Comparative Analysis of Alpha Rhythm Content in Spontaneous EEG Activity Among Subjects Practising the Transcendental Meditation Technique

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Abstract

Spontaneous EEG was studied in subjects who regularly practise the Transcendental Meditation (TM) technique in conditions of relaxation with open and closed eyes, and during the TM programme. In an experimental study conducted with six subjects, who each had 7–10 years experience of the TM technique, EEG was recorded in these three states from the locations Fp1 and Fp2. The results of this study indicate that TM participants show increased alpha activity in spontaneous EEG of frontal areas during eyes-open and eyes-closed relaxation states, as well as during TM practice. This increasing of alpha activity may be generated by the functional mobilization of the thalamic, cortical, and cortico-cortical coherent clusters. This last may serve as one of the possible brain mechanisms for mobilization of additional brain reserves.

INTRODUCTION

As was shown previously by experimental studies of the states of consciousness induced by the Transcendental Meditation (TM) technique [7], the main electrophysiological phenomenon which was connected with these states manifested in general synchronization of the dominant alpha activity in combination with its spreading to the foreparts of the cerebral cortex—frontal cerebral cortex areas [8].

 Obtained data allowed some researchers to put forward the general hypothesis that spontaneous EEG in subjects practising TM would contain much more alpha activity not only during practice of the TM programme, but also in states outside of these conditions—in states of relaxation with opened and closed eyes. In addition, this trend may occur not only in the spontaneous EEG of the occipital area, but in the EEG of the foreparts of the cerebral cortex—lobe and frontal areas [4,5]. The present research was designed to experimentally check this hypothesis.

METHODS

In this experimental research participated 6 subjects who were TM meditators (4 male and 2 female), chosen from the faculty and staff of Maharishi International University (now Maharishi University of Management), in Fairfield, Iowa, USA. Each of them had practised
the TM technique for 7–10 years and before participation in the experimental study had never used any other technique of self-regulation. Median age of the subjects was 39 years old (range—from 37 to 43 years old).

The experimental procedure consisted of consecutive eyes-open and eyes-closed relaxation states, at the direction of the instructions of the experimenter. In the experimental procedure, the functional states measured during the TM programme served as a control for these two relative states. A typical feature of the functional states of the TM programme, as mentioned above, was increased content of EEG alpha activity in combination with its general spreading to the foreparts of the cerebral cortex. Median duration of each of the tested and control states did not exceed 5 minutes.

During each of these functional states the EEG of subjects was recorded in a sound-protected experimental chamber. The EEG was recorded from the scalp locations Fp1 and Fp2 (10-20 system) by means of the bipolar method. The recording was conducted on the telemetric biopotentials registration complex ‘Interactive Brain Visual Analyser’ (Japan). For bipolar recording two disk electrodes (for each point’s location) with 1.5 cm distance between them were used. Each of these electrodes was fixed on a special tape fastened around the subject’s head. The digital EEG signal was evaluated ‘on-line’ by compressional spectral power analysis in 0.5–40 Hz frequency range, and simultaneously recorded on 1.4Mb floppy disks. The data obtained from compressional power spectral analysis was presented as the plane projections of the power spectral values, the density of which corresponds to their absolute values.

RESULTS

The comparison of EEG spectral characteristics of the measured cortical areas during relaxation eyes-opened state (fig. b) with dynamics of EEG spectral parameters for the TM programme state (fig. c) revealed considerable similarities of the analyzed EEG parameters for these two states, in most (83.3%) of the subjects. As during practice of the TM programme, the main spectral power values of EEG recorded in symmetrical frontal areas in states of relaxation with closed eyes were concentrated mainly in the alpha activity range—from 8 to 13 Hz. The marked tendency was quite stable and continued throughout the period of analysis of this functional state. As a result of this marked similarity of EEG spectral power values, there was not a clear boundary of dynamic transition from relaxation closed eyes state to the meditative state. It is necessary to emphasize that this marked similarity was not absolute and it demonstrated only the similarity of electrographic reflection of these functional states. The stable pattern of alpha activity in frontal lobe leads in subjects in relaxation eyes closed state is possible to consider as an original phenomenon, because in normal states of consciousness the topology of spatial distribution of alpha activity in most cases has marked regional differences, with its main localization at the back of the brain—parietal and occipital cortex areas.

During comparative analysis of EEG spectral power characteristics for the relaxation eyes-open (fig. a) and eyes-closed (fig. b) the dominance of alpha activity was marked in these electrode locations; however for the first states (eyes-opened) the spectral EEG distribution was combined with non-zero values of spectral power corresponding to the fast oscillations of
the beta range. Thus, the common contribution of alpha activity to the spectral distribution of EEG lobe locations in subjects during relaxation eyes-opened states was quite higher.

The observed data demonstrates that spontaneous EEG measured at the foreparts of the brain cortex in subjects practising the TM Programme is characterized by the considerable dominance of alpha activity (8–13 Hz), as indicated by the high level of spectral power values for oscillations of this frequency range. The dominance of alpha activity at these electrode locations takes place not only during the practice of the TM Programme, as was shown previously, but also in background EEG activity during eyes-opened and eyes-closed states among TM Programme participants.

The increased presence of alpha activity and its topological spatial distribution in the functional states of eyes-closed and eyes-opened relaxation suggests considerable expansion of subcortical relationships; primarily thalamic, cortical, and cortico-cortical coherent clusters formed by the corresponding neurons may create the necessary conditions for the possibility of generation and dominance of alpha activity at the foreparts of the brain cortex [6]. It may be possible that this dominance of alpha activity in frontal areas is a consequence of regular and long-time practice of the TM Programme by subjects, because the practice of the technique is connected with the involvement and mobilization of the additional reserve abilities of the brain [3]. From this point, it is possible to suggest that mechanisms of involvement of these additional reserve abilities in some manner, for example as a result of formed and stable reaction due to repeated performance, is responsible for the states directly measured during the practice of the TM Programme.

Considering the functional significance of these findings, if we consider EEG to reflect the function of the brain state and region [2], and based on the fact that the alpha activity dominant oscillatory mode of organization of the electric patterns, found in these subjects, is providing an integration of anatomically distributed cortical areas into one whole [6], it may be possible to suggest that spectral and topological EEG features obtained in the relaxation states of TM participants are reflecting the processes of functional consolidation, and possibly simultaneous activation, of large numbers of neuronal groups of the cerebral cortex, including its foreparts.

References


Caption to figure:

The dynamics of EEG spectral power parameters of Fp1 and Fp2 leads in a sample TM subject (a) during the eyes-opened and (b) eyes-closed relaxation states, and (c) during practice of the TM Programme.

On the abscissa (x-axis) is frequency in Hz. The y-axis is time. The density of plane projections of power spectral values corresponds to the power spectral power absolute values (in microvolts) which is calculated with the applied calibration scale.