International Journal of Psychophysiology, 15 (1993) 147–152

INTPSY 00471

Autonomic changes in Brahmakumaris Raja yoga meditation

Shirley Telles and T. Desiraju

Department of Neurophysiology, National Institute of Mental Health and Neurosciences, Bangalore (India)

(Accepted 4 May 1993)

Key words: Autonomic change; Meditation; Heart rate; Skin resistance; Finger plethysmogram; Respiratory rate

This report presents the changes in various autonomic and respiratory variables during the practice of Brahmakumaris Raja yoga meditation. This practice requires considerable commitment and involves concentrated thinking. 18 males in the age range of 20 to 52 years (mean 34.1 ± 8.1), with 5–25 years experience in mediation (mean 10.1 ± 6.2), participated in the study. Each subject was assessed in three test sessions which included a period of meditation, and also in three control (non-meditation) sessions, which included a period of random thinking. Group analysis showed that the heart rate during the meditation period was increased compared to the preceding baseline period, as well as compared to the value during the non-meditation period of control sessions. In contrast to the change in the heart rate, there was no significant change during meditation, for the group as a whole, in palmar GSR, finger plethysmogram amplitude, and respiratory rate. On an individual basis, changes which met the following criteria were noted: (1), changes which were greater during meditation (compared to its preceding baseline) than changes during post meditation or non-meditation periods (also compared to their preceding baseline); (2), Changes which occurred consistently during the three repeat sessions of a subject and (3), changes which exceeded arbitrarily-chosen cut-off points (described at length below). This individual level analysis revealed that changes in autonomic variables suggestive of both activation and relaxation occurred simultaneously in different subdivisions of the autonomic nervous system in a subject. Apart from this, there were differences in patterns of change among the subjects who practised the same meditation. Hence, a single model of sympathetic activation or overall relaxation may be inadequate to describe the physiological effects of a meditation technique.

INTRODUCTION

Most of the reports on physiological effects of meditation have dealt with Transcendental Meditation (TM), Zen and Tantric Yoga. TM was adapted from the Indian Yogic tradition by Maharishi Mahesh Yogi. Practising TM, subjects sit in a comfortable posture and silently repeat a given mantram, returning their attention to it whenever attention wanders. Zen meditation forms an integral part of Zen Buddhism. Subjects sit in the lotus position, keep their eyes open and their attention focussed (initially on their breathing, and later on, on a 'Koan' or riddle). Tantric Yoga involves intense concentration of attention, with the ultimate aim of channelling all of ones energies into the spiritual energy of union with the object of devotion.

The practice of TM was reported to cause reductions in heart rate, respiratory rate, and oxygen consumption, and to increase the level or stability of the electrodermal response (Wallace, 1970; Wallace et al., 1971). A later report (Heide, 1986), noted a difference in the heart-rate response but not in the electrodermal response evoked by 80 dB tones, when TM practitioners and non-meditators were compared.

Contradictory results were observed in Zen and Tantric meditations. One set of studies reported changes suggestive of autonomic activation (Hirai, 1974; Corby et al., 1978), whereas

Correspondence to: S. Telles, Vivekananda Kendra Yoga Research Foundation, No. 9, Appajappa Agrahara, Chamarajpet, Bangalore-560018, India.

another set of studies reported changes suggestive of autonomic relaxation (Kasamatsu and Hirai, 1966; Sugi and Akutsu, 1968; Elson et al., 1977)

With the background of contradictory reports on the effects of meditation techniques, the present study was carried out to determine whether a given meditation technique would bring about the same effects in all the subjects practising it. Practitioners with 5 or more years of experience in Brahmakumaris Raja yoga meditation were chosen. This technique requires considerable commitment and involves concentrated thinking.

METHODS

Subjects

18 healthy male volunteers participated in this study They were between 20 and 52 years (mean $\pm$ S.D. was 34.1 $\pm$ 8.1 years), and they had 5–25 years experience of the meditation procedure (mean $\pm$ S.D. was 10.1 $\pm$ 6.2 years). The study was explained to the subjects and their signed informed consent was taken, according to the ethics laid down by the Indian Council of Medical Research; New Delhi.

Meditation

The Brahmakumaris Raja (= Raj) yoga meditation (BK) has spread from the organisation's headquarters at Mount Abu (Rajasthan, India) throughout India, and to other countries as well. During meditation, subjects sit in a comfortable posture with their eyes open, and with gaze fixed on a meaningful symbol (a light). At the same time they actively think positive thoughts about a Universal force pervading all over, as light and peace (Easy Raj Yoga, 1981).

Test sessions

Each subject was assessed in two types of session involving either a meditation period (with targetted thinking) or a non-meditation period (with random thinking). Each type of session was repeated thrice on different days, but at the same time of day.

During the recording session the subject sat in a comfortable chair in a dimly-lit, air-conditioned and sound-attenuated cabin. Subjects were observed throughout on a closed-circuit television. Each session was of 36 min duration, of which 24 min was spent in meditation (with eyes open) preceded and followed by 6-min periods of relaxation, also with eyes open. These meditation sessions were repeated thrice by each subject on different days. In addition, there were also three non-meditation ('control') sessions, which were similar in design, except that the period corresponding to the 24 min of meditation was spent sitting relaxed, without targetted thinking.

Data acquisition and analysis

Recordings were made on Grass model 78D polygraph. EKG was recorded using a standard limb lead II configuration. Skin resistance (SR) was recorded with AgCl disc electrodes placed approx. 4 cm apart on the palmar surface of the right hand. Electrode gel CSR (Technocarta, Hyderabad, India) was used, and a constant current of 10 μA was passed. Finger plethysmogram amplitude was recorded with a photo-cell transducer kept at the base of the right thumb nail. Respiration was recorded via a rubber stethograph connected through a pressure transducer.

In addition, the EEG was recorded from electrodes placed at F3, F4, O1 and O2, referenced to the contralateral earlobe. Also, EOG and chin EMG were recorded as is usual for sleep-stage scoring (Rechtschaffen and Kales, 1968). This allowed any sleep episodes to be detected and excluded from the analysed data.

The SR values were sampled at 20-s intervals from the continuously acquired record. The heart rate was obtained by counting the number of QRS complexes occurring in successive epochs of 40-s periods analysed throughout. The respiratory rate was calculated from the record by counting the breath cycles in successive 40-s epochs continuously. 20 s or its multiple (i.e., 40 s) time epochs were used while calculating SR, heart rate and respiratory rate to make it feasible to correlate these data with that of EEG acquired simultaneously and subjected to computerized power spectral analysis in 20-s epochs. For the present group

of meditators the EEG data have been presented elsewhere (Kulkarni et al., 1988), and have not been reiterated here as no interesting correlations emerged between autonomic and EEG changes. The finger plethysmogram amplitude was calculated from measurements made on 20 plethysmogram waves picked up randomly in each 6-min period.

Data analysis was done in two ways, viz., (I), For the group as a whole two statistical tests were used. (a), A two-factor (Factor A, meditation vs. non-meditation and Factor B, pre vs. during) ANOVA was carried out to assess the effects of both factors, as well as the interaction of all four variables listed above (Snedecor and Cochran, 1967; Zar, 1984). (b), A paired t-test (two-tailed) was performed on the averaged data. The values of each variable obtained in the three meditation sessions of a subject were averaged for: (a), the-24 min period of meditation; (b), the corresponding 24 min period of a non-meditation session; (c), the baseline state of the 6-min period in the eyes open state preceding the meditation, or the non-meditation period in the corresponding type of sessions and (d), the post-meditation (or post-non-meditation period). The averaged data of each of the 18 meditators were subjected to the paired t-test (two-tailed) to assess at the group level whether the following comparisons were significantly different: (a), meditation period and its preceding (eyes open) baseline period; (b), non-meditation period and its preceding (eyes open)

TABLE I

Heart rate in different conditions of the meditation and non-meditation sessions of the 18 subjects

M, meditation period; pre-M, period preceding Meditation; NM, non-mediation period; n, number of values averaged per subject; pre-NM, period preceding Non-meditation; n.s., not significant.

Subject	*Age (years)*	*Meditation experience (years)*	*Heart rate per 40 s (mean ± S.D.)*			
			Pre-M (n = 20)	*M (n = 80)*	*Pre-NM (n = 20)*	*NM (n = 80)*
DRN	38	8	51.4 ± 2.8	51.5 ± 2.7	49.6 ± 1.9	49.9 ± 3.3
RR	48	18	42.1 ± 0.8	43.3 ± 1.8	42.9 ± 5.0	43.2 ± 4.5
NAR	28	8	50.4 ± 3.9	52.6 ± 4.0	53.6 ± 3.9	55.5 ± 5.9
MNH	28	5	51.5 ± 1.6	57.5 ± 2.3	47.6 ± 2.9	47.7 ± 2.4
NLN	40	16	44.6 ± 2.6	45.1 ± 1.8	45.8 ± 3.6	45.3 ± 3.2
AM	30	9	54.4 ± 0.6	60.0 ± 2.7	54.9 ± 5.5	53.9 ± 5.1
MN	52	15	56.4 ± 0.9	55.6 ± 0.8	55.9 ± 0.8	55.2 ± 0.9
MG	29	5	50.5 ± 3.5	54.9 ± 2.9	51.6 ± 2.9	51.9 ± 1.9
JGN	34	10	40.9 ± 3.1	48.3 ± 3.0	47.4 ± 0.6	45.8 ± 1.8
SM	41	5	42.8 ± 3.9	43.5 ± 3.5	41.6 ± 1.9	42.0 ± 2.5
DP	20	8	61.0 ± 2.5	60.3 ± 3.5	54.1 ± 1.6	53.5 ± 1.4
SU	38	6	63.0 ± 6.1	62.5 ± 5.1	58.3 ± 5.0	58.5 ± 5.1
SVP	30	5	53.3 ± 1.6	51.7 ± 2.1	51.2 ± 1.5	50.1 ± 2.0
AC	31	18	53.4 ± 0.3	54.1 ± 1.3	51.2 ± 0.7	50.2 ± 1.8
AG	36	15	62.2 ± 1.6	65.2 ± 2.0	59.8 ± 0.7	58.9 ± 1.4
FE	22	5	39.0 ± 1.4	41.5 ± 0.9	42.1 ± 2.7	42.5 ± 1.6
MR	33	15	48.5 ± 0.7	48.6 ± 1.1	47.8 ± 3.4	48.5 ± 3.0
GA	35	25	49.2 ± 4.7	51.8 ± 3.6	47.7 ± 5.5	45.7 ± 4.7
Mean ± S.D.			50.81 ± 7.1	52.7 ± 6.8	50.2 ± 5.3	49.9 ± 5.3
Paird t-test (two-tailed) on data of whole group				t (17) 2.66 $P < 0.02$ (M vs. pre-M)		t (17) 1.19 n.s. (NM vs. pre-NM)

Note: paired t-test (two-tailed) M vs. NM, t (17) 3.84 $P < 0.01$.

baseline period; (c), meditation period and non-meditation period and (d), post-meditation period and pre-meditation period.

(II), On an individual basis data were also examined and changes which met the following criteria were noted: (a), changes during meditation (compared to the preceding period) should exceed those during post-meditation or non-meditation periods (also compared to the initial baseline period); (b), changes should occur in one direction, consistently during the three repeat sessions of a subject and (c), in order to quantify the change, arbitrary cut-off points were selected for each variable as follows: changes in heart rate should be equal to/more than 2 beats per 40 s, similarly for respiration, a change equal to/more than one breath per 40 s, for SR a change equal to/more than 10 kΩ; and for finger plethysmogram amplitude a change equal to or more than 0.40 cm.

RESULTS

Heart rate

Group analysis. The two-factor ANOVA did not reveal significance of (a), meditation vs. non-meditation ($F = 1.35$); (b), states (pre vs. during) ($F = 0.31$) or (c), interaction between the two factors ($F = 0.50$). In contrast, with the paired t-test, comparison of the data of meditation (M) against pre-meditation (pre-M) for the 18 subjects as a group showed that the heart rate was increased by 2.1 beats per 40 s during M, and the difference was significant ($P < 0.02$) (see the last row of the column M of Table I). There was no significant change during the non-mediation (NM) period compared to its preceding baseline (paired t-test, two-tailed, see the last row of the column NM of Table I). A third comparison (M vs. NM) revealed that the heart rate during M was also significantly higher than during NM ($P < 0.01$, paired t-test, two-tailed, last row of the column of the extreme right of Table I). Also, since one way of removing the regression of each treatment on its baseline is to analyse the change score of heart rate of the 18 subjects (M–pre-M vs. NM–pre-NM). These data were subjected to analysis using the paired t-test, which revealed that the change scores of M (mean = +1.4 change of heart rate/40 s) were significantly different from the change scores of the NM condition (mean = 0.3 change of heart rate/40 s (t (17) 2.97, $P < 0.01$). Also, the heart-rate values of the meditation condition have a significant correlation with the baseline value of the subjects obtained in the pre-meditation period ($r = 0.94$, $P < 0.001$ (2)), or in the pre non-meditation sitting period ($r = 0.93$, $P < 0.001$ (2)).

Individual analysis. The heart-rate data of each subject were also examined separately. Based on the three criteria mentioned above (Methods section, under data analysis), it was noted that in eight subjects there was a definite trend of increase in heart rate during M, whereas one subject showed a decrease in heart rate during NM.

Other parameters (SR, finger plethysmogram amplitude, respiratory rate)

Group analysis (using both two factor ANOVA, as well as the paired t-test) did not reveal a significant effect of meditation compared to its preceding baseline, or to the non-meditation period ($P > 0.10$ for both tests and in all the comparisons described in detail for heart rate).

The group mean $\pm$S.D. values for these three variables were as follows (1), SR; pre-M = 256.5 $\pm$ 62.1 kΩ, M = 246.3 $\pm$ 55.8 K, pre-NM = 264.3 $\pm$ 47.6 K, and NM = 271.3 $\pm$ 41.3 K. (2), Respiratory rate; pre-M = 12.1 $\pm$ 2.4 breaths/40 s, M = 13.4 $\pm$ 3.5 breaths/40 s, pre-NM = 11.9 $\pm$ 1.8 breaths/40 s, and NM = 12.2 $\pm$ 2.3 breaths/40 s. (3), Finger plethysmogram amplitude; pre-M = 1.68 $\pm$ 0.74 cm, M = 1.24 $\pm$ 0.64 cm, pre-NM = 1.72 $\pm$ 0.71 cm, and NM = 1.66 $\pm$ 0.56 cm..

Individual level analysis (based on the three criteria cited in the Methods section) has been summarized in Table II. It is given below in detail. (1), SR; During M, 5 subjects showed a decrease and 3 showed an increase. In contrast, during NM 7 subjects showed an increase and 3 a decrease. (2), Respiratory-rate changes occurred during M (but not during NM), i.e., 4 subjects showed a decrease, one showed a increase. (3), Finger plethysmogram amplitude; during M, 4

TABLE II

Changes in heart rate, palmar GSR, finger plethysmogram amplitude and respiratory rate based on individual level analysis

I, increase; D, decrease; M, Meditation period; Pre-M, period preceding meditation; NM, nonmeditation period; pre-NM, period preceding non-mediation period.

Parameter	*Number of subjects showing change*			
	M against pre-M		*NM against pre-NM*	
	I	*D*	*I*	*D*
Heart rate	8	0	0	1
Palmar SR	3	5	7	3
Finger plethysmogram amplitude	0	4	2	0
Respiratory rate	1	4	0	0

subjects showed a decrease, whereas 2 subjects showed an increase during NM.

DISCUSSION

The most important finding of this study on the effects of Brahmakumaris Raja yoga meditation was a small (but consistent) increase in the heart rate during meditation, compared to the preceding period, as well as compared to the non-meditation period. In contrast, changes in respiratory rate, finger plethysmogram amplitude and SR were fewer and often in opposite directions for the subjects practising the same meditation. However, they were consistent during repeat sessions of a subject. These individual differences did not seem to be correlated with differences in age, duration of meditation experience, or commitment to meditation. Individual differences in autonomic response specificity have been known for a long time. Detailed descriptions have shown that autonomic responses are a function of both the evoking stimulus (stimulus-response specificity) and of the responding individual (individual response specifity (Engel, 1960). It is interesting to speculate that the contradictory reports on Transcendental Meditation (TM), Zen, and Tantric yoga, described in the Introduction as either 'activating' or 'relaxing', may in fact be due to differences in the individual response patterns.

Holmes (1984) commented that no studies showed consistent differences between resting and meditating subjects in heart rate, electrodermal activity, respiratory rate and other similar variables. However, he stated that in 4 out of 16 experiments, meditating subjects showed greater increases in heart rate than did resting subjects, and none showed decreases. In this study also, the most consistent change was an increase in heart rate during the practice of Brahmakumaris Raja yoga meditation which was suggestive of cardiosympathetic activation, and a possible sign of psychophysiological arousal. This finding can be correlated with the fact that BK meditation requires intense involvement and concentration. The changes in the other variables (though often consistent for an individual) did not reveal any group pattern.

These results suggest that use of some autonomic and respiratory variables (e.g., heart rate) may reveal group effects of meditation, whereas other variables can alter in an individualistic way. Hence, a single model of meditation producing either overall relaxation or overall activation is probably inadequate.

REFERENCES

Corby, J.C., Roth, W.T., Zarcone, V.P. and Kopell, B.S. (1978) Psychophysiological correlates of the practice of Tantric yoga meditation. *Arch. Gen. Psychiatr.*, 35: 571–577.

Easy Raj yoga (1981) *Prajapita Byahmakumaris Ishwariya Vishwa*, Vidyalaya, Bombay, pp. 82+5.

Elson, B.D., Hauri, P., and Cunis, D. (1977) Physiological changes in Yoga meditation. *Psychophysiology*, 14: 52–57.

Engel, B.T. (1960) Stimulus-response and individual-response specificity. *Arch. Gen. Psychiatr* 2: 305–313.

Heide, F. (1986) Psychophysiological responsiveness to auditory stimulation during Transcendental Meditation. *Psychophysiology*, 23: 71–75.

Hirai, T. (1974) *The Psychophysiology of Zen*, Igako Shoin, Tokyo.

Holmes, D.S. (1984) Meditation and somatic arousal: A review of the experimental evidence. *Am. Psychol.* 39: 1–10.

Kasamatsu, A. and Hirai, T. (1966) An electroencephalographic study on the Zen meditation (Zazen). *Folio Psychiatr. Neurol. Japonica*, 20: 315–336.

Kulkarni, D.D., Ramachandra, M., Hanumanthaiah, B.H., Narasimhalu, G., Joseph, C. and Desiraju, T. (1988) EEG power changes in senior practitioners of Transcendental Meditation, Brahmakumaris Raja yoga and Pranayama. *Ind. J. Physiol. Pharmacol.*, 32: 419–420.

Rechtschaffen, A. and Kales, A. (1968). *A Manual of standardised terminology, techniques, and scoring system of human subjects,* Public Health Service Government Printing Office, Washington, pp. 8–15.

Snedecor, G.W. and Cochran, W.G. (1967) *Statistical Methods,* Oxford & IBH, New Delhi, 593 pp.

Sugi, Y. and Akutsu, K. (1968) Studies on respiration and energy metabolism during sitting in Zazen. *Res. J. Phys. Edu.*, 12: 190–206.

Wallace, R.K. (1970) Physiological effects of Transcendental Meditation. *Science,* 167: 1751–1754.

Wallace, R.K., Benson, H., and Wilson, A.F. (1971) A wakeful hypometabollic physiologic state. *Am. J. Physiol.*, 221: 795–799.

Zar, J.H. (1984) *Biostatistical analysis* Prentice-Hall International, Englewood Cliffs, pp. xiv + 718.