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Sleep During Transcendental Meditation

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.*

In 1970, Wallace reported several physiological changes observed during transcendental meditation (TM) (*1*). His results were replicated and extended by Wallace, Benson, and Wilson (*2*) and they were subsequently made available to a wider audience (*3*). They found, in meditating subjects, reduced oxygen consumption, increased skin resistance, increased alpha activity in the electroencephalogram (EEG), decreased heart rate, and decreased blood lactate. Although many of these changes take place in ordinary relaxed wakefulness and in sleep, Wallace and his co-workers postulated that, during most of the meditation period, experienced practitioners of TM enter a single, unique state of consciousness, a "wakeful hypometabolic state," that differs from ordinary relaxed or sleep states.

The Stanford Research Institute estimates that, from a few hundred in 1965, the number of practitioners of TM has increased to more than 240,000 as of June 1973. Estimates from the TM organization indicate that this number now exceeds 900,000 (*4*). The findings of Wallace and his co-workers are often cited to prospective meditators and may have played an important role in producing this increase.

We have found that meditators spend considerable time in sleep stages 2, 3, and 4 during meditation; their subjective reports of sleep confirm our analysis of the EEG records. Further, our data suggest that the meditation period is not spent in a single, unique, wakeful, hypometabolic state.

The five subjects we observed had at least 2.5 years of experience with TM, and four of them were teachers of the technique. All were male Caucasians between the ages of 20 and 30, accustomed to meditating for 40-minute periods twice each day, and not in the habit of napping. Subjects reported, on the average, 7.8 hours of sleep per night.

Psychophysiological measures were made on each subject during ten sessions, each of which lasted 40 minutes. During five of these sessions, the subjects were asked to meditate in their accustomed sitting position, and in the other five sessions, they were asked to nap lying down on a bed. The first nap and the first meditation were scheduled on the first observation day. The data collected on this day are not included for analysis here because initial unfamiliarity with the laboratory situation produces atypical sleeping patterns (*5*). On eight subsequent days, subjects were asked either to meditate or to nap. These sessions were all conducted in the afternoon within 2 hours of the same time each day. The order in which the two types of sessions were scheduled followed an irregular pattern, and subjects were not told whether they would be asked to meditate or to nap on a particular day until they arrived in the laboratory. If a subject reported that his previous night's sleep was more than 30 minutes shorter than normal, he did not take part on that day. Subjects were asked not to consume food, coffee, or tea for at least 2 hours before each session.

At the beginning of each session, electrodes were applied so that occipital, central, and frontal EEG responses, eye movements, submental (below the chin) muscle potentials, and skin resistance level could be measured (*6*). The subject then moved to the room where he was to meditate or nap. A 45-db white noise partially masked any disturbance from the adjoining apparatus room (*7*). The room in which the subject sat during meditation was dimly illuminated, but the room was dark when the subject lay down to nap. Once the recording was proceeding smoothly, the subject was asked to relax for 5 minutes with his eyes closed, and then a signal was given to begin meditation or napping. After 40 minutes, an identical signal required the subject to stop meditating or napping and to relax with his eyes closed for an additional 5 minutes before leaving the recording room. At the end of the session, the subject filled out a questionnaire on his subjective impressions of what had transpired and stated whether he had slept or become drowsy during the meditation or nap.

The most striking feature of our data is that meditators spent appreciable amounts of time in EEG sleep stages 2, 3, and 4 while they were meditating (Fig. 1). Averaged over meditation sessions, we found that 39 percent of the time was spent in wakefulness (stage W), 19 percent in stage 1, 23 percent in stage 2, and 17 percent in stages 3 or 4. More than a quarter of the meditation time was spent in stages 2, 3, or 4 in 13 out of the 20 meditation sessions (Table 1). It is customary to identify stages 2, 3, and 4 as sleep and stage 1 as drowsiness (*8*); according to these conventional designations, our subjects were asleep dur-

Table 1. Percentage of time spent in stages 2, 3, or 4 during each session.

Subject	Meditation session				Nap session			
	1	2	3	4	1	2	3	4
1	51	90	59	78	37	41	59	62
2	0	0	0	26	78	92	79	58
3	49	0	0	78	86	31	83	89
4	0	90	59	74	18	38	95	88
5	37	0	86	31	95	95	93	78

Table 2. Percentage of time spent in each stage, averaged over sessions.*

Subject	Meditation				Nap			
	W	1	2	3, 4	W	1	2	3, 4
1	19	12	42	27	32	17	40	10
2	44	46	6	0	7	14	62	14
3	53	15	16	15	15	12	31	41
4	37	6	28	27	31	8	51	9
5	43	17	23	15	1	7	54	36

*These percentages do not sum to 100 because some epochs were scored as movement time.

ing, on the average, 40 percent of their meditation time.

Meditation might produce a dissociation between the EEG and consciousness that would permit a subject to be awake even though his EEG record indicated sleep (*9*). However, this does not appear to have occurred in our study, because our subjects reported having slept in 12 of the 13 meditation sessions in which patterns of stages 2, 3, or 4 appeared. In addition, they reported feeling drowsy in 18 of the 19 sessions during which they spent more than 30 seconds in stage 1. The consistency of the reports with the EEG rcords indicates that the conventional EEG criteria defining sleep and drowsiness were applicable.

No rapid eye movement (REM) sleep was observed during either the meditations or the naps. This is probably because we conducted all sessions during the afternoon and limited each session to a length of 40 minutes; REM sleep does not normally occur during the first 40 minutes of an afternoon nap (*10*).

Although meditation in a laboratory might lead to a state different from that outside the laboratory, our subjects' ratings of their meditations indicated that in 7 of the 13 sessions in which stage 2 was observed, the subject rated his meditation as typical rather than atypical. Further, on a 7-point scale from 7 (very deep) to 1 (very light), the modal depth of meditation was 5, and there was no significant correlation between reported depth of meditation and the amount of time asleep. Thus, in several meditations described as typical and relatively deep, considerable amounts of sleep occurred. This corroborates reports that we have received from these and other meditators that they occasionally fall asleep while meditating in their normal settings.

If TM produces the wakeful state described by Wallace (*1*), one would expect to find less sleep during meditation than during a nap period. An analysis of variance of time spent in sleep stages 2, 3, or 4 revealed no significant differences between meditation and nap sessions ($F = 3.2$, $P > .1$). Because we obtained repeated measures over sessions for each subject, we also carried out individual *t*-tests on each subject's data. Only in subject 2 was there a significant difference ($t = 7.3$, $P < .01$) indicating fewer EEG sleep patterns during meditations than during naps. Because of the high variability in the states observed, we caution against the conclusion that meditation and napping produce identical distributions of EEG stages.

One of the striking features of our data was the variability in the time spent in the various EEG stages both for a single subject (from meditation to meditation) and between subjects (Tables 1 and 2). For example, subject 2 slept in only one of his four meditations, whereas subject 1 slept more than half the time in each of his four meditations. Subjects 3, 4, and 5 each had at least one meditation in which they did not sleep at all and another in which they slept for more than three-fourths of the session. What emerges from these EEG findings is that meditation is an activity that gives rise to quite different states both from day to day and from meditator to meditator.

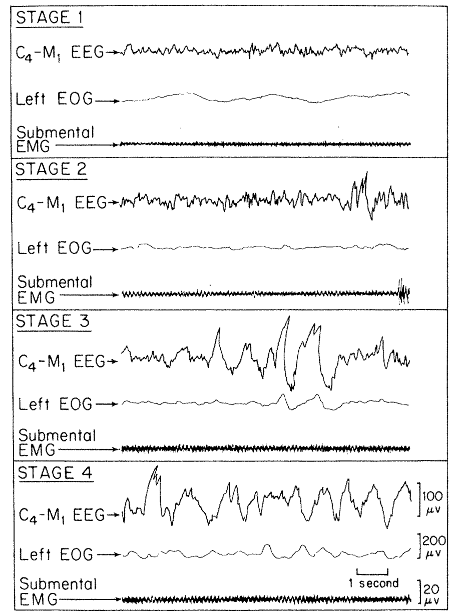

Fig. 1. Representative records from subject 5 during a meditation session. The time scale and channel gain are shown on the stage 4 record.

Our data differ from the EEG responses reported by Wallace (*1*). Only 4 of his 15 subjects occasionally evidenced drowsiness, and he states, "The EEG pattern during meditation clearly distinguishes this state from the sleeping state. There are no slow (delta) waves or sleep spindles, but alpha-wave activity predominates." Several factors may account for the differences between Wallace's data and ours. He reported on records from just one session per subject, presumably the first experience for the subject in the laboratory. In addition, many of his subjects meditated while breathing through a mouthpiece or with arterial cannulae or rectal thermometers in place (*1, 2*). Both of these factors would probably tend to activate the EEG more than would be expected in a normal meditation session outside the laboratory.

Wallace's subjects meditated for 20 to 30 minutes, whereas our sessions lasted 40 minutes; it could be argued that sleep was more likely to occur in our longer sessions. But when we examined the data from the first 20 minutes of each of our subject's meditations, the discrepancies remained: In the first 20 minutes, an average of 42.5 percent of the time was spent in sleep stages 2, 3, and 4.

In three other studies EEG responses were recorded during transcendental meditation: Younger *et al.* report that advanced meditators spent 41 percent of their meditations in sleep stages 1 and 2 (*11*); Wada and Hamm also found sleep stages 1 and 2 in the EEG records of both experienced and inexperienced meditators (*12*); Banquet recorded EEG responses during meditation but did not present an analysis by sleep stage (*13*). He did, however, mention the presence of "short bursts of large amplitude delta waves identical to those of sleep stage 4."

The results of Younger *et al.*, of Wada and Hamm, and of this experiment raise the question of whether the beneficial effects reported for meditation (*14*) are due to the sleep that occurs during meditation or to some other feature of that process.

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6. Electrodes for the EEG were placed according to the international 10-20 system, and recordings were taken between each of leads O_2, C_4, and F_4 and a reference electrode on the opposite mastoid. A Beckman Dynograph (type RM) was used to record the data, and the records were scored according to the criteria of Rechtschaffen and Kales [A. Rechtschaffen and A. Kales, Eds., *A Manual of Standardized Terminology, Techniques, and Scoring System for Sleep Stages of Human Subjects* (Public Health Service Publ. No. 204, Government Printing Office, Washington, D.C., 1968), pp. 8–15]. The scorers had no knowledge of the condition under which a record was made; the agreement between the two scorers averaged 93 percent.
7. In order to make additional comparisons between meditation and naps beyond those that we report here, a 45-db, 600-hertz tone of 0.5-second duration was presented on an irregular schedule averaging one presentation per minute. This tone was found to evoke EEG responses without disturbing the course of meditation, as judged by pilot subjects. In this report we present only the sleep stage and sleep report data. The galvanic skin responses and the responses to the tone have not yet been analyzed.
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Stress-Induced Hyperphagia and Obesity in Rats: A Possible Model for Understanding Human Obesity

Abstract. *Mild tail pinch administered to rats several times daily in the presence of sweetened milk induced immediate hyperphagia and led to considerable gain in body weight. Parallels are drawn with stress-induced hyperhagia and altered affective states in obese humans.*

Hyperphagia, and the obesity which typically accompanies it, is one of the major problems of modern society. Although the causal factors underlying hyperphagia are numerous, in many cases they appear to be related to stress (*1*). For example, many obese patients tend to eat when they are emotionally tense or during other unpleasant states, such as depression and boredom. Reports suggest that eating diminishes or prevents these states (*2*). Usually there is a well-defined pattern to the hyperphagia, and, in most cases, a definite finickiness exists. While bland foods are not eaten to excess, palatable foods stimulate hyperphagia (*1, 3*). When food is not readily available, such as when obese individuals are forced to adhere to strict dieting conditions, there is an enhanced reactivity to other goal objects; for example, there is a higher incidence of other oral activities such as smoking, and there is an increase in sexual activity (*1, 4*). Stress-related hyperphagia may therefore be a food-directed manifestation of a more general hyperresponsivity to environmental stimuli (*3*).

Recent research in this laboratory has shown that a mild nonspecific stress, tail pinch, reliably induces eating in sated rats (*5*). This behavior occurs with short latency, appears quite normal, and proceeds without obvious pain. Such animals are finicky, displaying an increased preference for highly palatable fluids and familiar foods (*6*).

The behavior observed during tail pinch is not limited to eating, but appears to be appropriate to the particular goal object at hand. For instance, if rat pups are present during tail pinch, maternal behavior occurs (*7*). A similar stimulus, tail shock, induces copulatory behavior in naive male rats in the presence of a receptive female, and aggression in the presence of another male (*8*). When all goal objects have been removed from the testing arena, the incidence of grooming (washing of the face and flanks) and nail pulling of the paws increases markedly. There also appears to be an increased tendency to vocalize and to attempt to escape, which suggests that the performance of a goal-directed behavior may mask the perception of aspects of the pinch related to stress.

There are some interesting, although indirect, parallels between eating in rats induced by tail pinch and hyperphagia in humans. Both may reflect a stress-related increase in responsiveness to environmental stimuli. This study provides evidence for a more direct parallel: in rats with access to a highly palatable fluid food, chronic stress induced by repeated tail pinch leads to dramatic hyperphagia, weight gain, and visible obesity.

Twenty-four adult female rats (Sprague-Dawley) were determined to readily ingest milk from a hand-held drinking burette during mild tail pinch. They were randomly assigned to one of three experimental conditions: (i) surgically intact ($N = 6$), (ii) ovariectomized ($N = 10$), or (iii) ovariectomized and injected daily with hormone replacement (1 μg of estradiol benzoate) ($N = 8$). Three animals from each of these conditions were assigned to the pinched group, and the rest served as weight-matched controls. Both groups were individually housed and allowed free access to sweetened milk (*9*) and tap water. In addition, the experimental animals received six daily pinch sessions (10 to 15 minutes each, spaced at equal intervals throughout the 24-hour cycle) in the presence of a hand-held burette containing milk (*10*) for up to five consecutive days. The tail was pinched between 1 and 2 inches from the tip with a hand-held, 25-cm hemostat, padded at the tips with foam rubber. Testing was conducted in a wire mesh cage 15 inches (38 cm) square.

Only slight pressure was required to induce ingestion of milk (it rarely approached the first notch of the hemostat) and infrequently resulted in any indication (for example, squealing) that the animals were attending to the pinch. Immediately after the beginning of the pinch, animals would explore the testing arena for a few seconds and then begin licking the milk tube. Ingestion usually proceeded continuously for several minutes at a time and

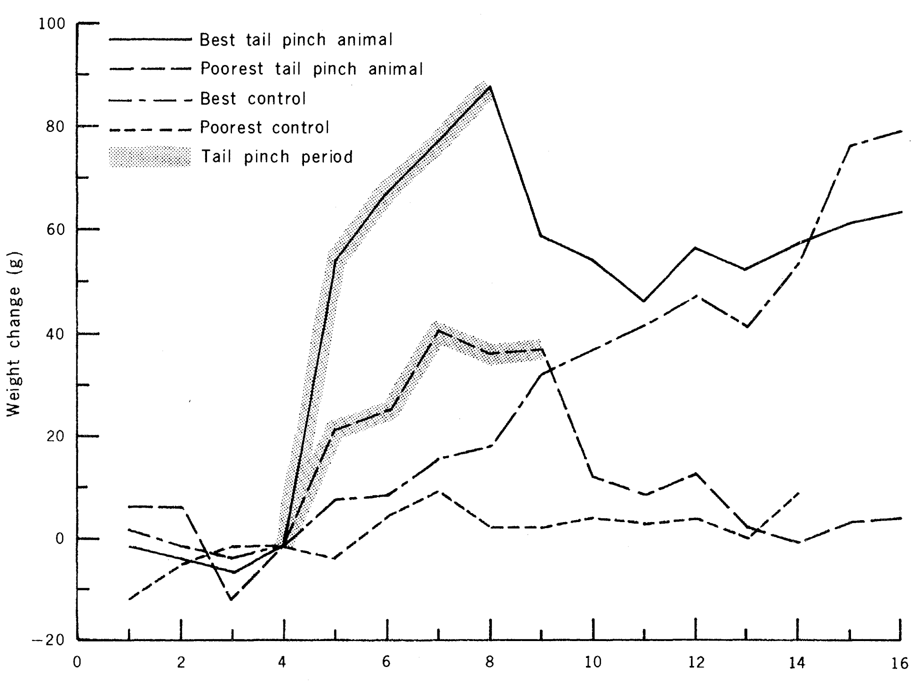

Fig. 1. Weight changes (in grams) for the best and poorest animals in both tail pinch and control groups. Data reflect comparisons before, during, and after the period of testing.