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MULTIPLE PHASE LOCKED LOOP GUIDANCE IN MEDITATION

A new scientific explanation

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ABSTRACT:
This research work is an attempt to present a new scientific perception of alterations in meditative consciousness states. India has been the land of civilizations and spirituality, contributing a lot in dimensions of mystic phenomena eluding understanding. From time immemorial such experiences and practices have been handed down to generations by word of mouth. This research work is the outcome of inspiration dawned on the authors to scientifically investigate such phenomena. This is one of their first systematic studies in this direction. This work concentrates on interpreting the mystic phenomena related to alterations in meditative consciousness states using concepts in science and engineering.

Keywords: Meditation, Consciousness states, Phase Locked Loop, Music.

INTRODUCTION

This research work is an attempt to explain and present a new scientific perception of the alterations in meditative consciousness states. Meditation is a mental activity associated with attaining a deeply restful yet fully alert state (1) and is characterized by the attainment of a restful yet fully alert physical and mental state practiced by many as a self-regulatory approach to emotion management (2).

Physiological alterations in the human subjects led to the attention of many researchers and journals to concentrate on Meditation, and its effect on the human subject was assessed in various ways. Meditation is labeled as “A wakeful Hypometabolic Physiologic State” (3). A series of research articles have been published on Meditation (4 - 8). The idea of a body–mind connection is not a new one. In fact, it is only in our recent past that the two ideas have been seen as separate (9). This paper attempts to explain alteration in Consciousness States in the lines of scientific and technological treatises.

MEDITATION, CONSCIOUSNESS AND MUSIC

Meditation is an ancient spiritual practice that has recently been studied due to its potential health promoting effects, and its status as a special form of consciousness, different from ordinary waking and sleep.

Meditation

The recent decades have witnessed a marked change in the perspective of viewing Meditation as a solely mystic process of spiritual quest to a complementary effective method in several health situations (10). In a survey of the EEG characteristics of persons practising Meditation, the theta bursts were preceded and followed by alpha rhythm. Subject reports elicited during theta bursts indicated pleasant states with intact situational orientation and no subjective experiences related to sleep. It is hypothesized that theta burst may be the manifestation of a state adjustment mechanism which comes into play during prolonged low-arousal states, and which may be related to EEG patterns of relaxation in certain behavioural conditions (11).

Changes in EEG coherence patterns were used to test a field model that proposes a common field of "pure consciousness" linking all individuals. The experimental data support a field model of consciousness (12). While a considerable number of studies has been carried out with EEG, only few studies have used PET and fMRI (13 & 14)

Consciousness

Consciousness is a subtle phenomena very closely related to Meditation. It has been debated in many areas, including brain sciences (15). Exploration and reflection on the interfacing of religion and the neurosciences in the last twenty-five years provide a unique point of convergence on the relationship between science and religion. By the 1990s, meaning-making and integrating consciousness emerged as shaping the agenda between religion and cognitive neuroscience. The emerging methodology combines analogical continuities among levels of complexity and metaphorical leaps of inferential patterning (16).

Also, Global brain imaging techniques (PET and fMRI) indicate that a different brain network is involved in moving the focus of attention from that involved in the initial processing of an attended input (17 & 18).

Consciousness is a subtle phenomenon, which has so far resisted all attempts to understand it, in spite of the present ‘race for consciousness’ (19). Recent neuroscientific works on the problem have surprisingly neglected attention as a guide to consciousness (20).

Without attention to an input there is no awareness of it (21 & 22). Yet several recent papers on consciousness (23 - 26) have surprisingly neglected attention as a guide to understanding consciousness. The following paragraphs concentrate on Music as an attention input.

Music

Meditation is defined as an exercise, which usually involves training the individual to focus the attention or consciousness in a single object, sound, concept or experience (27). Apart from Meditation, relaxation could also be induced through chemical means (muscle relaxant drugs, such as Valium) or through biofeedback techniques in which the subject’s EMG activity is monitored and revealed to the subject *via* light or tone signals.

Such biofeedback techniques allow persons to develop voluntary control over internal systems (such as heart rate, blood pressure, EEG activity) previously thought to be beyond such control (28)

The human being is thought of as a musical instrument. By changing the patterns and rhythms of sound and breath, it is possible to link all the systems of the body that regulate excitement, relaxation, action, reaction and intelligence. In basic meditation, only a small area of the brain was engaged while the addition of selected sounds in Medical Meditation produced more pronounced levels of activation (29). These selected sounds also include certain meditative chants and sacred music.

The forthcoming paragraphs discuss Phase Locked Loop and later explain alterations in Meditative Consciousness states on the basis of Phase Locked Loop.

PHASE LOCKED LOOP

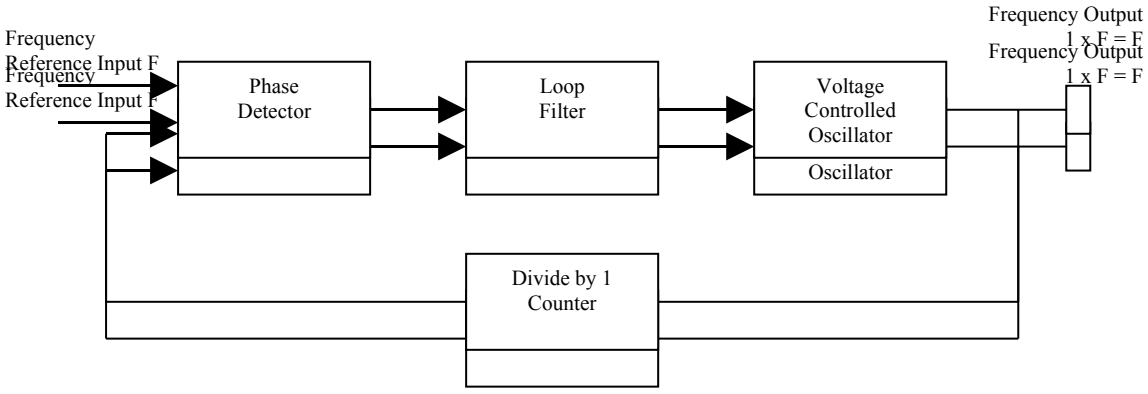

Fig 1. Block Diagram of a Phase Locked Loop (Courtesy: www.cardinalxtal.com/docs/notes/cardinal_phase_lock_loop_basics.pdf, as on Feb 28, 2007)

Figure 1 shows a Phase Locked Loop frequency multiplier. Since n = 1, the Voltage Controlled Oscillator gives an Output that is 1 times F, that is, F itself.

The Phase Locked Loop (PLL) is a conventional circuit used to lock to the input frequency when the frequency is within the PLL's bandwidth. The PLL is basically a feedback control system that controls the phase of the Voltage Controlled Oscillator (VCO). The input signal is applied to one input of a phase detector. The other input is taken from the output of a Divide by 1 Counter. The output of the Phase Detector will be a difference of the phases of the two inputs, and is applied to the Loop Filter. The Loop Filter determines the dynamic characteristics of the PLL and controls the VCO. The output frequency is N times the input, governed by the Divide by N counter. In a specific case of N = 1, the Divide by N counter becomes a Divide by 1 Counter, and the output frequency is exactly the same as the input frequency.

The design of the Loop Filter is decided by the proposed application of the PLL. If the PLL expects a single input frequency, then the bandwidth of the Loop Filter can be narrow. If the PLL is required to acquire and track a signal, then the bandwidth of the Loop Filter will be suitably larger (30).

MEDITATION AND MULTIPLE PHASE LOCKED LOOP (MPLL)

Observations

A summary of the salient points understood from the previous paragraphs is that

1. Music is used as an attention input to Meditation.
2. Consciousness is a subtle phenomena associated with Meditation.
3. EEG pattern changes were observed in Meditation.
4. Changes in EEG coherence patterns supported a field model of meditative consciousness.

Inferences

In short, certain types of music which are used as attention input to Meditation, can give rise to changes in EEG patterns, whose changes were reflected in a field model of meditative consciousness. Translated into a simple expression, this would imply that Meditation with music input can possibly lead to altered states of meditative consciousness.

If Meditation with music input can lead to altered states of meditative consciousness via alterations in EEG patterns, then scientific concepts should be able to explain the phenomena of altered states of meditative consciousness due to (selected) music input.

DISCUSSION

Recalling the explanation in the previous section about Phase Locked Loop, we find that the foundational concept of Phase Locked Loop can be applied to explain altered states of meditative consciousness due to meditative music input. Assuming that a human subject goes into meditative states aided by attention to selected music input and experiences changes in his EEG patterns, it is most likely that the selected music input which has triggered the meditative state continues to guide the changes in EEG patterns of the human meditative subject. This phenomenon is very much similar to the foundational concept of the Phase Locked Loop where the system acquires and tracks the frequency of the input. Here, meditative music input is analogous to the PLL frequency input and the EEG state is analogous to the output frequency of the PLL. In a similar manner, the meditative process is analogous to the Phase Locked Loop.

There is one exception that needs to be tackled. The above explanation / interpretation holds good as long as there is a single output, that is, a single human subject. But, there is an exception that arises when there are multiple human subjects. It is conventionally known that each human subject has distinct and unique responses to meditation. Therefore, their Meditative PLL analogy could fail to express the phenomenon. In such a case with multiple meditative human subjects, the authors propose a concept called Muliple Phase Locked Loop (MPLL).

Muliple Phase Locked Loop (MPLL) can be explained as multiple PLLs having their unique bandwidths responding to the multiple input frequency and giving out different output frequencies as response to their bandwidth, acquiring and tracking characteristics. Expressed in relation to this research work, the frequencies present in the meditative music input could be triggering and guiding various EEG patterns in various human meditative subjects at the same time. Translated equivalently in terms of alterations in states of consciousness, meditative music input can be able to initiate and guide alterations in states of consciousness in meditating human subjects according to their intrinsic characteristics analogous to MPLL.

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