Indian J Physiol Pharmacol 1998; 42(1) : 57–63

AUTONOMIC CHANGES WHILE MENTALLY REPEATING TWO SYLLABLES - ONE MEANINGFUL AND THE OTHER NEUTRAL

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(Received on July 7, 1997)

Abstract : Autonomic and respiratory variables were recorded in 12 volunteers in three types of sessions (1). Before, during and after a test period of mentally repeating a meaningful syllable 'OM' (MOM session) (2). A similar session except that the test period was spent mentally repeating a neutral work, 'one' (COM session) (3). A session with non–targeted thinking (NT session). The subjects were familiar with both syllables, and had been meditating on 'OM' for 20 days. During the test periods of both MOM and COM sessions the rate of respiration (RR) and heart rate (HR) decreased significantly [(two factor ANOVA (RR), paired t test (RR. HR)]. Compared to the pre period. Mental repetition of 'OM' (but not 'one') caused a significant decrease in skin resistance level (SRL) (paired t test). This was taken to mean that the subject recognized the significance of the syllable. No significant change occured during NT sessions.

Key words: relevant syllable, irrelevant syllable, skin resistance, breath rate, heart rate

INTRODUCTION

The syllable 'OM' is known to have profound significance in Indian culture. Mental repetition of this syllable was shown to cause significant changes in middle latency auditory evoked potentials, which were suggestive of a facilitation of neural activity at either mesencephalic or diencephalic level (1). In contrast mentally repeating a neutral syllable, 'one', inhibited neural activity at the same level. This was observed in subjects who had been regularly meditating on 'OM' every day for more than 10 years ('experienced meditators'). In 'naive' subjects, with 15 to 20 days of experience in meditation, repeating both 'OM' and 'one' caused the same effect, viz an inhibition of neural activity at mesencephalic or diencephalic level.

It was also reported that highly experienced meditators (20 years experience on an average) show a significant reduction in heart rate and a non significant trend of reduction in oxygen consumption, while mentally repeating 'OM', compared to a period of non targeted thinking (2). These subjects simultaneously displayed an

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increase in cutaneous vasoconstriction, which was interpreted as an increase in mental alertness (3), in the presence of other signs of reduced arousal (reduced heart rate and oxygen consumption).

The present study was conducted to compare the autonomic effects of mentally repeating a meaningful syllable with mental repetition of a neutral one and with non targeted thinking, in subjects who were acquainted with both syllables, and had been meditating on the meaningful syllable for 20 days, comparable to the naive subjects described earlier (1). The duration of meditation was believed to influence the ability to comprehend the significance of the syllable and a comparison with results obtained in experienced meditators, could be made.

METHODS

Subjects : There were 12 volunteers (4 male, 8 female) with normal health as determined by a routine medical examination and ages ranging from 25 to 40 years (Mean 30.1, SD 6.2 years). They had been practicing 'OM' meditation for 20 days twice a day, 15 min at a time, prior to testing. During a meditation session, subjects would keep their eyes closed and mentally repeat the syllable.

Design of the study : The subjects were assessed in 3 separate sessions conducted on different days, at the same time of the day. Each session lasted for 25 min. The test period was for 15 min, while the 2 periods preceding and following it, were for 5 min each. For all 3 sessions subjects, remained recumbent (supine) with their eyes closed while recording the 'pre' and 'post' periods. Instructions during the 'test' period (15 min) differed among the the 3 sessions. In the first 8 min of the 'OM' repetition session (MOM) subjects were given instructions using a prerecorded audio tape, to relax the body from the toes upwards, naming each part of the body. The next 7 min of the 15 min period were spent in mentally repeating 'OM'. During the test period of the 'control' session (COM), the same sequence was followed, i.e. 8 min following the same prerecorded instructions to relax as for the MOM session, followed by 7 min of mentally repeating 'one'. During the session with non targeted thinking (NT), subjects spent the first 8 min of the test period following the same prerecorded instructions as for MOM or COM test periods. The next 7 min were spent in non targeted thinking. These two periods (8 min of guided relaxation and 7 min of specific practice) were decided upon, as subjects reported that they were abole to relax while continuously repeating a syllable mentally for a given period, when it was preceded by guided relaxation. The data acquired during the 15 min period as a whole were analyzed. Also, the data obtained during the first 8 min (quided relaxation) and during the next 7 min ('OM'/'one' repetition/non targeted thinking) were examined separately to note any significant change during either period.

The order of the 3 sessions (MOM, COM, NT) was varied in a random fashion for the subjects. Hence 4 subjects had MOM sessions on day 1, with COM and NT sessions on the next 2 consecutive days. Anotherr 4 subjects had sessions in the order COM, NT, MOM. The 4 remaining subjects followed the order NT, MOM, COM.

Recording conditions and parameters: The sessions were conducted in a dimly lit, sound attenuated cabin. A model 10 polygraph (Recorders and Medicare, Chandigarh, India) was used to record the EKG, respiration, digit pulse volume (DPV) and skin resistance (SR). EKG was recorded using the standard bipolar limb lead I configuration and an AC bioamplifier with 1.5 Hz high pass and 75 Hz low pass settings. Respiration was monitored with a volumetric pressure transducer. The subject was asked to stand erect and the transducer was fixed around the trunk, 5 cm below the lower costal margin. A photoplethysmogram was placed on the volar surface of the distal phalanx of the left index finger to assess the digit pulse volume (DPV). Skin resistance (SR) was recorded using Ag/AgCl disk electrodes attached to the volar surfaces of the distal phalanges of the right index and middle fingers, with a reference electrode on the volar surface of the right forearm. Electrode gel (Medicon, Madras, India) was used, and a constant current of 10 µA was passed between the electrodes. The signal was processed through a DC preamplifier. The EEG was recorded with Ag/AgCl disk electrodes placed at F3, F4, 01 and 02 (4), each referenced to the contralateral earlobe. The EOG and EMG were recorded as for standard polysomnography (5). For EEG and EOG the time constant was 0.1 s, for EMG it was 1.0 s). Recordings of EEG. EOG and EMG allowed any sleep episodes to be detected with the purpose of excluding them from analysis.

Data acquisition and analysis: The skin resistance (SR) trace was sampled every 30 s. The amplitude of the digit pulse was sampled from the ascending portion of the wave at 30 s intervals and converted to mV as described elsewhere (6). The heart rate (HR) was calculated by counting the QRS complexes in successive 60 s epochs continuously, to give the HR in beats per min (bpm). The rate of respiration (RR) was similarly calculated by counting the number of respiratory waves also in successive 60 s epochs continuously, and noting the RR as cycles per min (cpm).

Data were analyzed in two ways: (i) a two factor ANOVA using data obtained in the 'pre' and 'test' periods, but not in the 'post' period. The ANOVA was used to examine two factors, viz. a) the two states ('pre' versus 'test' – Factor A) and b) the three sessions (MOM, COM, NT – Factor B). The multiple comparison Tukey test ('least significant difference' test) was used to make pairwise comparisons, e.g. 'pre' (MOM) versus 'test' (MOM).

(ii) The 't' test for paired data was used to compare the data of 'test' and 'post' periods with those of the corresponding 'pre' period.

RESULTS

General remarks: No sleep episodes were detected and hence the entire record was used for analysis. There were also (i) no significant changes in any of the parameters during the first 8 min (guided relaxation) of the 'test' periods, compared to the 'pre' periods, and (ii) the (non significant) changes observed during the first 8 min of the 'test' period did not differ among the 3 sessions. It was decided to use the data of the next 7 min of the 'test' period ('OM'/ 'one' repetition/non targeted thinking) for statistical analysis, so that the duration of this period (7 min) was comparable to that of the 'pre' and 'post' periods (5 min). The group mean values ± SEM are provided in Table I.

interaction between the Factors i.e. A × B (P>.10, in both cases). For the remaining parameters (heart rate, digit pulse volume and skin resistance level), the two factor ANOVA did not show significant differences between the values of 'pre' and 'test' periods (Factor A), between the three sessions (Factor B), or the interaction between the factors (A × B), (P>.20 in all cases).

TABLE I : Autonomic variables during pre, test and post periods of MOM, 'OM' repetition, COM, 'one' repetition, and NT, non targeted thinking sessions. Values are group mean ± SEM.

Session	*Period*	*Heart rate (bpm)*	*Digit pulse volume (mV)*	*Skin resistance (K)*	*Breath rate (cpm)*
	Pre	70.0 ± 1.9	1.4 ± 0.3	151.0 ± 32.3	15.5 ± 1.7
MOM	Test	66.6 ± 2.3*	1.6 ± 0.3	121.0** ± 26.8	12.9 ± 1.2***
	Post	70.9 ± 2.2	1.1 ± 0.2	99.0*** ± 32.3	13.5 ± 1.7*
	Pre	70.9 ± 1.8	2.0 ± 0.2	170.0 ± 35.2	15.1 ± 1.3
COM	Test	69.4 ± 2.0*	2.1 ± 0.1	177.0 ± 42.3	10.4 ± 1.3***
	Post	69.3 ± 1.9*	1.6 ± 0.1	182.0 ± 42.4	13.3 ± 1.5*
	Pre	70.4 ± 1.9	1.8 ± 0.1	165.0 ± 37.8	14.9 ± 1.4
NT	Test	69.9 ± 1.8	1.9 ± 0.1	166.0 ± 37.4	14.1 ± 1.6
	Post	70.9 ± 1.8	1.5 ± 0.1	144.0 ± 36.9	14.5 ± 1.5

*P<.05, **P<.01, ***P<.001 paired 't' test, compared to pre.

Two factor ANOVA : The two factor ANOVA showed a significant difference between the respiratory rate (RR) of 'pre' and 'test' periods, i.e. Factor A = 'pre' versus 'test' [F = 5.28 (F.05 (2) 1, 66 = 5.27) hence P < .05 or P = .05]. The F value has been derived by linear interpolation according to the method described (7), based on the F values for DF = 1, 60 and DF = 1, 70 in the standard table. The Tukey multiple comparison test did not reveal a significant difference between any two mean values. In all comparisons q was less than 3.50, [since q (6, 60) = 3.75 at .10 level, therefore P>.10]. Here 60 is utilized as the next critical value after 66, which is not listed in the table.

There was no significant difference between the 3 sessions (Factor B), or of

Paired 't' test : The HR during the 'test' periods of both MOM and COM sessions was significantly lower than that of the corresponding 'pre' period, by an average of 3.4 bpm and 1.5 bpm, respectively (P<.05 in both cases). The HR remained significantly low after COM (P<.05). There was also a significant decrease in RR in the 'test' periods of both MOM and COM sessions (by an average of 2.6 cpm and 4.7 cpm, respectively, P<.001, in both cases, compared to the corresponding preceding period). This effect persisted during the 'post' periods of both MOM and COM sessions (a decrease of

2.0 cpm and 1.8 cpm respectively, P<.05 compared to the corresponding preceding period).

There was a significant decrease in skin resistance level (SRL) during the 'test' period of the MOM session, compared to the preceding period (P<.01). There was also a significant decrease in SRL in the 'post' period of the MOM session compared to 'pre' (P<.01).

There was no difference in the trend of results according to the order of the three sessions (MOM, COM, NT) though the small sample size (four subjects with each sequence) precluded using statistical analysis.

DISCUSSION

The present study has shown that mental repetition of a syllable either meaningful (MOM) or neutral (COM), causes a decrease in heart and breath rate. Non targeted thinking (NT) for the same period of time does not have a similar effect. This result is similar to reports about the physiological changes during Transcendental Meditation (TM) (8, 9). During the practice of TM subjects silently repeat a particular mantram (see below) throughout each 20 min session, returning focus to it whenever attention wanders (10). A unique mantram is assigned to each individual, with the idea that a particular sound resonates optimally with a specific nervous system. The mantram is not 'meaningful' in the sense used in the present study.

It was noted that the change which was unique to the repetition of the meaningful syllable ('OM'), during MOM sessions was a significant decrease in the skin resistance level (SRL). This change is opposite to that observed in the studies on TM by (8, 9), in which an increase in skin resistance was reported.

It is now well recognized that different subdivisions of the sympathetic nervous system need not always be activated simultaneously. The responses to a given stimulus vary, depending on the individual and on the stimulus (11). Hence a subject may have a reduction in HR (reduced cardiac sympathetic tone) at the same time as a decrease in skin resistance level (SRL), which is believed to be due to increased sudomotor sympathetic tone. The interpretation of change in skin resistance is open to continuing debate. The sweat glands are believed to be the major contributors to changes in the spontaneous electrodermal activity (EDA) as is observed by recording the SRL (12). Human sweat glands are generally known to receive predominantly sympathetic cholinergic innervation (13). Hence though the EDA is regulated by the sympathetic nervous system, the EDA and cardiac sympathetic control systems are recognized to be organized differently (14). The HR is believed to be influenced by somatic activity and movement control mechanisms, whereas the EDA appears to be determined primarily by motivational or attentional arousal. Hence mental repetition of both 'OM' and 'one' may reduce somatic activity (HR reduction), while the mental repetition of 'OM' appears to cause an increase in attentional arousal (reduced SRL), as well.

In addition to the conventional concept of an increase in skin resistance signifying an increase in sympathetic tone, the sensitivity of the skin resistance (response) to significant stimuli is well known (the 'lie detection test').

It was reported (15) that the generation of frequent and large electrodermal skin responses were the only indication that in prosopagnosic patients, who have lost their ability to recognize faces, the process of recognition is still taking place. It was also noted that in these patients the results of cognizance were not available to consciousness. While these findings cannot be directly applied to the present results, they may suggest that even though mental repetition of both 'OM' and 'one' cause comparable changes in HR and RR, the neural processes involved in recognizing the significance of the syllable 'OM' are active, as reflected by the decrease in SRL.

Previous studies have demonstrated that subjects with a short experience of meditation (comparable to the subjects of the present study), show similar inhibition in sensory neural processing at mesencephalic and diencephalic levels, while repeating both 'OM' and 'one' (1). In the same study, in experienced meditators neural processing at these levels was significantly facilitated while repeating 'OM'. These observation on sensory neural processing, were based on recordings of middle latency auditory evoked potentials. In both short duration and experienced meditators there were significant changes (in opposite directions) in the amplitude of the Na wave. This is a negative wave occurring betwen 14–18 msec after the stimulus, with a neural generator at mesencephalic/diencephalic level (16). An increase in peak amplitude observed in experienced meditators, suggests facilition of sensory neural processing (17). In a separate study (2) on the autonomic changes in experienced 'OM' meditators, there was no change in the skin resistance level while repeating 'OM'. This is in contrast to the short duration meditators of the present study.

Hence to sum up the results of the present and previous studies, (i) a decrease in HR, RR (conventional indicators of relaxation) follow the mental repetition of any syllable, (ii) subjects who have brief (20 days) experience of medication on a meaningful syllable ('OM'), show a significant decrease in SRL during repetition of that syllable, but not while repeating a neutral syllable or during non targeted thinking. Subjects with longer meditation experience do not show this change, (iii) experienced meditators show significant facilitation of sensory neural processing at mesencephalic/diencephalic levels while repeating the syllable on which they meditate. Naive meditators do not show this change. These results suggest that the process of understanding the significance of a meaningful syllable may be continuous, and is significantly influenced by the duration of meditation. The decrease in SRL was observed in naive meditators but not in experienced meditators, hence this change may represent an intermittent stage during which changes in sensory evoked potentials (EPs) are not yet obtained. The present results also support the idea that the SRL may indicate cognitive involvement in the object of meditation in addition to being a conventional indicator of sympathetic tone.

REFERENCES

1. Telles S, Nagarathna R, Nagendra HR, Desiraju T. Alterations in auditory middle latency evoked potentials during meditation on a meaningful syllable – 'OM'. *Intern J Neurosci* 1994; 76: 87–93.
2. Telles S, Nagarathna R, Nagendra HR. Autonomic changes during 'OM' meditation. *Indian J Physiol Pharmacol* 1995; 39 (4): 418–420.
3. Delius W, Kellerova E. Reaction of arterial and venous vessels in the human forearm and hand to deep breath or mental strain. *Clin Sci* 1971; 40: 271–282.
4. Jasper HH. The ten-twenty electrode system of the International Federation. *Electroenceph Clin Neurophysiol* 1958; 10: 371–375.
5. Rechtschaffen A, Kales A. A manual of standardized terminology, techniques and scoring system of sleep states of human subjects. Washington DC, Public Health Service, Government Printing Office, 1968.
6. Roy M, Steptoe A. The inhibition of cardiovascular responses to mental stress following aerobic exercise. *Psychophysiol* 1991; 28: 689–699.
7. Zar JH. Biostatistical Analysis. Second Edition. London, Prentice-Hall, 1984.
8. Wallace RK. Physiological effects of transcendental meditation. *Science* 1970; 167: 1751–1754.
9. Wallace RK, Benson H, Wilson AF. A wakeful hypometabolic physiologic state. *Am J Physiol* 1971; 21: 795–799.
10. Woolfolk RL. Psychophysiological correlates of meditation. *Arch Gen Psychiat* 1975; 32: 1326–1333.
11. Engel BT. Stimulus response and individual response specificity. *Arch Gen Psychiat* 1960; 2: 305–313.
12. Fowles DC. The eccrine system and electrodermal activity. In Coles MGH, Donchin E, Porges SW, eds., Psychophysiology; systems, processes and applications, New York, Guilford Press 1986: 51–96.
13. Shields SA, MacDowell KA, Fairchild SB, Campbell ML. Is mediation of sweating cholinergic, adrenergic or both ? A comment on the literature. *Psychophysiol* 1987; 24: 312–319.
14. Roberts LE. Comparative psychophysiology of the electrodermal and cardiac control systems. In Obrist PA, Black AH, Brener J, Dicara LV, eds. Cardiovascular psychophysiology: current issues in response mechanisms, biofeedback and methodology. Chicago, Aldine Press, 1974: 163–189.
15. Tranel D, Damasio AR. Knowledge without awareness; an autonomic index of facial recognition by prosopagnosics. *Science* 1985; 228: 1453–1454.
16. Deiber MP, Ibanez V, Fisher C, Perrin F, Mauguiere F. Sequential mapping favours the hypothesis of distinct generators for Na and Pa middle latency auditory evoked potentials. *Electroenceph Clin Neurophysiol* 1988; 71: 187–197.
17. Woods DL, Clayworth CC. Click spatial position influences middle latency auditory evoked potential (MAEPs) in humans. *Elecroenceph Clin Neurophysiol* 1985; 60: 122–129.