

Yoga and Biofeedback - A Comparison

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Abstract

Biofeedback is a relatively novel technique for the control of autonomic nervous system not mediated through muscular activity. Thus, alpha enhancement in EEG, skin temperature control of visceral functions have all been reported through instrumental learning procedures. Yogic practices such as savasana and meditation have also shown reduced sympathetic tone through precise control over the autonomic activity. However, a subtle difference is countered in the psychophysiological response to biofeedback and to yoga. These are brought out in this report with special reference to the neuromuscular response and altered states of consciousness that is achieved in these two types of practices.

Biofeedback is a novel method for modulating the activity of the psychophysiological system through instrumental learning procedures. The term feedback was coined by the mathematician Norbert Wiener and is defined as 'a method of controlling the system by reinserting into it the results of its past performance [1]. Biofeedback may be considered as the availability of an information within a cybernetic model. Cybernetics is the science of control in an organism. An element indicative of the level of functioning of an organism is available for control. This is similar to information available for a thermostat in controlling the temperature of a room. In this example, a thermistor detects the temperature and feeds this appropriately for switching on and off the cooling system when the temperature goes above or below respectively of a preset value. However, biofeedback is more complex with both exteroceptive and environmental inputs that play a vital role in effecting a control.

Neal Miller conducted a series of experiments in mid-sixties wherein he detailed the operant learning effects involving visceral and automatic processes in animals [2], [3]. Initially, these changes were thought to be achieved through skeletal muscle mediation of the response. However, the latter study of Miller showed unequivocally (in curarized animals) the mediation is through operant conditioning of autonomic responses and not through manipulations of the skeletal muscles. Further, other studies indicated initial reinforcement and subsequent operant extinction when the response was no longer reinforced through stimulation [4]. Though theoretical discussions have not resolved the interdependence or otherwise of somato-motor and autonomic-visceral activities, it is presently beyond reasonable doubt that modulations and modifications of almost any psycho-physiological variable is possible through instrumental conditioning methods. The thumb rule is, if one is aware of a physiological function, one can control it volitionally.

Present biofeedback applications in psychosomatic medicine range from treatment of migraine headache, hypertension, asthma to non-sensory physiological processes such as single motor unit firing [5], [6]. In the simplest and most direct form, a thermometer is mounted on a finger tip. The steady peripheral temperature is noted. A series of autogenic phrases are uttered with focussed attention for 'quieting the body (low muscle tension), quieting the emotions (warmth in hands), and quieting the mind (inward turned attention) [6]. As the body-mind relaxation comes about, an increase in the skin temperature is observed. Blood flow in the periphery is controlled by the sympathetic nervous system. Thus, increased blood flow to the periphery as reflected by increased skin temperature implies reduced sympathetic tone at the hypothalamic level. Since the control is central, vascular relaxation of the entire periphery takes place resulting in control

of conditions such as migraine headaches and Raynaud's disease [7]. Another interesting application of biofeedback is the volitional control of alpha activity of the electroencephalogram. Again, alpha dominance is related to hypometabolic states of an individual conferring relaxation of the somatosensory states. The alpha state can also be induced in an individual through nonvolitional biofeedback method [8], and studies have indicated the depression of reticular activation system during this procedure resulting in enhanced alpha levels at the cortex. This study to date, is the most intensive to indicate the altered state of consciousness attained through a biofeedback procedure wherein the external (to the brain) stimuli are suppressed in preference to what may be called internal awareness.

Yogic Practices

The Yogic practices of interest here are asana, pranayama (bodily postures and breathing patterns) along with meditative techniques. We shall review briefly the types of psychophysiological changes brought about during these external yogic practices before attempting a comparison with biofeedback procedures.

The practice of asanas work specifically on the neuromuscular system. The asanas consists mainly of isometric postures wherein a muscle bears the weight of body segments along with muscle stretch. Isometrics are now accepted method of improving muscle performance. However, the role of passive strength of muscles are only now being understood in terms of their rehabilitative effects. The large diameter, rapidly conducting afferent fibres arising from stretch receptors within the muscle spindle make powerful, monosynaptic excitatory connections with alpha motoneurons innervating the muscle from which the afferent fibres arise. They also make polysynaptic, inhibitory connections with motoneurons innervating the antagonists. Thus, complete stretching facilitates the muscle activated and relaxes the antagonist. Since inhibitory processes are more complete than facilitatory, it is possible that full stretch maintained during asanas relax completely the antagonists.

Observations of EEG waveforms have revealed distinctive patterns emerging during various meditative techniques. Classical studies indicated alpha wave in the frequency range 8 to 13 Hz appearing predominantly in the occipital region [9]. Recent studies indicate that changes in alpha are both in its predominant frequency and in amplitude [10]. The peak shifts by one to two hertz and the amplitude may increase by fifty per cent. Synchronization of brain waves between hemispheres and between frontal, parietal and occipital areas have been observed [11].

Comparison

In spite of extensive work in biofeedback and yoga, a direct comparison of the psychosomatic response to these two procedures is difficult. At the level of the neuromuscular system, Yogic asanas differ considerably from biofeedback procedures for neuromuscular reeducation. The passive stretch of the muscle increases the reflex response and thus confers precise control of the agonist and complete relaxation of the antagonist respectively. This provides a basis for improvement in motor control of practitioners of asanas. The biofeedback is usually more gross with only modulations of the alpha motoneuron activity and it does not, as yet, involve manipulations of the reflex systems.

In brain wave training through biofeedback procedures, the ultimate aim is to achieve alpha or theta states which are usually correlated with hypometabolic and hypnogogic states respectively. Both in

somatomotor and autonomic-visceral training procedures, depending on the target and parameters brought under control, activation of the hypothalamus and the brain stem structures leads to either the ergotropic or the trophotropic syndromes [12]. The ergotropic response consists of an increase in sympathetic discharge with consequent increased skeletal muscle tone and diffuse cortical excitation reflected by desynchronization of the EEG. The trophotropic response, on the other hand, consists of an increase in parasympathetic discharge with consequent relaxation of skeletal muscles and EEG synchrony. In biofeedback therapy, depending on the response sought, an ergotropic or a trophotropic facilitation is aimed. For example, in muscle reeducation, usually an ergotropic syndrome is preferred. The above mentioned effects can be achieved in one of the two pathways:

- 1) by directly activating the ergotropic and trophotropic 'centres' in the hypothalamus and
- 2) through indirect activation.

The latter method is possible through cortical activation and through modulations of discharges arriving at the hypothalamus and the reticular system. For example, decreased proprioception through curare-like drugs reduces the ergotropic responsiveness of the hypothalamus and decreases the hypothalamocortical discharges [12]. This then is an indirect control for altering the ergotropic response. Many of the biofeedback learning procedures may be classified under this indirect manipulation of the hypothalamic activity.

The psychophysiological changes accompanying the mental states of meditation is due to a direct facilitation of the trophotropic system. This state is also associated with a 'reciprocal inhibition' of the ergotropic system referred to as trophotropic tuning [13]. This is indeed the case during meditation when an increase in skin resistance is noted showing a lessened ergotropic tone. Further, another interesting aspect of meditation not lead to sleep. This implies that some amount of ergotropic discharge is maintained during meditation. Yet another study is the habituation of the arousal response which is a part of orienting reflex. Increased ergotropic activity results in delayed habituation to orienting reflex. Increased ergotropic activity results in delayed habituation to orienting reflex. In meditation, habituation is usually absent or delayed implying increased ergotropic excitation.

In conclusion, it has been suggested that during meditation, there is not only increased trophotropic discharges leading to an increased amplitude and slightly decreased frequency of alpha waves, but also a slight activation of the ergotropic response which prevents onset of sleep stages, and also delays habituation to orienting reflex.

Conclusion

The psychophysiological indices studied in meditation and during biofeedback training indicate a shift in trophotropic/ergotropic (TE) balance towards trophotropic side. In other words, autogenic training, progressive relaxation, systematic desensitization procedures etc., can bring about a trophotropic predominance in an individual. However, only in meditation, a mild ergotropic stimulation maintains muscle tone and delayed habituation to external sensory stimuli. The ultimate result of meditation may be characterized by an emptiness of consciousness without loss of consciousness. For such a psychological state to be achieved, a conscious effort is required and hence a TE balance with both T and E system is implicated during meditation only.

The higher states of yoga consisting of pratyahara (restraining the senses), dharana (onepointedness),

dhyana (meditation) and samadhi (superconscious awareness) are still beyond the usual, known scientific tools and language. The psychic energy fields are not understood, much less accepted though they have many times been well documented [14]. They have also categorized the human substance and perceptual structure into personal and transpersonal levels. At the personal level, the dense physical is at the lowest followed by the emotional and the mental. The transpersonal level ascends from the personal, starting with the intuitional over which a vast uncharted territory of supraconscious awareness expands.

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