

**GLOBAL NEURAL GROUND STATE:
COHERENT BRAIN MECHANISMS ASSOCIATED
WITH TRANSCENDENTAL CONSCIOUSNESS**

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Abstract

This paper seeks to provide a framework for discussing and understanding the brain state and attentional mechanisms that underlie the subjective experience and objective measurements of subjects practicing the Transcendental Meditation® (TM®) technique. During the TM technique, the mind effortlessly attends to a specific object and automatically transcends the normal boundaries of conscious perception: experiencing a shift from active, waking consciousness to one without boundaries, a state of pure consciousness. Past research suggests that the TM technique produces a unique state of profound rest and relaxation in subjects. Objectively, measurements of blood chemistry, skin galvanic response, and EEG recordings while subjects are practicing the technique indicate profound changes occur in the physiology. Subjectively, subjects report the experience of awareness alone without an object of perception.

This experience has been described as the fourth major state of consciousness, “restful alertness”.. The Vedas, more than 5000 years old, are the classic texts describing this fundamental human experience. The Vedas call this experience of awareness without an object of perception *pure awareness*. *According to the Vedas this state of restful alertness or transcendental consciousness is considered to be the fundamental mode or ground state of human consciousness* Thought processes represent fluctuations of this underlying, abstract, pure field of intelligence, similar to the way unified field theories describe matter emerging as fluctuations in the unified field of natural law.

Research on the TM technique has documented changes in electroencephalographic, respiratory, cardiovascular and other physiological parameters indicative of a unique de-excited state of the nervous system. During the process of transcending, sustained periods of marked coherence in brain activity and spontaneous respiratory suspension are closely correlated with subjective reports of awareness without thought. **A model is proposed to explain the process of transcending that is based upon cognitive and neural mechanisms similar to the well-known orienting reflex (OR).**

In this model, the state of restful alertness is produced by a coordinated response of orienting and habituating processes. The prefrontal cortex (PFCX) and the basal forebrain (BF) interact to produce a sequence of progressive de-excitations of neuronal activity. The brainstem (BS) core, in particular the mesencephalic reticular formation and the locus coeruleus, are involved in maintaining awareness by producing ORs to the object of perception (stimulus) used in meditation at each stage in the sequence of de-excitation and generating global neural coherence. The regulation of attentional processes during transcending is via an integrated hierarchy of control converging on the thalamocortical system. An important aspect of the orienting mechanisms in the model are neural reference systems, coordinated by a hippocampal-based comparator, that evaluates the changing configuration of both stimulus and brain state. **The coherent integration of cortical-thalamic processing loops would lead to a global state of neural integration corresponding to a transcendental state of awareness.**

Consistent with OR theories, the process of transcending would markedly enhance the signal-to-noise ratio of the neural system and facilitate the conscious analysis and perception of

modes of cognitive activity not ordinarily available to conscious awareness leading to marked psychological and physiological benefits. This model of transcending is supported by a large body of cognitive neuroscience research on brain state and attentional mechanisms.

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6. Summary and Conclusions

I. Introduction

The primary goal of neuroscience is to describe the dynamic structure of the brain and consciousness. In the pursuit of ordering principles underlying the complex dynamic neural and cognitive systems, a number of fundamental concepts have been successfully developed from neuroscience research. One important concept is that the dynamics of physiological functioning are closely coupled to the dynamic functioning of human cognitive processes. Thus, subjective activities across a wide range of periodicities, from perceptual cycles of fractions of a second to the 2 hour sleep-waking cycle, can be described in terms of specific configurations of objectively measured physiological variables.

A second concept is that of phasic and tonic activities to create and maintain an orderly sequence of brain states subserving homeostatic purposes for the organism. For example, research describing the interactions between excitatory and inhibitory processes, and specific and non-specific systems has contributed not only to our current perspective of the major states of consciousness, but also to the mechanisms which underlie the transition from one state to another.

During the past 25 years research reports have documented the existence of a fourth state of human consciousness, in addition to the states of waking, sleeping and dreaming. The significant role this fourth major state of brain physiology will undoubtedly play in the future of neuroscience research necessitates the elaboration of a brain state model which represents a plausible framework integrating the cognitive and neural events during the process of transcending: passing from waking state awareness to this fourth state of consciousness, transcendental consciousness.

This paper presents a neuropsychological model which considers the attentional and brain state mechanisms considered to underlie the transition from ordinary waking state to this de-excited state of brain and consciousness that occurs during the Transcendental Meditation® (TM®) technique. In this paper we will describe the unique subjective and objective characteristics of this fourth state, relate this to a cognitive framework in which elements of the orienting response are considered to play a central role in the process of spontaneous transformation of cognitive systems during transcending and then describe dynamic interactions of the major brain state control systems which may underlie the process of transcending.

2. Transcendental Consciousness: A Fourth State of Consciousness

The Transcendental Meditation technique is a simple, natural, effortless procedure for generating a de-excited state of conscious experience. During the practice, periods of maximum de-excitation in which the mind is devoid of any thought activity are reported to occur. Although such transcendental experiences have from time to time been recorded by a few individuals in various cultures, the TM technique provides a simple and systematic means to cultivate this experience in human awareness.

Wallace concluded in 1970 that the TM technique produced a fourth major state of consciousness, restful alertness or transcendental consciousness (TC), which was physiologically distinguishable from waking (WC), dreaming (DC) and sleeping (SC) consciousness (see figure 1). Since that time, numerous studies have been published on the TM technique reporting striking changes in respiration, blood chemistry and hormones, blood flow and brain wave activity. Thus, a constellation of electrographic and biochemical markers now exist which can be used to reliably and objectively differentiate the de-excited state generated during the TM technique from the tonic steady state dynamics associated with WC, DC and SC. For the purposes of this paper, these findings can be briefly summarized as follows.

(a) Respiration and Metabolism: During the TM technique, marked reductions in oxygen consumption, carbon dioxide elimination, minute ventilation and breath rate are found. In some advanced practitioners, the sudden onset of spontaneous and sustained suspension of respiration (SRS), 1 to 6 seconds in length, occur periodically in a uniform pattern during meditation (See figure 2). Recent studies of individuals exhibiting SRSs indicate a reduced sensitivity to CO₂ and an increased sensitivity to O₂ and the respiratory quotient was found to decrease. Together, these findings support the concept that the occurrence of suspension is not a passive response to reduced metabolism (although decreased metabolic rate would play an important permissive role), but rather a manifestation of an active inhibitory mechanism acting upon brainstem respiratory centers (See SEC 5.3.2 below).

(b) Brain Wave Activity: During the TM technique, high levels of EEG alpha activity appear across the scalp along with frontal and central theta and beta spindle bursts. The alpha activity usually appears first in frontal regions and rapidly spreads posteriorly. The high amplitude theta activity is distinguishable from sleep onset synchronous activity. Changing coefficients of wakefulness (alpha/delta, increase) and activation (beta/alpha, decrease) correspond to a de-excited state with awareness maintained. Numerous scalp topographic studies have shown dramatic increases in inter- and intra-hemispheric synchrony and coherence of the EEG signals. These changes are clearly different from the patterns of EEG correlation during WC, DC and SC. The sudden transition in respiratory pattern is accompanied by marked, parallel changes (increases) in EEG power and coherence values.

(c) **Other Parameters:** During the TM technique, regional blood flow becomes significantly altered with major decreases in hepatic and renal flow and large increases in brain blood flow. Heart rate decreases with a mean of about 5 bpm. Plasma cortisol decreases rapidly and markedly during the TM technique. Blood lactate and TSH decrease during the practice and prolactin decrease after meditation. Basal GSR increases and phasic GSR becomes more stable during meditation, especially during periods of SRS. Together, these physiological changes differentiate the meditative state, especially the periods of SRS, from WC, DC and SC. The periods of SRS are emphasized here since this particular substrate of meditation is accompanied by both dramatic and comprehensive shifts in physiological parameters indicative of a profound state of de-excitation (changes in heart rate, basal GSR, spontaneous fluctuations in skin resistance and inter- and intra-hemispheric EEG coherence) and by clear subjective experience of a complete inner wakefulness or transcendental consciousness indicated by button signal at the offset of each SRS period. The characteristics of these sudden and sustained periods of SRS support the existence of a powerful, global inhibitory influence in brain activity giving rise to a de-excited state of great orderliness and simplicity.

In summary, during the TM technique, there exists discrete periods of low metabolic rate, high cortical coherence, and spontaneous respiratory suspensions correlated to the experience of TC. This state of self-referral or transcendental consciousness displays characteristics which clearly separate it from WC, DC and SC: a profound level of de-excitation coexisting with conscious awareness. These two dimensions, activation and awareness, can be used to map the separate domains of these four states (see figure 1). In addition, the normally exclusive combination of both cognitive and brain functioning characteristic of TC represent fundamental requirements to be fulfilled by a model of transcending.

3. WHAT IS TRANSCENDING?

A proper analysis of the process of transcending should include an understanding of both the meditative technique and the generic set of cognitive events that are reported to occur during meditation. The transition from ordinary waking cognitive activity to TC is experienced as a simple, effortless and spontaneous process. The technique is composed of three components: (1) the initial conditions, (2) a proper vehicle or sound and (3) the instructional set. An individual sitting upright comfortably in a chair with eyes closed constitutes the initial conditions. Then, starting in normal waking awareness, the individual places the attention on a particular mental 'vehicle' or thought (a specific sound is selected). At the time of initial instruction in the practice, the vehicle is introduced as a sound without meaning or other intellectual significance. Thus, the focus of attention is solely on the basis of the sensory attributes of the vehicle and not any intellectual, meaning or association. In this nondirected state, the individual thinks the vehicle in a simple, effortless manner.

Spontaneously, the quiet, restful yet lively initial conditions support the mind's movement in an inner direction and allow the focus of attention to experience the presence of fainter, more delicate values of the thought process normally in the background of conscious awareness, referred to as the preconscious, preattentive, subconscious or unconscious mind. In this state, gross values of verbal thought process fade away and still fainter values of the thought process are appreciated. In this way, normally preconscious cognitive levels of development of the thought process are consciously experienced. During the process of transcending, the individual spontaneously experiences the sequential shifting of attention from grosser, more developed, concrete values of the vehicle or a thought to progressively finer and finer values of the vehicle and the process of thought development (see figure 3a).

Accompanying this stepwise transition in the conscious experience of lesser and lesser developed values of the vehicle, the individual also appreciates a profound reduction in background cognitive activity. Each step serves as the platform for the further refinement of experience until a point is reached in which the attention shifts from the faintest value of the vehicle to a completely silent, self-referral state of experience--one devoid of space-time dimensions in cognitive activity. The individual transcends cognitive activity and experiences a state of transcendence, hence referred to as transcendental consciousness (TC). After a short period of time, the attention is found once more engaged on faint normally preconscious levels of the thinking process, then the vehicle is again appreciated and the process of transcending is repeated. Thus, meditation is experienced as an alternation of transcending and coming out onto a thought. No concentration is necessary or helpful, since the natural tendency, of the mind (see below) appears to be sufficient to direct the attention spontaneously inward to areas of greater charm and reward. The process of transcending generates increasing feelings of pleasure and enjoyment, clarity, energy, and coherent sense of self.

In waking cognitive activity, the attention is constantly and spontaneously shifting from one thought or perception to another following fundamental cognitive rules. These rules can be classified as the basic tendency of the mind to search for newer or more rewarding possibilities in a horizontal dimension (see figure 3b). The mind is constantly attracted through the functioning of the sensory systems to changing modes of the environment so as to extract out or construct a more stable, complete and reliable nonchanging internal representation of the environment. The continual spontaneous shifts in attention serve to orient the organism for this purpose of extracting information to increase the organizing power of perceptual and behavioral representations and programs. Motivation is a cognitive process which links the feeling state and associated states of physiological balance of the individual with this attentional control mechanism.

Based on the initial conditions of the TM technique and the intellectually neutral nature of the vehicle, this natural tendency is directly experienced as generating a sequence of progressively refined values of the vehicle and a cognitive shift in the VERTICAL dimension. The natural attraction of the attention to a less developed, more abstract values of the vehicle is considered to be due to the increasing charm of the more abstract, less concrete values of the vehicle found along the vertical continuum of the subconscious or preconscious areas of cognitive activity. Ultimately, the process leads the mind to a simple, least excited, self referral state (TC) which, as the source of thought is an infinite reservoir of energy, intelligence and bliss and hence most charming to the mind. This charm is considered the motivating force behind the effortless and successful dive of conscious awareness during the process of transcending along this vertical path of thought development not normally available to conscious experience. Figure 3c illustrates the difference between the HORIZONTAL dimension of cognitive experience and the vertical dimension of conscious experience during the process of transcending.

B. Attentional Mechanisms of Transcending

B.1. Attention and States of Consciousness

The TM technique, a simple and effective procedure, is proposed to utilize the inherent capabilities of selective attention mechanisms to shift conscious awareness from the ordinary waking state level of experience along a vertical dimension of thought development to progressively finer, less excited, more abstract states of a thought and finally transcend and go beyond the thought process altogether.

The flow of conscious attention involves the interaction of three elements: (1) the observer or knower, (2) the observed, or object or known, and (3) the process linking together the knower and known, the process of knowing or observing. The status of the three elements, in particular the observer, is closely linked to the state of consciousness. In waking state, these three elements are sufficiently dynamic and integrated to support conscious experience. In dreaming, the three elements may be said to be present, but this state of the subject, knower, or observer is modified and lacking to preclude conscious appreciation of dream activity. Hence, dream activity may represent preconscious cognitive activity disconnected from ordinary WC criteria of reality. Periods of slow wave sleep may represent the three elements in a de-excited state of inertia. In contrast, during the process of transcending, the three-fold value of conscious experience is maintained in a lively, integrated state, within the domain of normally preconscious cognitive activity until the finest state of the object (vehicle) is transcended and the observer is left by itself, a self referral state of pure consciousness. From this perspective, each major state of consciousness can be distinguished by the nature of the three-fold dynamics of attention.

In the state of transcendence, the cognitive apparatus is left without any object of attention. There is nothing left to be conscious of, no relative space-time boundaries remain, only the state of consciousness itself - Self-consciousness. Normally, states of significant de-excitation (e.g., SC) are not associated with either cognitive activity or conscious experience. Thus, in order to transcend, the cognitive apparatus must be organized so as to maintain the integrity of the three-fold structure of conscious experience across de-excited levels of thought development which normally are not available to direct conscious appreciation (hence called preconscious or subconscious, see figure 3a). Ultimately, the instrument of cognition becomes devoid of all experience of objects, yet does not lose its ability to experience, as in deep sleep.

In this section, a set of operational transformations of cognitive activity are described which are postulated to develop or condition these mechanisms of selective attention so as to permit the attention to move in a vertical direction through a sequence of increasingly de-excited states during the TM technique. In the section following will be discussed proposed interactions of a neuronal network capable of being conditioned to support this unique mode of cognitive activity.

B.2. Components and Control of Selective Attention

Control of selective attention is usually appreciated as an outwardly directed cognitive activity within an extra-personal space where objects are usually specific sensory events within a complex sensory background. The TM technique reverses this process and conditions the perceptual mechanism to operate in an inwardly directed path through preconscious levels of activity - that is, within intra-personal space. Although the direction of attentional control is reversed, the mechanics during transcending must possess the same components and representational systems and fulfill the same basic requirements for attentional control so as to maintain the integrity of the three-fold nature of conscious experience. These system operations include the ability to focus on an object of attention, the ability to inhibit distracting stimuli and the ability to flexibly shift attention from focus to another.

In order for this shifting to occur in an orderly, purposeful manner a comparator function must be invoked and a set of representational systems on which it acts, including the sensory model corresponding to the current focus or object of attention, previous representations (stored as short term and long term encodings) and motivational maturational references which serve to in part a value of significance to each object or set of objects.

3. The Orienting Response

The present model of transcending postulates that the above operations and representational systems can be incorporated into an extension of the framework of the well-known orienting response (OR) which is capable of modulating the inward flow of attention during transcending. Since the cognitive events associated with transcending are based upon this biological reflex, a brief description of the OR in the context of this model will be helpful.

The OR is the 'What is it?' reaction which can be defined as a shift in body and attention to facilitate evaluation of environmental change. Stimuli normally occurring in the extrapersonal space can elicit an OR as a result of either qualitative (e.g., frequency) or quantitative (e.g., intensity) changes. Usually the OR is elicited by novel, unexpected, complex or highly significant stimuli. The attentional shifts in ORs can be either involuntary or voluntary in nature. The OR is usually considered an involuntary change in information processing leading to increases in alertness and redirection of attention helpful in the detailed investigation of a relevant stimulus or subsequent stimuli. Thus, the OR is considered to enhance adaptation and stability of the organism. Another form of OR called voluntary OR, elicited in the process of goal-oriented thinking, is also considered to be part of normal cognitive operations.

Current understanding of the OR suggests that a few key events takes place which lead to the physiological and cognitive changes associated with alerting and response preparation. These are illustrated in figure 4 and mentioned below.

- 1) The signal enters the sensory systems and undergoes preliminary analysis at preconscious levels of cognitive processing.
- 2) This stimulus representation or model is accessed by a comparator mechanism along with a similar representation from short- and long-term storage systems. A motivational system is also engaged so as to evaluate the significance of the stimulus to the individual within the current spatio-temporal context.
- 3) There are three possible outcomes of this comparator function: (a) If the stimulus and the stored representation converge or MATCH and the stimulus is predictable, expected or tagged non-significant, etc. , then no OR occurs and no further action is taken with regards to analyzing the stimulus. In fact, any further repetition of such a matching stimulus will lead to a state of inhibition, at first towards the stimulus and stimulus modality and then generalized to a global de-excited state and probably sleep. (b) If, however, the stimulus MATCHES, but is previously tagged to be significant (like someone speaking your name) then an OR occurs and facilitation of the analysis takes place. (c) In the third case, the comparator system signals a sufficient MISMATCH or divergence (based on some significant criteria or, consequentiality, of the stimulus) between the preliminary analyzed stimulus configuration and corresponding stored neural representations. The OR then leads to further, more extensive evaluation of the stimulus and continual comparator function.

Repetition of a nonchanging stimulus eventually leads to an acceptable level of match and habituation of response to any further evaluation, similar to the first outcome above. Generally novel or unexpected stimuli lead to mismatch and facilitation of sensory processing and the degree of the stimulus change is correlated with the magnitude of the OR elicited. For habituated stimuli, however, almost any change in the stimulus or in the relationship of the stimulus and its background may be capable of re-eliciting an OR. For example, even a decrease in intensity or complexity of a previously habituated stimulus could generate a mismatch and re-evoke an OR. Another example is the re-evocation of the OR to a nonchanging stimulus under certain conditions. Since a stimulus is analyzed in a specific context, a mismatch could register to a nonchanging stimulus if the sensory background in which the stimulus is embedded changes (but the background change does not itself evoke an OR).

In summary, the OR can be elicited by a change in either the stimulus or the field in which it exists. The field could be the external environment or in the case of the present model, the internal cognitive state in which the stimulus is being evaluated. In any case, the postulated effect of the OR is to increase the sensitivity and possibly speed of the sensory system, and to increase the signal to noise ratio of the ongoing sensory processing. Finally, the OR to a stimulus is associated with increased vigilance and activation to facilitate further sensory processing, and habituation to repeated stimulation leads to decreased vigilance and de-excitation of the system.

4.4. THE TRANSCENDING REFLEX: THE ROLE OF THE OR IN THE PROCESS OF TRANSCENDING.

In this model of transcending the process of orienting and habituation are considered to be repetitively engaged as the conscious attention shifts with the repetition of the vehicle. The two basic requirements of transcending, de-excitation while maintaining awareness, are satisfied by the close coupling of these two processes. The sequence of repeated orienting is postulated to maintain the integrity of the three-fold nature of cognitive activity and hence conscious experience while the sequence of increasing habituation is postulated to progressively de-excite the system.

Habituation leads to re-evocation of orienting and orienting leads to strengthened habituation. The following sequence of events are envisioned to occur during transcending (also see figure 5).

Supported by the initial conditions of the practice:

1) The vehicle becomes the focus of attention in a relatively de-excited sensory context, and preliminary preconscious analysis of the stimulus configuration takes place.

2) The comparator function then evaluates the nature of the stimulus against similar stored representations considering motivational representations encoding significance or, consequentiality. The comparator mechanism could access many representations of the vehicle based upon variations in the quantitative and qualitative features of the stimulus configuration. Some of the representations would, to varying degrees, match and some would mismatch.

3) The outcome would be predominantly one of MATCH, and with simple repetition, lead to habituation and inhibition or de-excitation of the system. Such a tendency is strengthened by the initial conditions and by the quality of the vehicle: simplicity of configuration, lack of semantic or intellectual associations, a neutral, non-manipulative attitude and repetitive use during previous periods of meditation.

Although de-excitation of the system is a desired result, this outcome alone would normally lead to minimally de-excited states characterized by drowsiness and decreased vigilance as can happen during contemplation or daydreaming. In addition, the overall loss of vigilance would predispose the system towards transitions to sleep onset and sleep processes associated with partial or complete loss of conscious experience, respectively. As a result, the process of transcending would end prematurely and the reduction in the excitation of the system would be minimal .

The essential tenet of the proposed model is that during transcending MISMATCH outcomes are sufficiently strong as to provide the necessary level of systematic activation and integration to maintain conscious awareness and the stability of progressive state de-excitation. There are at best three paths of comparator processing that are suggested to be capable of generating an OR during transcending.

(1) One scenario is that the MATCH which occurs is tagged as significant to the individual, that is, the presence of the vehicle is associated with a (rewarding) consequence. In spite of the undistinguished nature of the vehicle, its presence is associated with previous experiences of transcending which are reported to be pleasurable and hence impart significant motivational valence to the signal . Pleasure motivates useful behavior that provides a transition to a more balanced homeostatic condition of the system. From this perspective, the vehicle is expected to elicit an OR due to the matching representations being tagged with strong conditional associations of transcending.

(2) The second possible path of cognitive activity leading to an OR is based on a MISMATCH between the current value of the vehicle and a more refined, less developed representation. An OR would then facilitate sensory processing and enhance the analyses of the vehicle in this context. Eventually the attention is identified with this less developed version of the vehicle, and a condition of MATCH with this less developed version is attained. The attention thus flows from one value to the next along the vertical dimension of thought development. Then, as a result of the matching which tends to inhibit (de-excited) the system, the attention is found focused on the lesser developed version of the vehicle located at a previously subconscious level of cognitive activity.

It is postulated that the system can detect and preferentially orient inwardly along this vertical gradient of thought activity. Motivational or drive systems must be activated which facilitate the approach behavior to less developed, more abstract and pleasurable states of cognitive activity. As a consequence, repeated cycling of this process of mismatch and matching would produce a sequential refinement and de-excitation of attention without loss of conscious appreciation which corresponds to the reported subjective experience.

This activity of mismatch between the vehicle and less developed representations is a relatively local or short-range comparator function which is object-dependent and is referred to as a local or vehicle-dependent orienting response (LOR). It is also proposed that a context- or State-dependent orienting (SOR) is in operation. Acting in parallel with LOR, the SOR elicits a mismatch, OR, and facilitation of sensory processing and increased signal-to-noise ratio.

It is suggested that the comparator mechanism has access to and can evaluate the state of the system which includes the global sensory context in which the vehicle is located. Should the state of the system change, for example, become partially de-excited, then the relationship between vehicle and state would also be altered (akin to novelty) and an OR could be elicited. Since pleasure is dependent upon the internal state of the system and is associated with transition towards more balanced and integrated states of the system, the spontaneous and rapid shift of attention towards decreased levels of excitation and simpler states of conscious experience suggest that the inward vertical direction and, finally, TC represent a strong motivation or drive for the individual to attain such de-excited conscious states.

In this context do we begin to understand the expression, “the natural tendency of the mind.” towards more and more, and the increasing charm, associated with the conscious attention experiencing more subtle and refined states of the vehicle. It has been

suggested that the cognitive apparatus is continually developing and using a model of future perceptual events based on extrapolation of previous analysis. It is not implausible to further suggest that human cognitive processes are capable of accessing a model of thought development that is postulated to occur during transcending. Therefore, during transcending, local (LOR) and global (SOR) relationships are intimately coupled as the focus of attention flows from one value of the vehicle to the next through progressively less excited and developed levels of preconscious cognitive processing.

5. SUMMARY

In summary, a model is presented in which the process of selective attention is molded so that a particular thought (the vehicle), picked up on the conscious thinking level, can be systematically followed back along its developmental trajectory. During the TM technique, the vertical path of thought development, normally within the preconscious or subconscious domain of cognitive activity, is consciously appreciated.

In the model, this ability to maintain conscious awareness during a progressive sequence of de-excitation is based upon a close coupling of continuous orienting and habituation processes. The repetition of the vehicle as the focus of attention leads to habituation and growing de-excitation, while a series of local and global orienting responses maintain the integrity of the attentional mechanism and conscious awareness.

The rapid and effortless characteristic of this inward march of the focus of attention is dependent upon the three components of the technique: the initial conditions of a relaxed state of reduced sensory input, the vehicle characterized by simplicity and lack of semantic association, and the instructional set which makes use of the natural tendency of the mind. The most potent way to modify pleasure and hence, motivational control, is by changing the 'Mileur Interieur', and the programmed transition to de-excitation of conscious experience leading to a state of TC represents a profound change in the state of the system--a transition to a unique psychological and physiological state of order and balance. As a result of repeated practice of the technique, the otherwise indifferent vehicle would develop strong associations with the rewarding experience and would likely result in establishing a strong conditional control over the attentional mechanism.

5. Brain State Mechanisms And Transcending

5.1. Introduction

Neuroscience research has developed a preliminary understanding of brain dynamics associated with mechanisms underlying shifts in attention as well as shifts in states of consciousness. The changes in attentional mechanisms that occur during the practice of the TM technique must obviously involve transformations in various aspects of brain physiology. Since physiological analysis and subjective reports provide a consistent picture of TC being a simple, self-referral and highly ordered state of brain and cognitive function (see SEC 2), the transition from WC to TC must involve specific modes of brain functioning not normally encountered in daily life.

This section proposes an integrated neural network approach for the regulation of the selective attention mechanisms coupled to orienting and habituating processes outlined in the previous section. The underlying neural basis of transcending should not be seen in the activity of any particular structure, but rather in the alteration of the activity of a distributed network within the brain. Nevertheless, brain state analysis has indicated that there exists, nodal points which play central roles in the transition from one state of consciousness to another and hence would also be expected to participate in the transition from WC to TC during the process of transcending.

Five major levels of neural substrates will be discussed to illustrate brain state mechanisms which support the process of transcending (see figure 6). These five levels of integration and coordination of information processing in the brain are (1) the thalamocortical (THCX) system including key state-regulating thalamic nuclei, (2) an Internal inhibitory (II) system centered on the basal forebrain and an internal excitatory (IE) system centered on the mesencephalic reticular formation (MRF) whose activity converge upon and mold THCX activity, (3) a prefrontal attentional system providing control over the temporal development of brain state activity, (4) an amygdala-centered motivational system and (5) the locus coeruleus exercising global control on information processing and brain state.

5.2. The Thalamocortical System and Transcending

The exchange of information within and between the thalamic nuclei and the various areas of the cerebral cortex is the most probable neural substrate for the human cognitive activities of thought development and conscious experience. Thalamocortical (THCX) activity reflected in scalp EEG and unit recordings are currently the best indicators of phasic and tonic changes of brain state and in some cases, predictors of transition between states. Thus, the fluctuating patterns of neocortical and thalamic activity are considered to be associated not only with different stages of perceptual analysis and integration, but also with different states of consciousness.

5.2.1. Paradoxical States?

In using the two dimensions of awareness and activation (see figure 1), brain state analysis of different states of consciousness has been confronted with the paradox of dream state in which the direct correlation of level of awareness and level of activation is found reversed. Another apparent paradox is found in the characteristics of TC - a state of restful alertness. This self-referral state accompanied by high levels of alertness appears to contradict the notion that high amplitude, low frequency EEG activity is associated with loss of conscious awareness (e.g. sleep). During the process of transcending, the continued focus of attention on the vehicle as it is perceived in lesser and lesser developed stages suggest that THCX systems also become progressively transformed--become more and more integrated--so as to sustain conscious experience. It is obvious that the level of activation alone is not a sufficient criteria for reliably determining the level of awareness.

What may be most important in establishing awareness is not the activity level itself, but the quality or degree of integration or, connectedness, of brain activity. Even low or self-referral levels of brain function could be conducive to conscious experience provided the residual activity is properly connected or coherent. Following this line of reasoning, during normal waking state cognitive activity, loss of excitatory influence leads to loss of awareness due to the lack of any compensatory increase in system coherence. During transcending, however, this lack of coherent functioning does not occur and the attentional apparatus is kept intact within the previously preconscious stages of thought development.

5.2.2. RE-ORGANIZATION OF THE THCX SYSTEM

A new style of neurophysiological functioning is proposed to occur during the process of transcending. Modes of brain functioning which normally exerted opposite effects on brain state are cultured through the attention mechanisms engaged by this simple technique to coexist in a dynamic self-referral state. In this regard, the specific and nonspecific systems of the thalamus would play important roles in creating this paradoxical state. In particular, the nucleus reticularis thalami (NRT), and the intralaminar and dorsomedial nuclei may exert these opposite tendencies on specific relay nuclei and THCX processes in general (see below). The entire THCX system becomes more and more committed to attending to the intrapersonal space and the sequential changes to lesser developed versions of the vehicle. In turn, it is possible that the inward movement of the attention on a single vehicle would then transform the state of cognitive activity from a diverse, highly differentiated fabric of many impulses of sensory processing (both conscious and preconscious) to a single, unified, highly undifferentiated state of experience (see figure 7). Competing external and internal stimuli normally capable of distracting the flow of attention fail to gain access to the central processing system (see SEC 5. 3.2 and 5. a below).

Whereas waking state attention and corresponding spatio-temporal patterns of THCX activity are distributed among many complex objects and stimuli which compose the entire intrapersonal and extrapersonal space, during the act of transcending reorganization of the THCX system takes place so that the whole extent of 'synaptic space', representing specific cognitive processes would become devoted to a single object of attention. The high significance value of the vehicle would lead to increased allocation of computational resources for stimulus evaluation. Since arousal level is correlated with the narrowness of attentional focus, the decreased state of arousal would permit increased sensitivity towards the stimulus configuration permitting a broader range of signal characteristics to be processed together. Major re-organization to more distributed and integrated modes of THCX processing may form the basis for the progressive loss of space-time cognitive boundaries during transcending and, ultimately, the experience of 'unboundedness' during TC.

It is possible that the repetition of orienting and habituating would create a recursive feedback loop in the THCX System supporting the growth and stability of this more distributed representation of a single cognitive impulse. The feedback could be considered negative in that it facilitates internal inhibition and thus leads to a decrease in excitatory processes. At the same time, the feedback could be considered positive in that it leads to an increase or expansion in the neural territory or representation allocated to the vehicle. This self-referral activity giving rise to a state of long range order, perhaps reflected in the very high levels of EEG coherence during the process of transcending, would provide the necessary temporal and spatial stability to permit a highly integrated, yet self-referral, state of brain function necessary for the experience of transcending and TC (see figure 7).

5.2.3. NRT, Synchronization, and Transcending

The slowing frequency and increased coherence of THCX rhythms depends upon the activity of key thalamic nuclei. Research presently supports the view that the NRT plays the central role in thalamic rhythmic generation and hence in the development of THCX synchronization. This sheet of reticular cells functions as an interface between the thalamus and cortex acting, in part, as a pacemaker of thalamic rhythmic processes. NRT-mediated inhibition of thalamocortical relay cells is argued to represent the selective attention or gating mechanism of THCX processing of information. The transition in thalamic activity from a high fidelity relay or transfer mode to an oscillatory mode corresponding to shifts in brain states (e.g., WC and SC, respectively) is also under the control of the NRT.

The EEG signature during transcending and especially TC suggest that the NRT is in a bursting discharge pattern which would support de-excited states of thalamic and cortical activity while preventing high firing rates and proper encoding of peripheral sensory

stimuli. It is possible that with decreasing levels of excitation in THCX circuits, oscillatory behavior would lead to highly synchronized behavior among many thalamic nuclei by increased dendrodendritic coupling and recurrent collateral processes within the entire NRT.

Such a mechanism would predict that the thalamus is a significant contributor to the appearance of high levels of cortical EEG coherence during the process of transcending. The feedback loops involved in the hypothesized expansion of the neural representation of the vehicle would be stabilized by such intrathalamic synchrony and reinforced by the cortico-thalamic discharges back upon the NRT and thalamus. This may be seen as self-sustained rhythmic activity of the THCX system, forming a stable background for fluctuating cognitive events during the process of transcending. Space does not permit discussion of the potential roles played by the ventromedial, rostral intralaminar and the dorsomedial nuclei of the thalamus, and their cortical linkage.

3. THE COUPLING OF INTERNAL INHIBITION AND INTERNAL EXCITATION SYSTEMS DURING TRANSCENDING

This second level of analysis of brain state control during transcending focuses on the coupling of the brain systems for internal inhibition (II) and internal excitation (IE) by the hippocampal-based comparator system. The II and IE systems are known to converge on the THCX system, in particular the NRT and the intralaminar nuclei. This convergence of opposite tendencies contributes to the tonic and phasic changes observed in the THCX circuits during the sleep-waking cycle. In turn, the hippocampal (subicular) system serving a comparator function, can influence the activity of the II and IE systems and thus modulate the flow of information and cognitive events.

5.3.1. THE TRANSCENDING REFLEX

In this model, the attentional mechanisms previously outlined are provided neural substrates. Both the initial conditions of the practice and the cognitive processes associated with the repetition of the vehicle during the process of transcending will impact on the II and IE systems and thus alter THCX processes. The initial conditions facilitate contrary brain processes. Sitting comfortably with closed eyes and with a neutral attitude represents a state of strong withdrawal from afferent (sensory and motor) input. This passive component will strengthen the II system and create an initial de-excited state in the CNS conducive to further steps of de-excitation. In contrast, sitting with the back and neck in an upright position most likely adds some tonic drive to the IE system via vestibular and axial musculature inputs relayed to the reticular formation. This aspect of the initial conditions would contribute to the activation and integration of CNS function and help preserve conscious awareness during the self-referral states and preventing the system from being overpowered by the II system, that could otherwise lead to loss of consciousness and shift to sleep state .

With the start of meditation, the vehicle becomes the focus of attention and is analyzed in the appropriate THCX channels related to the different senses . The hippocampal-based comparator then accesses the various representations and signals, an outcome based, in part, on the consequentiality of the stimuli . On the one hand, the vehicle is considered to lead to a match under most conditions .. The comparator relays this outcome to other brain areas, in particular, inhibiting the IE system and facilitating the II system. Activated by the match, the II system de-excites brain activity. On the other hand, a mismatch outcome (see SEC - . 3) has the opposite effect: the inhibition of II and the facilitation of IE. This leads to an OR associated with activation and increased sensory processing of the stimuli .

Since the II influence is proposed to dominate, the overall effect would be like a sequence of miniature ORs riding the descending slope of brain state activity. The comparator, by signaling alternately match and mismatch, forces the CNS to oscillate between II and IE directives, with the II system and its inhibitory state quickly dominating, but not eliminating, the excitatory drive of the IE system. This is in large part due to the attentional mechanism associating with progressively less developed levels of the vehicle and thus correspondingly less excited states of the brain. Thus, throughout the process of transcending and growing de-excitation, ORs continue to be re-evoked for reasons discussed in detail above (see sec 4.3 and 4.4). This provides some level of integrative activation even in the least active levels of cognitive processing. This value of IE continues to be present and coexist with the growing value of II and contributes to the integrative quality of neural functioning necessary for maintaining conscious experience.

5.3.2 . THE INTERNAL INHIBITION SYSTEM

The basal forebrain is a rostral component of a powerful brain system for internal inhibition. The basal forebrain system (BFS) includes the preoptic area and the nucleus basalis and is linked with other II system components such as the medullary centers, the prefrontal cortex and the dorsomedial thalamus. Many inhibitory processes in the brain, including those expressed as changes in brain state (e.g. sleep), in phasic gating functions in selective attention and in state-dependent somato-visceral reflexes, can be induced by the BFS stimulation.

The model suggests that the BFS is intimately involved in the attentional mechanisms during the process of transcending. The continual habituation conditions signaled by the comparator activates the BFS which eventually generates a maximum state of II or a state of self-referral cognitive and brain activity. As such, the BFS plays an active role in inducing the electrographic, somatic and cognitive events reported to occur during the practice. The mental procedure exerts two influences on the II system (see SEC 5. 3.1).

One is the initial conditions. Since induction of sleep behavior and EEG synchronization can occur rapidly not only to direct stimulation of the BFS but also by simple classical conditioning paradigms, the association of the initial conditions with the process of transcending will, with time, provide these conditions with strong ability to activate the II system. In this way the BFS would participate in a conditioned transcending reflex.

The second influence is the attentional changes and the growing habituation due to the matching outcomes and the activation of the BFS. The proposed activation of the BFS is consistent with the physiological events that occur during transcending. For example, a number of hormonal and EEG changes can be argued to develop from BFS activation. Perhaps one of the most striking changes is the pattern of respiration. The periods of spontaneous respiratory suspension can best be explained as a direct, powerful inhibition of the brainstem respiratory control centers. Experiments in primates and humans demonstrate the ability of BFS stimulation to induce the rapid onset of respiratory arrest followed by an escape reaction before the termination of stimulation. Similarly, BFS-mediated inhibition is suggested to account for the SRS (see SEC 2) which occur during the process of transcending. The resumption of breathing appears when brainstem centers responsive to changes in blood gases during the apneic periods eventually overrides or escapes, the II influence. In fact, the increase in IE most likely shifts the entire system (back) to some higher level of activation from which the process of transcending is re-initiated.

5.3.3. THE INTERNAL EXCITATION SYSTEM

Whereas, the BFS is the probable substrate for the de-excitatory drive during the TM technique, acting alone without proper balance, the II system would lead de-activated states without awareness (sleep) rather than to a state of restful alertness, TC. The mesencephalic reticular formation (MRF) is the central representative of the IE System. The rostral projecting MRF neurons exhibit tonic discharge patterns and increased firing rates during states of activation with (WC) and without (DC) awareness. Changes in the pattern of MRF activity parallels and actually precede state transitions (WC/SC, SC/WC) observed in the THCX system.

During the process of transcending the withdrawal of MRF ascending tonic excitation on the diencephalon, postulated to result from a combination of BFS inhibition and signals relayed from the hippocampal-based comparator system, would shift thalamic activity into the oscillatory mode and permit the development of cortical synchronization and reduce the synaptic responsiveness of thalamic nuclei to incoming sensory information. The direct consequence is that sensory channels become relatively insensitive to afferent input which allows greater intrathalamic coordination of sensory processing necessary for selective attention to maintain a single coherent focus. Furthermore, the self-referral loops in THCX activity could then expand in a stable pattern.

Thus, the reduction to the ascending reticular drive on the thalamus and cortex (via rostral intralaminar relays) would create favorable conditions for the development of progressively more de-excited states of the CNS. In order to maintain the level of neural integration necessary to support conscious awareness, it is also proposed that MRF (IE) activity is not reduced completely. A low level of MRF activity and hence IE influence would result from the ORs that continue to be re-evoked as the attention repeatedly shifts from one value of the vehicle to a lesser developed value (see discussion in SEC - 3 and a. -).

Since the reticulofugal influence on the THCX system is suggested to be mediated principally by the relay through the rostral intralaminar system (CL-PC), OR-mediated MRF activation would control thalamic and cortical excitability in parallel with the specific projection systems. The superficial laminar cortical projection of the CL-PC and VM (IE relay) nuclei would have a distributed and nonspecific depolarizing influence on cortical pyramidal cells. This would facilitate the processing of successive patterns of selective attention during de-excited brain states, in particular, the transition from one state to another. That is, a burst of MRF activation time-locked to the shift in attention from one state of the vehicle to the next would reset the THCX circuits providing the most flexible conditions for processing of the new pattern and stabilizing the new level of de-excitation. Thus, the coupling of orienting and habituating responses during the process of transcending would mold MRF activity so that the THCX system is predominantly de-activated with a low level of persistent MRF-mediated activation.

5.4. THE PREFRONTAL CORTICAL SYSTEM AND TRANSCENDING

The concept of functional, connectedness, can be analyzed from two interdependent dimensions: space and time. The spatial domain has been discussed above. Control over the spatial expansion of neural activity devoted to the transformation of a single focus of attention (the vehicle) during the process of transcending is a task involving cortical-cortical and cortical-thalamic interaction. The NRT and intralaminar nuclei were mentioned in this process. Time is the second domain. The process of transcending occurs over time and thus requires a control system capable of coordinating the temporal organization of the sequential pattern of progressive de-excitation leading to TC.

The temporal ordering of the flow of attention during the process of transcending is undoubtedly quite complex, having to deal with normally preconscious modes of cognitive activity. For example, it is possible that the number, novelty and abstractness of thought impulses increases along the continuum from WC to TC and hence the increased possibility of distraction and divergence of attention from the vehicle and the orderly inward march of conscious experience. If this flow of attention became distracted from the vehicle it seems likely that cognitive activity would become fragmented leading to daydreaming and the delicate balance between

orienting and habituating processes would not be maintained in an orderly sequence of de-excitation leading to loss of conscious experience and sleep.

It was proposed earlier that part of the orienting behavior results from the ability of the attentional apparatus to detect and evaluate both local or specific patterns of cognitive activity associated with different objects of attention and states of the system. In particular, an individual starts in one state (WC) and travels along a vertical dimension through many levels or states of preconscious, de-excited activity towards a final state or goal, TC. During early stages of the practice of the TM technique, this particular inward perceptual path may not be as completely orderly or efficient as the well-traveled path of an experienced meditator whose attentional and brain mechanisms would be quite conditioned to this unique sequence of functioning. Again, this difference may be due to, for example, differences in stability of the attentional focus in the presence of distracting stimuli. However, published physiological and subjective reports suggest that early forms of this conditioning occur quickly.

In any case, the cognitive path would be organized as a set of brain representations corresponding to the starting point, the goal and the overall plan or mode of travel along a sequence of cognitive acts. The cognitive plan of transcending seen in the uniformity of direction and goal would be in great contrast to the diverse possibilities, from meditation to meditation, of actual states and experiences along the behavioral sequence.

This model of transcending proposes that the orderly sequential progression of conscious experience from WC to TC requires the organizing power of the prefrontal cortex (PFCX). Extending previous theories of PFCX function from predominantly extrapersonal to intrapersonal space, it is postulated that this cortical system exerts executive control over the temporal organization of cognitive events that occur during transcending. The PFCX is envisioned to help regulate the evolution of conscious experience in at least two ways: (1) by suppressing internal and external cognitive interference (distractions) at preconscious levels and (2) by providing an efficient cognitive framework or plan to guide the inward flow of attention which constitutes the transcending reflex.

Since transcending can also be viewed as a linguistic transformation, the regulating function of the PFCX in language processes can be applied. Thus, the PFCX can be seen to mediate a linguistic plan which contains the path and goal of sequential transformation of a simple linguistic unit (vehicle).

Probably the most critical function mediated by PFCX activity lies in bridging the unique discontinuity or 'gap' in conscious experience that begins in the final step of transcending. Since TC is characterized by a complete lack of any object of attention and any space-time boundaries, the cognitive apparatus must be capable of bridging this transition from bounded to unbounded back to bounded states. The orderly sequence of repeatedly entering and emerging from the self-referral state of brain and consciousness that occurs during the practice of the TM technique must represent the most abstract transformation of the attentional mechanism.

If the period of actual experience of TC approximates the length of an SRS (from 1 to 60 seconds), then for a considerable period of time complete, although temporary, suppression of distracting memories and other internal and external sensory stimuli must be achieved and the overall scheme of the transcending reflex must be maintained during the gap, the experience of TC. This integrative executive function of the PFCX is also suggested to bridge the discontinuous input-output processes that operate in the performance of the sutras on the level of self-referral consciousness during the TM Sidhi technique). Published research has repeatedly documented the rapid onset and high levels of long range order (EEG coherence) within the frontal leads and between the frontal locations and posterior cortical areas. Such profound changes in THCX temporal integration which accompany the subjective experience of transcending may depend heavily upon the proper functioning of the PFCX-dependent cognitive programs.

5.5. The Amygdaloid Complex and Transcending

Subjective reports and theoretical analysis indicate that the process of transcending is a rewarding experience. In fact, the cognitive mechanisms invoked as an explanation for the vertical movement of attention rely on a natural tendency of attention to spontaneously seek out more rewarding events and conditions. As discussed above, this tendency and the pleasure associated with the shifts in attention to seek out more rewarding events and conditions are considered to facilitate the transition to more balanced or integrated (homeostatic) states of the system. The model extends this idea to suggest that the process of transcending and its goal, TC, represent states of increasing integration and physiological balance. How does the CNS link cognition and affect, and help direct behavior toward biological and physiological goals? It is proposed that the amygdaloid complex (AC), acting as part of the limbic system, is responsible for establishing and controlling affective association of sensory experience. The AC thus plays an important role in the attachment of significance to the progressive refinement of the vehicle and progressive de-excitation of the cognitive and brain state.

Serving as a pivotal structure in the link between neocortical-limbic systems and cognition-affect processes, the amygdala would contribute the following functions during transcending:

- 1) Sensory processing of the vehicle in neocortical areas would be transferred via the AC to the hypothalamus and BFS signaling the presence of a rewarding stimulus. Both the initial conditions and the vehicle would conditionally evoke increased motivation.
- 2) The AC would also facilitate the further processing of the vehicle by a direct control over cortical activity through its reciprocal connections with the neocortex. This modulation would strengthen the focus of selective attention during transcending based on the growing motivational valence of finer levels of the vehicle and less excited states of the system.
- 3) Based on its reciprocal connections with the dorsomedial (DMN) and midline thalamic nuclei, the AC could complete a PFCX-AC-DMN-PFCX loop processing the relevance and novelty of the vehicle.
- 4) The above cognitive events would also be transformed into autonomic and respiratory responses by AC contributing to both the II (predominantly) and I.E. systems.

In summary, the AC represents an important component in the transcending reflex by serving as a relay between high level sensory processing cortical systems and central limbic structures mediating emotional and motivational processes. In this way, the AC would serve to orient selective attention in the most rewarding direction or path along the vertical dimension of thought development towards TC.

5.6. THE LOCUS COERULEUS AND TRANSCENDING

The last level of analysis of brain state control during transcending explores the possible involvement of the predominantly noradrenergic cells of the locus coeruleus (LC). The LC is known to operate in both tonic and phasic modes to control CNS and behavioral states. For example, the tonic discharge pattern of LC cells exhibit state-dependent fluctuations. In contrast to the usual v-shaped pattern of cerebral neuronal tonic firing activity (high during WC and DC, and low during SC), LC cells become essentially silent during DC. Thus, the usual activation-awareness correlation of most neuronal cells during both WC and DC is not seen in LC activity.

In this model, the tonic and phasic fluctuations of LC, distributed in a global CNS pattern, are considered to exercise several integrative functions during the process of transcending:

- (1) LC-mediated inhibition of most cells would contribute to the state of increasing de-excitation. Reduction in target cell spontaneous activity is also associated with dramatic increases in signal-to-noise ratio. During transcending, the ORs elicited by both significance label and changing/novel nature of the vehicle will activate the LC, which in turn would globally bias the responsiveness of THCX cells towards processing the focus of attention and suppressing other competing stimuli and distracting activities. LC activation, closely coupled to the presence of relevant stimuli, would be time-locked to cortical excitability changes and serve as a key element in simultaneously creating and maintaining a globally de-excited state conducive to high levels of vigilance and increased discriminative abilities. In this way, LC activation during the de-exciting process of transcending would aid in stabilizing the vertical orientation of the attentional mechanism and thus enhance the reliability and efficiency of feature extraction.
- (2) Recent studies suggest an essential role of LC in mechanisms of cortical plasticity and learning. The continued activation of LC during transcending is argued to modify the structural and functional organization of the THCX system so that the new cooperative modes of neural integration produced during transcending become stabilized. This re-organization or shaping of the CNS would modify neuronal connectivity enabling previously preconscious modes of cognitive activity to be experienced in WC. In terms of the cognitive model of thought development, the action of the LC is considered to result in a lowering of the threshold of conscious appreciation so that earlier, more abstract values of thought development are perceived in daily WC periods.

Much like the experience-dependent changes in cortical activity during the development of the visual system, the repeated conscious experience of progressive refinement of the vehicle during meditation would lead to new, long lasting changes in cortical function. These changes would support the conscious experience of a wider range (vertical) of cognitive activity. In advanced stages of this THCX plasticity, the experience of TC along with WC is reported to gradually develop as the nervous system becomes capable of maintaining both styles of cognitive functioning simultaneously. This culturing of the CNS is referred to a fifth unique state of conscious experience, a state of enlightenment.

- (3) The activation of the LC is postulated to arise from both the OR signaled by the hippocampal comparator and from the PFCX. Consistent with the role of the PFCX discussed above (SEC 5. 3), the highly processed control information concerning the relevance of complex stimuli and situations would be selectively transmitted to the LC from the PFCX. This is another way in which the executive function of the PFCX can be organized on a global scale.

(4) Finally, the hypoxic conditions which gradually develop during SRS would strongly activate the LC facilitating the mechanisms underlying the termination of respiratory inhibition. This arousal reaction, in coordination with the MRF, would disengage the completely self-referral attention process operating in TC and bring the awareness to more excited levels of function with attention focused back on abstract objects such as the vehicle or other thoughts.

6. SUMMARY AND CONCLUSIONS

A neuropsychological model of transcending is outlined. The model describes a distributed neuronal approach to understanding the attentional control mechanisms considered to underlie the systematic de-excitation of the human nervous system to a self-referral state of conscious awareness, transcendental consciousness.

(1) The model formulates a dynamic picture of coherent, self-referral brain processes which, then provide the proper initial conditions and guidance of the TM technique, spontaneously allows for the sequential refinement of the conscious thinking experience as the brain activity becomes progressively de-excited.

(2) The transcending reflex appears to be a universal human ability utilizing inherent properties of the orienting response to direct conscious attention along a vertical dimension of de-excited cognitive activity. As a consequence of the close coupling of physiological and psychological processes, transcending produces a self-referral, highly coherent state of brain functioning.

(3) The model discusses the possible roles played by many brain areas including the thalamocortical system and NRT, the basal forebrain-internal inhibitory system, the MRF-internal excitatory system, the prefrontal cortex, the amygdaloid complex and the locus coeruleus.

(b) It is proposed that these neural systems, normally interacting to control our conscious attention, can be conditioned to coexist so as to support conscious experience in a self-referral state of brain physiology.

(5) the existence of a fourth state of consciousness in addition to wc, dc and sc, and the systematic exploration of the entire range of vertical dimension of cognitive activity has numerous implications for neuroscience research. What are the interactions and interdependencies of these four states, and what are the brain state control mechanisms that support the transition from one state to another-

(6) What you put your attention on grows! Repeated, systematically experiencing the process of transcending and transcendental consciousness must modify brain structure and function. Teaching the system to appreciate deeper levels of the cognitive process would induce long-term changes in the brain and in the content and temporal organization of our creative and intellectual abilities, affect and mind-body coordination. Research documenting enhanced abilities in these and other areas of physiology and psychology in meditators has been widely published over the past 30 years.

(7) The model provides a modern, scientifically-derived framework to encourage further investigation of the process of transcending in order to increase our appreciation of the significant implications this process has for the development of human cognitive potential. By helping to clarify the nature and mechanics of this simple mental procedure, the model may contribute to

(8) Veda and human physiology