotropic excitation. Like all other animals, humans attempt to cope with the environmental situation via motor behavior. The motor behavior we choose goes back far into our phylogenetic past. It is usually a repetitive motor activity with visual, auditory, or other sensory stimulus feedback; as we have just seen this strongly drives the ergotropic system. Even the cadence and chanting of words contributes to this repetitive quality. The slow rhythmicity of a religious procession or the fast beat of drums or rattles all serve to drive the ergotropic system.

With prayers and chanting, this system is often driven in two ways. The myth may be presented within the ritual prayer, thus exciting by its meaning the cognitive ergotropic functions of the dominant hemisphere. The rhythmicity of the prayer or chant, by its very rhythmicity, drives the ergotropic system independent of the meaning of words. If the ritual works, the ergotropic system becomes, as it were, supersaturated and spills over into excitation of the trophotropic system, resulting in the same end state as meditation but from the opposite neural starting point. In any case the holistic operator is activated.

This unusual physiological state, produced by both approaches (meditation and ritual), produces other aesthetic-cognitive effects besides a sense of union of opposites. Numerous reports from many religious traditions point to the fact that such states yield a feeling not only of union with a greater force or power but an intense awareness that death is not to be feared, accompanied by a sense of harmony of the individual with the universe. This sense of harmony with the universe may be the human cognitive extrapolation from the more primitive sense of union with other conspecifics, which ritual behavior also excites in prehuman animals.

Thus we see that the phylogenetic origins of ritual carry through in an unbroken line to the most complex human religious rituals. However, onto these primitive functions is grafted other adaptive functions, namely, those of higher cognition. Humans are not simply the sum of neural mechanisms, independently evolved under various selective

pressures. Rather, each of us functions as an integrated whole. Although our higher cognition may have evolved as a very practical, adaptive, problem-solving process, it carried with it—indeed it requires—the formation of myths that present problems for which the ancient rhythmic motor behaviors help generate solutions. In other words, when ritual works (and it by no means works all the time), it powerfully relieves our existential anxiety, and, when it is most powerful, it relieves us of the fear of death and places us in harmony with the universe. It allows individual humans to become incorporated in myth, and conversely allows for the very incarnation of myth. Is it no wonder then that any behavior so powerful has persisted throughout the ages? Indeed, ritual is likely to persist for some time to come.

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