

Badawi K; Wallace RK; Orme-Johnson D; Rouzere AM

*Electrophysiologic characteristics of respiratory suspension periods occurring during the practice of the Transcendental Meditation Program.*

Psychosom Med 1984 May-Jun;46(3):267-76

Abstract:

In a study designed to identify the electrophysiologic characteristics of the Transcendental Meditation Program, 52 periods of spontaneous respiratory suspension (RS) were observed in 18 subjects during the practice of this program. These periods were correlated with some but not all the subjective experiences of pure consciousness. Nineteen RS periods (belonging to 11 subjects) free from any artifact were selected for EEG analysis. The mean total EEG coherence over all frequencies and over nine derivations for TM subjects showed a significant increase during the RS periods as compared to pre- and post-RS control periods. There was no significant change in mean total EEG coherence in a control group of 30 subjects voluntarily holding their breath. The heart rate showed a significant decrease during the RS periods in both the experimental and control groups, whereas there was no significant change in EEG alpha power in either group. These findings extend those of previous studies and help characterize the physiologic correlates of the state of pure consciousness during the TM program.

## Barolin GS

*Experimental basis for a neurophysiological understanding of hypnoid states.*

Eur Neurol 1982 Jan-Feb;21(1):59-64

Abstract:

We postulate the hypnoid state of the human organism to be a third possible state besides waking and sleeping. This state can be equally induced by heterohypnotic and by autohypnotic means, by various techniques for meditation, relaxation and psychotherapy as well. It forms a basal status of the organism with partial deprivation of external stimuli. Out of this deprivation derives the possibility of stronger concentration on special stimuli (such as hypnotic suggestions) which would hence be able to act stronger in this state than in the waking state. Thus, it is possible to change external stimuli within their subjective perception (probably by ways of a subcortical modulating effect derived from the hypnotic suggestion). However, within their bioelectric parameters the stimuli pass unchanged through the peripheral receptor up to the cortex, which is measurable. If somebody produces actions within the hypnoid state these actions will have the same neurophysiological correlate as in the waking state, which means desynchronization. This does not exclude such actions (by concentration in the hypnoid state) having a stronger effect than in the waking state and/or having a different subjective perception.

Benson H; Malhotra MS; Goldman RF; Jacobs GD;  
Hopkins PJ

*Three case reports of the metabolic and electroencephalographic changes during advanced Buddhist meditation techniques.*

Department of Medicine, New England Deaconess Hospital, Boston.

Behav Med 1990 Summer;16(2):90-5

Abstract:

To examine the extent to which advanced meditative practices might alter body metabolism and the electroencephalogram (EEG), we investigated three Tibetan Buddhist monks living in the Rumtek monastery in Sikkim, India. In a study carried out in February 1988, we found that during the practice of several different meditative practices, resting metabolism (VO<sub>2</sub>) could be both raised (up to 61%) and lowered (down to 64%). The reduction from rest is the largest ever reported. On the EEG, marked asymmetry in alpha and beta activity between the hemispheres and increased beta activity were present. From these three case reports, we conclude that advanced meditative practices may yield different alterations in metabolism (there are also forms of meditation that increase metabolism) and that the decreases in metabolism can be striking.

Corby JC; Roth WT; Zarccone VP Jr; Kopell BS

*Psychophysiological correlates of the practice of Tantric Yoga meditation.*

Arch Gen Psychiatry 1978 May;35(5):571-7

Abstract:

Autonomic and electroencephalographic (EEG) correlates of Tantric Yoga meditation were studied in three groups of subjects as they progressed from normal consciousness into meditation. Groups differed in their level of meditation proficiency. Measures of skin resistance, heart rate, respiration, autonomic orienting responses, resting EEG, EEG alpha and theta frequencies, sleep-scored EEG, averaged evoked responses, and subjective experience were employed. Unlike most previously reported meditation studies, proficient meditators demonstrated increased autonomic activation during meditation while unexperienced meditators demonstrated autonomic relaxation. During meditation, proficient meditators demonstrated increased alpha and theta power, minimal evidence of EEG-defined sleep, and decreased autonomic orienting to external stimulation. An episode of sudden autonomic activation was observed that was characterized by the meditator as an approach to the Yogic ecstatic state of intense concentration. These findings challenge the current "relaxation" model of meditative states.

Delmonte MM

*Electrocortical activity and related phenomena associated with meditation practice: a literature review.*

Int J Neurosci 1984 Nov;24(3-4):217-31

Abstract:

The state effects of meditation appear to include decreased electrocortical arousal. There is also evidence that meditators more readily demonstrate alpha and theta activity than nonmeditators, even when not meditating. It is not clear whether prospective meditators as a group already possessed this characteristic, or whether the state effects of meditation practice eventually generalize to become traits. However, certain individuals, namely the psychologically "healthy" and those with a capacity for relaxed absorbed attention, appear to be more favourably disposed to meditation. Meditators appear to show both stronger orienting and recovery responses to stressors while meditating than controls. Meditation practice may begin with left hemisphere type activity, which gives way to functioning more characteristic of the right hemisphere. However, it appears that during advanced meditation ("no thought") both left and right hemisphere activity are largely inhibited or suspended. Depending on the individual, inexperienced meditators may report sleep, hypnogogic reverie, trance or abreaction during practice. The evidence to date does not support the notion of unique state effects associated with the practice of meditation.

Dillbeck MC; Bronson EC

*Short-term longitudinal effects of the transcendental meditation technique on EEG power and coherence.*

Int J Neurosci 1981;14(3-4):147-51

Abstract:

EEG alpha coherence and slow alpha power were recorded from frontal and occipital derivations during relaxation or the Transcendental Meditation (TM) technique in fifteen subjects. Subjects were tested before and after a two-week baseline period in which half practiced twice daily relaxation and half did not change their schedule. All subjects were then instructed in the TM technique and retested after a two-week period of twice daily practice of the technique. During the first two-week period there were no group differences or group by session interactions, but there was a significant effect of repeated measurement, indicating a decrease in occipital power independent of group. After the two-week TM technique period, subjects showed a significant increase in frontal alpha coherence above a 0.95 threshold. Frontal alpha coherence was found to be a more sensitive discriminator of the TM technique than alpha power, which may clarify previously reported nonsignificant EEG differences between the TM technique and general relaxation.

Dillbeck MC; Vesely SA

*Participation in the transcendental meditation program and frontal EEG coherence during concept learning.*

Int J Neurosci 1986 Mar;29(1-2):45-55

Abstract:

This study assesses variation in frontal bilateral EEG coherence among normal subjects during trials of a concept learning task; the task used a concept-reversal paradigm found from prior research to distinguish frontal lobe patients from normal adults. Subjects were either participants in the Transcendental Meditation (TM) program or controls matched for age, sex, and intellectual ability, and additional experimental factors were whether or not the subject gained information on a given trial and whether or not the trial occurred before, during, or after the shift of concept. It was hypothesized that: (1) higher frontal EEG coherence (alpha and beta frequencies) would be associated with trials on which information was gained; (2) higher coherence in the same frequencies would be found in the two concept-solution periods in contrast to the concept-reversal period that divided them; and (3) these patterns would be more clearly expressed among TM program participants. Each hypothesis received partial support. The first hypothesis was true only for TM program participants for alpha coherence, and only during the first concept-solution period for beta coherence. The second hypothesis was true for alpha coherence only, and the third hypothesis received support for alpha coherence. Results were not

attributable to muscle or eye artifacts. However, a different response style was found to the change in concept among the two groups; control subjects displayed greater arousal (muscle artifact) during the concept-reversal period, while TM program participants displayed less arousal.



## Freed S

*Implications of physiological and behavioral states of extremely low noise-levels for acupuncture.*

Acupunct Electrother Res 1985;10(4):297-303

Abstract:

On the basis of reported results it is here postulated that acupuncture induces states of exceptionally low noise-level and that it shares essential features with the "quiet: of meditation. Noise, in the present context, can be represented by physiological interactions with factors that have no relevance to the nature of the essential physiological activities. These are "disturbed" by the noise. Decreasing relative noise-levels for a given signal are illustrated informationally by thermal noise in physics, chemistry, and physiological chemistry. Information, as noise decreases, becomes less diffuse and concurrently the perceived signals becomes sharper, more specific, and effectively more intense. Sharp differentiation becomes evident between formerly blurred signals. Weak signals ordinarily lost in the background become recognizable. Equivalent refinements in perception are cited by Zen Buddhist practitioners during and because of meditation. We are thus led to ascribe similar refinement during acupuncture to physiological activities, in particular, to those of the cerebral cortex. Thus, the processing and flow of physiological information have become more specific, sensitive, and comprehensive for regulation and for restoration to normal function.

Gallois P

*[Neurophysiologic and respiratory changes during the practice of relaxation technics]*

Language: Fre

Encephale 1984;10(3):139-44

Abstract:

A polygraphic study, of 40 minutes duration, among 10 subjects who practiced autogenic training (TA) and 10 subjects who practiced transcendental meditation (MT), compared to 10 control subjects, gave the following results: rarity of the number of sleeping episodes during relaxation, cardiac rhythm, significantly decreased in the TM group, increased stability of the E.D.G. during and after relaxation, respiratory rate decreased to a value of 33% of the initial rate, respiratory suspensions were frequent in the TM group, reaching a maximal duration of 50 seconds. The absence of compensatory hypercapnia and hyperpnea is an argument in favor of their central origin, lastly, the simple reaction time after relaxation is slightly decreased, whereas it is increased in the controls, this aerobic hypometabolic state, the stability of the autonomic nervous system and the maintenance of the vigilance, induced by deep relaxation, seems to be the opposite of the state which is induced by stress; therefore deep relaxation may play a role in a psycho-somatic approach to treating a variety of disease states.

Gaylord C; Orme-Johnson D; Travis F

*The effects of the transcendental mediation technique and progressive muscle relaxation on EEG coherence, stress reactivity, and mental health in black adults.*

Int J Neurosci 1989 May;46(1-2):77-86

Abstract:

Eighty-three black college students, staff and adults were pretested on EEG coherence, skin potential (SP) habituation to a series of loud tones, psychometric measures of mental health (Tennessee Self-Concept Empirical Scales and Spielberger State-Trait Anxiety Inventory) and IQ. They were then randomly assigned to one of the three treatment groups: the Transcendental Meditation technique (TM); Progressive Muscle Relaxation (PR); or cognitive-behavioral strategies (C). Approximately one year later, they were posttested. TM and PR increased significantly on an overall mental health factor ( $p$  less than .036) and anxiety ( $p$  less than .0006). TM showed a greater reduction in neuroticism than PR and C ( $p$  less than .032). TM also showed global increases in alpha and theta coherence among frontal and central leads during the TM period compared to eyes closed ( $p$  less than .016), whereas PR and C did not show EEG state changes. The coherence increases during TM were most marked in the right hemisphere (F4C4). TM showed faster SP habituation at posttest compared to pretest ( $p$  less than .047) whereas PR did not (data was missing for C). None of the groups showed longitudinal changes in EEG, perhaps due to lack of regularity of participation in the treatment programs.

Hebert R; Lehmann D

*Theta bursts: an EEG pattern in normal subjects practising the transcendental meditation technique.*

Electroencephalogr Clin Neurophysiol 1977 Mar; 42(3): 397-405

Abstract:

In a survey of the EEG characteristics of persons practising the Transcendental Meditation technique, 21 of 78 people demonstrated intermittent prominent bursts of frontally dominant theta activity. On the average across subjects, the theta bursts occurred about every 2 min, had an average duration of 1.8 sec, and an average maximal amplitude of 135  $\mu$ V. Typically, the 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. Fifty-four non-meditating controls showed no theta bursts during relaxation and sleep onset. 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.

## Lerner M

*[Recent medical research on yoga and states of concentration]*

Language: Spa

Acta Psiquiatr Psicol Am Lat 1975 Mar;21(1):56-63

Abstract:

Traditional oriental thinking attracts the growing scientific interest of occidental practitioners. Dr. Pierre Et:evenon, head of the Department of Neuro-Psycho-Pharmacology at the French Institute for Health and Medical Research (INSERM), held several conversations and scientific exchanges with the author, and kindly provided copies of some of his works. They are at the basis of the present paper. M. A. Descamps (Paris) found that asanas--yoga postures-- are generators of dynamic action when there is an extension of the spinal column, whilst they lead to quiet states when there is a flexion of it. Claeys and Gones (Belgium) proved that overall global relaxation, as well as differential relaxation were far more effective and deep when obtained by yogis than those attempted by University students majoring in Physical Education. Lonsdorfer and Nussbaum (France) studied several parameters concerning hatha-yoga and concluded that it provides a regular functioning of the main bodily functions fostering thus a psycho-physical balance. Wallace and Benson (U.S.A.) proved that transcendental meditation increases aerobic metabolism, counteracting anaerobic metabolism which is related to mental distress. Et:evenon (Paris) investigated neurophysiological effects of yoga in

connection to ancient Indian concepts (Upanishads) on sleeping, meditation and degree of consciousness. Dr. Et:evenon has studied the phylogenetic evolution of waking-sleeping cycles, focusing on phylogenetic and ontogenetic appearances of REM cycles (activated sleep). A correlation has been made with EEG studies during states of concentration (yoga, transcendental meditation, Zen). These states have been found to be specific brain activities, and different from deep sleep, in spite of certain similarities in the EEG. Several hypothesis are set forth to explain brain activities underlying sites of concentration. The possibilities of developing a conscious mastering of dreams are also under research, and special attention is paid to the works of Saint Denys (1867), and hindu tradition. This paper discusses also the psychological, therapeutic and anthropological implications of recent discoveries in the field.

Orme-Johnson D; Dillbeck MC; Wallace RK; Landrith GS  
3d

*Intersubject EEG coherence: is consciousness a field?*

Int J Neurosci 1982 May;16(3-4):203-9

Abstract:

EEG coherence was measured between pairs of three different subjects during a one-hour period practice of the Transcendental Meditation (TM) program. Coherence between subjects was evaluated for two sequential fifteen minute periods. On six experimental days, these periods preceded and then coincided with a fifteen minute period during which 2500 students participated in the TM-Sidhi program at a course over 1000 miles away. After the course had ended coherence was evaluated on six control days. It was found that intersubject coherence was generally low, between 0.35 and 0.4, with coherence in the alpha (8-12 Hz) and beta (16-20 Hz) frequencies significantly higher than at other frequencies. On the experimental days, intersubject EEG coherence increased during the experimental period relative to the fifteen minute baseline period immediately preceding the experimental period. Coherence increased significantly from baseline to experimental periods on experimental days compared with control days ( $p = 0.02$ ). This effect was particularly evident in the alpha and beta frequencies. The results reinforce previous sociological studies showing decreased social disorder in the vicinity of TM and TM-Sidhi participants and are discussed in terms of a field theoretic view of consciousness.

Pagano RR; Rose RM; Stivers RM; Warrenburg S

*Sleep during transcendental meditation.*

Science 1976 Jan 23;191(4224):308-10

Abstract:

Five experienced practitioners of transcendental meditation spent appreciable parts of meditation sessions in sleep stages 2, 3, and 4. Time spent in each sleep stage varied both between sessions for a given subject and between subjects. In addition, we compare electroencephalogram records made during meditation with those made during naps taken at the same time of day. The range of states observed during meditation does not support the view that meditation produces a single, unique state of consciousness.



Persinger MA

*Striking EEG profiles from single episodes of glossolalia and transcendental meditation.*

Percept Mot Skills 1984 Feb;58(1):127-33

Abstract:

Transient, focal, epileptic-like electrical changes in the temporal lobe, without convulsions, have been hypothesized to be primary correlates of religious experiences. Given these properties, direct measurement of these phenomena within the laboratory should be rare. However, two illustrated instances have been recorded. The first case involved the occurrence of a delta-wave-dominant electrical seizure for about 10 sec. from the temporal lobe only of a Transcendental Meditation teacher during a peak experience within a routine TM episode. The second case involved the occurrence of spikes within the temporal lobe only during protracted intermittent episodes of glossolalia by a member of a pentecostal sect. Neither subject had any psychiatric history. These observations are commensurate with the hypothesis that religious experiences are natural correlates of temporal lobe transients that can be detected by routine EEG measures.

Stigsby B; Rodenberg JC; Moth HB

*Electroencephalographic findings during mantra meditation (transcendental meditation). A controlled, quantitative study of experienced meditators.*

Electroencephalogr      Clin      Neurophysiol      1981  
Apr;51(4):434-42

Abstract:

The EEGs of 13 experienced practitioners of transcendental meditation (TM) were recorded for 5 min preceding TM, during 20 min of TM and until 5 min after, as well as during closed-eyed wakefulness, drowsiness, sleep onset and sleep. Thirteen healthy volunteers matched for age served as control subjects. Computer period-amplitude analysis of F3-C3, T3-T5, P3-O1, F4-C4 and P4-O2 epochs of 50--100 sec duration resulted in a frequency and amplitude spectrum (0.5--28.6 c/sec), and the mean frequency and the mean voltage of each EEG lead. The EEG frequency spectra constituted a continuum with increasing theta and delta activity and decreasing alpha activity as the participants tended to fall asleep. The frequency spectrum during TM corresponded to a spectrum situated between that of wakefulness and drowsiness and remained virtually unchanged during the 20 min of meditation. The EEG mean frequency of the TM group was about 1 c/sec slower than that of the control group. Intra- or interhemispheric differences between quantities of EEG activity remained stable during TM, nor did we observe any theta bursts. There was no consistent EEG patten associated with a successful or unsuccessful meditation, nor did the EEGs of two meditators who stated they had felt drowsy during TM show a different pattern.

Tebecis AK

*A controlled study of the EEG during transcendental meditation: comparison with hypnosis.*

Folia Psychiatr Neurol Jpn 1975;29(4):305-13

Abstract:

A controlled, quantitative investigation of the electroencephalogram (EEG) and transcendental meditation (TM) revealed that EEG changes during TM were rarely as pronounced or consistent as previous reports suggest. There was considerable variation between subjects, some displaying no EEG changes at all during TM compared with an equal period of non-meditation. Any changes that did occur in a particular individual were not necessarily repeated in a subsequent session. A comparison of mean EEG parameters of the experimental group revealed no consistent significant differences between meditation and non-meditation, although trends towards increased theta and decreased beta activity during meditation were apparent. The biggest differences in mean EEG parameters were between subject groups. In particular, the group of meditators exhibited significantly more theta activity (during both TM and non-meditation) than a randomly selected group of individuals that had never meditated or been hypnotized. The EEG characteristics of the group of meditators were similar to those of a group of subjects experienced in self-hypnosis. It is concluded that the most obvious EEG changes during meditation are long-term. In people who regularly practise TM (or self-hypnosis), the EEG gradually (over weeks or months) tends to "slow down.": Such a "slowed down: EEG is apparent during both normal waking conditions and altered states of consciousness in these individuals.

Travis FT; Orme-Johnson DW

*Field model of consciousness: EEG coherence changes as indicators of field effects.*

Int J Neurosci 1989 Dec;49(3-4):203-11

Abstract:

Changes in EEG coherence patterns were used to test a field model that posits a common field of "pure consciousness: linking all individuals. In ten trials, EEG was concurrently measured from pairs of subjects, one practicing Transcendental Meditation (TM) and the TM-Sidhi technique of "Yogic Flying: (YFg)--said to enliven the proposed field of consciousness--and the other performing a computer task. Box-Jenkins ARIMA transfer function analysis indicated that coherence changes in the YF's 5.7-8.5 Hz band, the band sensitive to TM and YFg, consistently led coherence changes in the other subject's 4.7-42.7 Hz band. A clear relationship was seen among subjective reports, coherence patterns, and strength of intervention effects. These data support a field model of consciousness. Alternate explanations are explored.

Wachsmuth D; Dolce G

*[Visual and computerized analysis of EEG during transcendental meditation and sleep (author's transl)]*

Language: Ger EEG EMG 1980 Dec;11(4):183-8

Abstract:

Polygraphic records (EEG, EOG, heart rate) were obtained of 5 subjects during and after transcendental meditation (TM) as well as during night sleep. The records were analyzed twice. During TM the amplitude of the alpha-waves was higher as before TM and appeared continuously. Bilateral theta-bursts were also observed. The same EEG changes were seen during relaxation with closed eyes. The discriminance-analysis of 5 frequency-bands of the EEG recorded from C3 showed either no differences in dominant frequency, power and variance. No differences were observed between the flat EEGs recorded during TM or sleep. The heart rate was significantly slower during meditation or light sleep - when a flat EEG (stage 1) was recorded - as when the recording showed an alpha-rhythm. The vigilosomnograms of all our subjects were normal. The subjects reported that they experienced an increased relaxation, alertness and floating consciousness. They were able to maintain themselves for unusually long time in a state of decreased alertness (stages W1;10).

Waxman J

*A finite state model for meditation phenomena.*

Percept Mot Skills 1979 Aug;49(1):123-7

Abstract:

Various reports of brain wave synchrony during Transcendental Meditation have appeared in the literature and have been interpreted as indicating a heightened state of integration of brain function. We suggest that this observed synchrony rather than indicating a greater integration of brain function might be an artifact of parts of the brain acting like a finite state machine. The finite state model is developed, its properties derived and a test for the hypothesis is presented.

West MA

*Meditation and the EEG.*

Psychol Med 1980 May;10(2):369-75

Abstract:

Previous research on meditation and the EEG is described, and findings relating to EEG patterns during meditation are discussed. Comparisons of meditation with other altered states are reviewed and it is concluded that, on the basis of existing EEG evidence, there is some reason for differentiating between meditation and drowsing. Research on alpha-blocking and habituation of the blocking response during meditation is reviewed, and the effects of meditation on EEG patterns outside of meditation are described. In conclusion, the need for more precisely formulated research is pointed out.

Williams P; West M

*EEG responses to photic stimulation in persons experienced at meditation.*

Electroencephalogr Clin Neurophysiol 1975  
Nov;39(5):519-22

Abstract:

The EEG responses to intermittent photic stimulation were examined in a group of subjects experienced in meditation, and compared with those of a control group. The meditators exhibited a significantly smaller decrement in alpha activity and alpha blocking over the course of the experiment than did the control group, and alpha induction occurred earlier and more frequently in the meditators. These findings support the hypothesis that experienced meditators spontaneously enter the meditative state on closing the eyes, and also the view that physiologically the meditative state is one of prolonged drowsiness. An alternative interpretation, that meditation is a state of sustained attention, is discussed.



Woolfolk RL

*Psychophysiological correlates of meditation.*

Arch Gen Psychiatry 1975 Oct;32(10):1326-33

Abstract:

The scientific research that has investigated the physiological changes associated with meditation as it is practiced by adherents of Indian Yoga, Transcendental Meditation, and Zen Buddhism has not yielded a thoroughly consistent, easily replicable pattern of responses. The majority of studies show meditation to be a wakeful state accompanied by a lowering of cortical and autonomic arousal. The investigations of Zen and Transcendental Meditation have thus far produced the most consistent findings. Additional research into the mechanisms underlying the phenomena of meditation will require a shifting from old to new methodological perspectives that allow for adequate experimental control and the testing of theoretically relevant hypotheses.