ALTERATIONS IN AUDITORY MIDDLE LATENCY EVOKED POTENTIALS DURING MEDITATION ON A MEANINGFUL SYMBOL - OM

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Abstract: Middle latency auditory evoked potentials were recorded in 18 male volunteers with ages between 25 and 45 years, 9 of whom had more than ten years of experience in OM meditation (senior subjects), whereas the other 9 had no meditation experience (naive subjects). Both groups were studied in two types of sessions. (1) Before, during, and after 20 minutes of mentally repeating "one" (control session), and (2) a similar session, though with 20 minutes of mentally chanting OM (meditation session). The senior subjects showed a statistically significant (paired t-test) increase in the peak amplitude of Na wave (the maximum negative peak between 14 and 18 ms) during meditation, while the same subjects showed a statistically significant reduction in the Na wave peak amplitude during control sessions. In contrast, the naive subjects had a significant decrease in the Na wave peak amplitude during meditation sessions and a nonsignificant trend of reduction during control sessions, as well. This difference between senior and naive subjects was significant (two way ANOVA). There were no significant changes in short latency wave V or Pa wave (the positive peak between the Na wave and 35 ms). The changes in the Na wave suggest that both meditation on a meaningful symbol, and mental repetition of a neutral word cause neural changes at the same level (possibly diencephalic). However, the change could be in opposite directions, and this difference could be correlated with differences in the duration of experience in meditation between senior and naive subjects.

Key words: Middle latency auditory evoked potentials; Meditation-Meaningful symbol- Neutral word.

Meditation has been described as a training in awareness which, over long periods, produces definite changes in perception, attention and cognition (Brown, 1977). Objective evidence of such altered sensory perception exists, since yogis in deep meditation showed an absence of alpha blocking in the EEG even when exposed to diverse (visual, vibratory. thermal, and sensory) stimuli (Anand & Chhina, 1961). The effects of Transcendental Meditation (TM) on auditory evoked potentials (AEPs) have already been reported. The first study (Barwood, Empson, Lister & Tilley, 1978) showed that long latency AEPs (i.e., with latency more than 100 ms) did not change significantly during meditation. Later on, McEvoy, Frumkin and Harkins(1980), reported a change in short latency (brainstem) AEPs after meditation. Hence, if short latency AEPs change, whereas long latency AEPs remain unaltered during meditation, the effects of meditation on middle latency AEPs is interesting. This knowledge could help in understanding how neural processing at different stages alters with meditation. Hence the present study was carried out, recording middle latency AEPs during meditation on the syllable. OM, which has profound significance in Indian belief. Recordings were made at the end of a 10 day retreat during which subjects meditated for approximately 6 hours a day, and maintained silence for the remaining time.

METHOD

Subjects

There were two groups of nine subjects each. They were all males, with ages ranging from 25 to 45 years. The first group (average age 32.1 ± 4.2 years) consisted of "Senior subjects" who had more then 10 years experience in meditation (average 12.4 ± 1.8 years). The second group (average age 36.2 ± 3.8 years) cosisted of "naive" subjects who were strongly motivated to practice mediation, but had no experience prior to the present, intensive 10 day retreat. The study was explained to the subjects. and their signed informed consent was taken, according to the ethical guidelines of the Indian Council of Medical Research (New Delhi, India)

Sessions

All the subjects were studied in 2 types of sessions, each lasting 32 min. (a) The "control" or nonmeditation session consisted of 20 min. of sitting with eyes closed, mentally repeating a neutral word i.e. "one". This period was preceded and followed by two 6 min. periods of sitting relaxed, with eyes closed. The next session was recorded after a gap of about 15 minutes during which the electrodes were disconnected, and the subjects were allowed to get up. This next session (b), was a meditation or "test" session, which was identical in design to the control session described above, except the 20 min. spent repeating "one," were spent mentally chanting the syllable OM.

Meditation

IIndian teachings consider the syllable OM to be the force behind all thought. Either uttering or thinking about OM is supposed to cause a quiet mental state. The meditation practiced in the present study involves mentally chanting the syllable "Om".

Recording of Evoked Potential

Middle latency auditory evoked potentials (AEP-MLRs) were recorded in the 70ms poststimulus time period, from Cz, referenced to the left earlobe, with the ground electrode on the forehead. The preamplifier band width was set at 1-1500 Hz. 1500 responses were averaged for each period. Sweeps containing artifactually large signals were rejected through software specification. The rejection level was expressed as a percentage of the full scale range of analogto- digital convertor. This level was set at 100%. The number of sweeps was also known from the print-out (NICOLET, USA, Clinical averaging package). Click stimuli of 40 µs duration and alternating polarity were delivered at 5 Hz binaurally, through acoustically shielded earphones (Amplivox, UK). The intensity was kept at one and half times the threshold of hearing. This value was (on an average) 45 dB above the threshold of hearing, which was approximately 24 dB with stimulus parameters kept as described above. This was sufficient to evoke the potentials consistently, at the same time leaving the subjects undisturbed.

TABLE 1

Peak Latencies and Peak Amplitudes of AEP - MLRs Recorded on Senior Subjects in Meditation (M) and Non-Meditation (NM) Sessions

		Wave V[a]		Na Wave V[a]		Pa Wave V[a]	
		M	Nm	M	Nm	M	Nm
Peak Latency (ms)	Pre	6.8 ± 1.0	6.5 ± 1.2	16.3 ± 2.2	16.2 ± 1.9	28.4 ± 4.7	26.6 ± 4.1
	During	6.8 ± 0.9	6.5 ± 0.8	16.6 ± 1.8	16.7 ± 2.1	29.0 ± 4.4	28.7 ± 5.8
	Post	6.6 ± 1.0	6.7 ± 1.2	16.6 ± 1.8	16.1 ± 1.2	30.1 ± 4.0	29.6 ± 3.9
Peak Amplitude (uv)	Pre	0.7 ± 0.3	0.6 ± 0.2	1.0 ± 1.0	1.1 ± 1.4	1.3 ± 0.8	1.7 ± 1.4
	During	0.6 ± 0.2	0.6 ± 0.2	1.5[b c] ± 1.1	0.8[d] ± 1.1	1.3 ± 0.7	1.3 ± 0.7
	Post	0.5 ± 0.2	0.6 ± 0.4	1.3 ± 1.1	1.0 ± 0.9	1.1 ± 0.9	1.3 ± 0.9

a N = 9
b $p < .05$, t-test for paired data, during to pre.
c $p < .05$, t-test for paired data, during M to during NM
d $p < .001$, t-test for paired data, during to pre

AEP-MLRs Components

Peak amplitudes of short latency wave V, and middle latency Na and Pa waves were measured from the baseline existing at the beginning of sweep. Peak latency was measured from the time of click delivery. The middle latency auditory evoked response components (AEP-MLRs) were described as follows: wave V was the maximum positive peak between 5 and 8 ms, the Na wave was the maximum negative peak between 14 and 18 ms, and Pa wave was described as the maximum positive peak between the Na wave and 35 ms. These descriptions are similar to those in other studies on AEP-MLRs (Erwin & Buchwald, 1986).

Data Analysis

The data were analyzed in two ways, viz a) using a two factor ANOVA (Factor A= senior subjects versus naive subjects and Factor B = Premeditation versus during meditation). The two factor ANOVA was repeated using the values obtained in control sessions as follows: Factor A= Senior subjects versus naive subjects and Factor B = Precontrol versus during control period. The t-test for paired data (two tailed) was used to check for statistical significance in the following comparisons: (1) premeditation with meditation, (2) Precontrol with control period, (3) meditation with control period.These two tests were carried out on the peak latencies and peak amplitudes of short latency wave V and middle latency Na and Pa waves.

RESULTS

The two factor ANOVA revealed a significant difference in the peak amplitude of the Na wave during the meditation session, between the two categories of subjects:

Meditation Effect on AEP - MLR

PD/46(12 years)
Without Meditation

With Meditation

FIGURE 1 Typical example of AEP- MLRs recorded in a senior subject during a control session (left) and during a meditation session (right). IN each session AEP- MLRs were recorded four times i.e. before (C1), after (C2) and twice during a test period which involved either mentally repeating "one" (N of the control session). or meditation on OM (M of the meditation session).

(viz Factor A = seniors Vs naive subjects), [$F = 4.60$ ($F_{.05}$ (1) 1, 32 = 4.15) hence $p < .05$] However, there was no significant difference between the two states (viz Factor B = premeditation versus during meditation), or of interaction between Factors A and B in meditation sessions ($P > .10$ in both cases). The two factor ANOVA for the peak amplitude of the Na wave during control sessions, and also for the peak latency and peak amplitude of the short latency wave V and the Pa wave, did not reveal significance of either factors or their interaction, during both meditation and control sessions ($p > .10$, in all cases cited above). The t-test for paired data (two tailed), revealed a significant ($t = 2.78$, $P < .05$) increase in the Na wave peak amplitude of the senior subjects during meditation compared to the values of the preceding state, as well as compared to those of the nonmeditation (control) sessions

($t = 2.69$. $p < .05$). In contrast, there was a significant ($t = 5.37$, $p < .001$) reduction in Na wave peak amplitude during tile control period (while repeating "one") compared to the preceding state (Figure 1).

In the naive subjects there was a significant reduction in the Na wave peak amplitude during meditation sessions ($t = 6.16$. $p < .001$) compared to the preceding period (Figure 2). There were no significant differences in the Na wave peak amplitude of naive subjects during the control period compared to the preceding period ($p > .10$). Also there were no significant differences in the peak amplitudes and peak latencies of wave V and Pa wave, during both meditation and control periods, compared to their preceding periods or in a comparison between meditation and control periods for both categories of subjects ($p > .20$, in all comparisons)

AEP - MLRs DURING OM MEDITATION

SCK/38 (15 days)
Without Meditation

With Meditation

FIGURE 2 Typical example of AEP - MLRs recorded in a naïve subject during a control session (left). and during a meditation session (right). The rest of the details are the same as for FIGURE 1.

The group means and standard deviations of the different parameters for the senior subjects have been provided in Table 1, and for naive subjects in Table 2.

DISCUSSION

The results of the present study revealed that in subjects with more than 10 years of meditation experience there was a significant increase in the peak amplitude of the Na wave during meditation (mental chanting of OM) compared to a significant decrease in the Na wave peak amplitude during a control period, spent mentally repeating "one". In contrast, naive subjects had a significant reduction in Na wave peak amplitude during meditation, and a nonsignificant trend of reduction during the control period, as well. Our earlier study (Telles & Desiraju, 1993) on 7 subjects with meditation experience ranging from 5 to 25 years, showed that mentally chanting OM produces a small but consistent reduction in the peak latency of the Nb wave. However, this negative component shows considerable variability, and occurs between 35 and 65 ms, and hence it was mentioned that the change had to be viewed caution. It was also reported that changes in Na and Pa waves were fewer and often and often in opposite directions for different subjects, through there was less intersubject variability in the values.

TABLE 2

Peak Latencies and Peak Amplitudes of AEP - MLRs Recorded on Naive Subjects in Meditation (M) and Non - Meditation (NM) Sessions

		Wave V[a]		Na Wave V[a]		Pa Wave V[a]	
		M	Nm	M	Nm	M	Nm
Peak Latency (ms)	Pre	6.7 ± 0.8	6.3 ± 0.4	15.9 ± 1.6	15.0 ± 1.6	30.3 ± 4.1	28.5 ± 3.3
	During	6.1 ± 0.4	6.3 ± 0.5	15.3 ± 1.6	15.8 ± 1.9	29.6 ± 2.7	29.8 ± 2.1
	Post	6.5 ± 0.7	6.0 ± 0.7	15.9 ± 1.7	16.6 ± 2.7	30.1 ± 3.7	29.6 ± 3.5
Peak Amplitude (uv)	Pre	0.7 ± 0.4	0.8 ± 0.4	0.8 ± 0.3	1.0 ± 0.7	1.3 ± 0.6	1.6 ± 0.3
	During	0.6 ± 0.3	0.7 ± 0.3	0.5[b] ± 0.3	0.8 ± 0.5	1.4 ± 0.6	1.2 ± 0.5
	Post	0.7 ± 0.3	0.8 ± 0.6	0.9 ± 0.3	0.7 ± 0.4	1.3 ± 0.3	1.3 ± 0.5

a N = 9 b $p < .001$, t-test for paired data, during to pre.

In the present study there was no attempt to assess the Nb wave since the variability precludes using it as a reliable way of assessing the subtle changes in neural processing, which could be expected during meditation. Instead, we placed emphasis on wave V, Na wave, and Pa wave. The subjects of our earlier study (Telles & Desiraju, 1993), had been practicing meditation for several years, and they had evolved individual methods of focusing the mind for meditation. For example, some subjects would mentally focus on the visual image of the syllable OM as it is written in Sanskrit, while other subjects would allow their thoughts mentally to encompass a limitless expanse (e.g., the sky or the ocean).

In the present study, the senior subjects had comparable experience of meditation, but this group attended a 10 day retreat during which they were given lectures and instructions on meditation. During the actual practice all of them were instructed to focus attention on the visual image of OM, while mentally chanting it.

One can speculate that subtle differences in the mental processes during meditation, could have explained the intersubject differences in the changes in our earlier study cited above since these differences in MLRs could not be correlated with differences in age, or meditation experience. Similarly, the consistency in the mental processes during meditation among the subjects of the present study could explain why changes in the Na wave during meditation were consistent for the whole group.

These changes in the Na wave occurred in both senior and naive subjects (though in opposite directions) during meditation, and during control session conducted on senior subjects. However, wave V and Pa wave did not change. 1t has been postulated that the Na wave may be due to activity at the mesencephalic or diencephalic level (Deiber, Ibanez, Fischer, Perrin, & Mauguiere 1988). Hence, either mentally repeating "one" or meditation on OM appears to alter neural processing at the same level. However, the nature of change is dependent on whether subjects are "senior" or "naive," and occurs in opposite directions during the two sessions in senior subjects, and in the same direction during both sessions in naive subjects. An increase in amplitude of MLRs has been interpreted as an indicator of increased efficiency in activating the neural generator (Woods & Clayworth, 1985). Hence, it appears that meditation in "senior" subjects facilitates neural activity at mesencephalic or thalamic (medial geniculate) level, similar to that noted in subjects practicing consciously regulated yogic breathing or pranayama (Telles, Joseph, Venkatesh, & Desiraju, 1993). In contrast, in naive subjects meditation inhibits neural activity at this level. The same result (i.e., inhibition) is also seen in senior subjects while mentally repeating "one". These findings could be correlated with the facts that (a) "senior" subjects found meditation on OM less effort than mental repetition of "one," whereas (b) "naive" subjects felt the opposite i.e., they felt that both meditation and repeating "one" required effort, which was greater for the former.

Hence, the results of the present study may provide objective correlates for the altered mental state during meditation. These results can, perhaps, be correlated with the subjective experiences of the volunteers.

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