PHYSIOLOGY

Dynamic Characteristics of Modified Consciousness During and After Transcendental Meditation

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Dynamic features of the meditative state in 11 subjects practicing the Transcendental Meditation Program are analyzed. In each subject, an electroencephalogram (EEG) was recorded from the frontal areas before, during, and after meditation. The transition to a meditative state was marked on the EEG by a decrease in the power of slow delta and theta waves, no significant change in alpha-wave activity, and a very marked increase in beta-wave activity. The changes detected in the spectral distributions on the EEG in the meditative state tended to persist after the return to the control state.

Key Words: *electroencephalographic rhythms; Transcendental Meditation*

Studies of electrical activity in the brain of persons in modified states of consciousness have demonstrated a wide diversity of responses corresponding to those states [1,2,5,6]. Most studies of this type were aimed at finding electrophysiological correlates of the particular consciousness-modifying techniques used. The dynamic attributes of altered states of consciousness (e.g., their stability, inertness, and relation to control states) have been addressed to a much lesser extent. The lack of such information hampers understanding of the mechanisms underlying modified states of consciousness.

In the present experimental study we analyzed dynamic characteristics of the meditative state in individuals practicing the Transcendental Meditation (TM) Program [4]. We chose this program, which currently represents one of the most readily accessible and widely used TM techniques, as a possible model of consciousness modification.

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MATERIALS AND METHODS

The experiment was conducted on 11 subjects (8 men and 3 women) ranging in age from 23 to 46 years (mean age, 39) and selected from the student body and service personnel of the Maharishi International University. All the subjects had been practicing TM for 1 to 1.5 years and none of them had used any other technique of self-regulation prior to the experiment.

The control states of the subjects were periods of relaxation with the eyes shut before and after TM. The TM session lasted 5 min and the control states 2.5 min each.

During the above-mentioned functional states, the total electrical activity of the brain was recorded electroencephalographically in a soundproof chamber from frontal points Fp1 and Fp2 (according to the 10-20 system) in the bipolar mode using an Interactive Brainwave Visual Analyzer, a two-channel instrument for telemetric recording of biopotentials. For the bipolar leads, disk electrodes were used, placed 1.5 cm apart and fixed on a special tape encircling the subject's head. The electroencephalograms (EEGs) were re-

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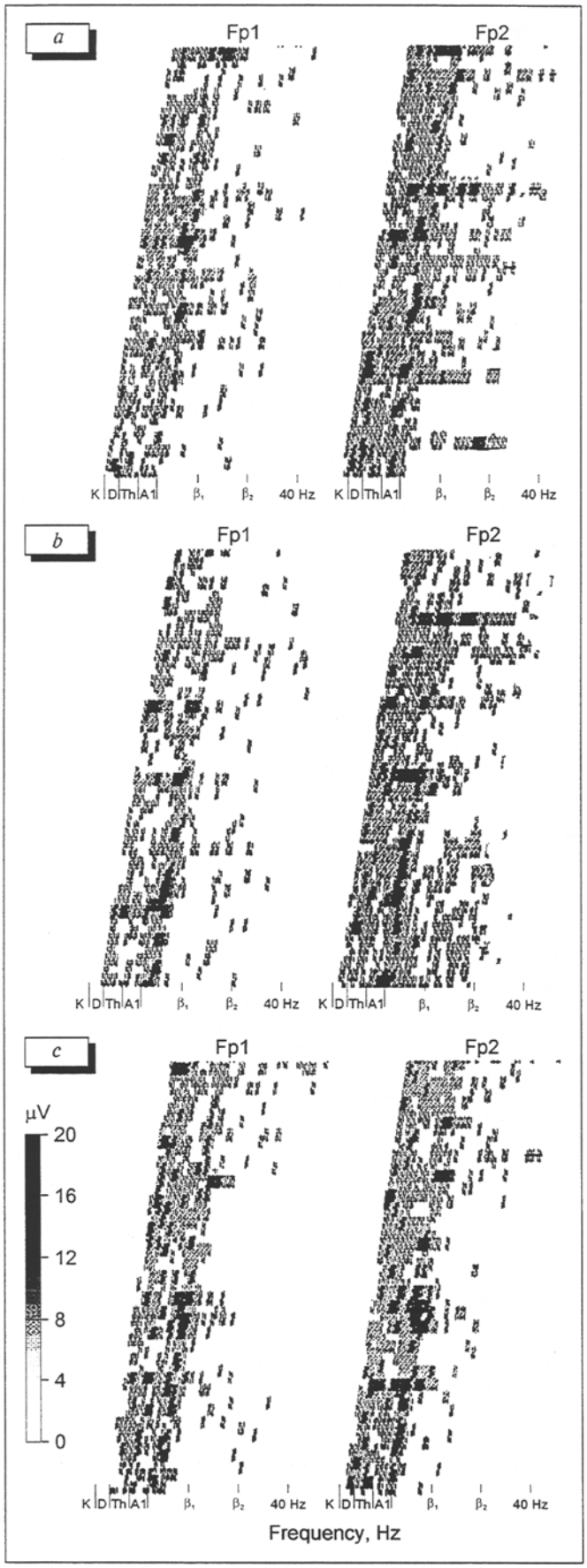

Fig. 1. Typical spectral parameters of the EEGs recorded from frontal leads Fpl and Fp2 before (*a*), during (*b*), and after (*c*) a TM session in one of the subjects. The planar power projections have densities corresponding to the absolute power values (expressed in mV) as calculated using the calibration scale shown on the right in Fig. 1, *c*.

corded on magnetic media (1.4 Mb floppy disks) and processed on-line by the method of compression spectral analysis in the frequency range 0.5-40 Hz. The results were presented and printed out as planar graphic projections of absolute spectral power values.

Characteristics of the meditative state were identified by a comparative evaluation of spectral parameters of the EEGs before, during, and after the 5-min TM session. In addition, spectral distributions in the control state before meditation were compared to those during the transition from this state to one of meditation and to those in the postmeditation control state.

RESULTS

The transition to the meditative state (Fig. 1, *b*) was accompanied by dips of the slow (delta and theta) waves on the EEGs. The spectral power of the dominant alpha-wave activity (8-12 Hz) did not change significantly, but the range of alpha waves narrowed to 10-12 Hz and a stabilization of power values was noted for the potentials in this narrowed range. Taken together, the changes observed during TM indicated an increased regularity of oscillations in the alpha range in the leads used, which agrees with the results reported by other workers [2,6]. These changes in EEG spectral composition were accompanied by marked and consistent increases in the power of high-frequency (20-30 Hz) potentials in the beta range, which was reflected in the uniform coverage by graphic projections of the corresponding frequency bands, as is exemplified in the spectrograms shown in Fig. 1. During the transition to the postmeditation control state (Fig. 1, *c*), the spectral distributions observed in the meditative state persisted in most (>80%) cases throughout the 2.5-min period of the control state. Such differences between the control states before (Fig. 1, *a*) and after (Fig. 1, *c*) the meditation session should be taken into consideration when comparing electroencephalographic correlates of TM.

The results of this study point to an inertial character of the meditative state in individuals practicing the TM Program, as is evidenced by the tendency for the altered spectral characteristics of the high-frequency (20-30 Hz) beta-wave activity to persist after the emergence from the meditative state (postmeditation effect). This property has previously been shown to be shared by the energy characteristics of rhythmic oscillations in the alpha range [3]. Regular practice of TM, even over quite a short period (up to 18 months),

can apparently result in relatively stable changes of cortical rhythmicity in meditators, and this, in turn, may pave the way toward modifying certain mechanisms of neurophysiological functioning.

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