Changes in Midlatency Auditory Evoked Potentials Following Two Yoga-Based Relaxation Techniques

Pailoor Subramanya and Shirley Telles

Key Words

Cyclic Meditation
Midlatency Auditory Evoked Potentials
Supine Rest
Yoga

ABSTRACT

Practicing meditation while focusing on a sound or a symbol influenced midlatency auditory evoked potentials (MLAEPs). Cyclic meditation (CM) is a technique combining yoga postures with meditation while supine, which has influenced the P300 event-related potential. The effects of CM on MLAEPs have not been previously studied.

The MLAEPs were studied before and after the practice of CM compared to an equal duration of supine rest (SR) in 47 male volunteers (group mean age 26.5 ± 4.4 years), recorded from the vertex referenced to linked earlobes. The sessions were one day apart and subjects were randomly assigned to each session.

The Pa wave peak latency and Nb wave peak latency significantly increased following CM compared to before CM (repeated measures ANOVA, *post-hoc* analysis with least significant difference, $p<0.05$). There was a significant increase in the peak amplitude of the Nb wave ($p<0.05$) compared to before CM. Post SR there was a significant increase in the peak latency of the Na wave ($p<0.05$) compared to before SR.

In conclusion following CM the latencies of neural generators corresponding to cortical areas is prolonged, whereas following SR a similar change occurs at mesencephalic-diencephalic levels.

INTRODUCTION

Yoga is an ancient science, which includes diverse practices, such as physical postures (*asanas*), regulated breathing (*pranayama*), and meditation.[1,2] Meditation, in fact, is the seventh out of eight steps prescribed to reach an ultimate stage of spiritual emancipation (Patanjali, *circa* 900 B.C.).[3] While many practitioners do learn meditation directly, others find it easier to pass first through the other stages, learning yoga postures (*asanas*) and regulated breathing (*pranayamas*).[4] Based on this, a technique called Cyclic Meditation (CM) has been devised which combines periods of meditation while supine, interspersed with practicing yoga postures (*asanas*).

Practicing CM has been followed by a decrease in oxygen consumption and an increase in minute ventilation,[5,6] as well as changes in the heart rate variability spectrum suggestive of a shift towards vagal dominance.[7] Despite these changes suggestive of parasympathetic dominance following CM, in a previous study a decrease in the P300 peak latency and an increase in the P300 peak amplitude when the P300 was obtained using an auditory oddball paradigm.[8] The P300 reflects fundamental cognitive processes requiring attentional and immediate memory processes.[9] These findings are in line with a previous description of meditation as a training in awareness which, when practiced over long periods, produces definite changes in perception, attention, and cognition.[10]

Several studies have evaluated the effect of meditation on perception using sensory evoked potentials. Most studies have been conducted using midlatency auditory evoked potentials (MLAEPs), which were selected for study as they reflect changes at the level of the thalamus (i.e., the medial geniculate nucleus), thalamic radiation, and the Heschl's gyrus. Meditation is believed to influence MLAEPs through changes at cortical levels and corticofugal controls, which may significantly alter the processing of information at brainstem and thalamic levels.[11-13]

In a previous study MLAEPs recorded when practitioners meditated on one day on a meaningful syllable (i.e., "OM") and on another day on a syllable of no special significance (i.e., "one").[14] There were definite differences in the MLAEPs recorded during the two sessions. During meditation on the significant syllable there was an increase in the peak amplitude of a particular component, the Na wave, a negative wave between 14 and 19 msec.[15] The increase in the Na wave peak amplitude was understood to suggest an increase in the number of neurons recruited at the level of the corresponding neural generators, when meditating on a syllable of significance.[16] In another study, MLAEPs were recorded during an eyes open meditation, when the gaze is focused on a point of light.[17] There was a significant decrease in the peak latency of the Na wave. The decrease in peak latency was understood to suggest a decrease in the processing time at the mid-brain thalamic level.

While the studies cited above described MLAEP changes in normal participants due to meditation, another study was conducted on patients with primary idiopathic epilepsy[18] and showed that 6 months of meditation on a series of meaningful thoughts (Sahaja yoga meditation) increased the Na-Pa amplitude.

We believe there have been no reports on MLAEPs following the practice of CM, which differs from other meditations as it includes the practice of yoga postures. The present study was designed to record MLAEPs for comparison before and after CM, and before and after an equal duration period of supine rest (SR). Hence, the hypothesis of the present study was that the practice of CM (which combines supine rest and yoga postures) may have influenced MLAEPs due to changes in mesencephalic-diencephalic and primary auditory cortical components of the auditory pathway.

METHODS

Participants

Forty-seven male participants whose ages ranged from 18 to 40 years (mean 26.5 ± 4.4 years) were recruited. All participants were

From the Indian Council of Medical Research, Center for Advanced Research in Yoga and Neurophysiology, SVYASA, Bangalore, India.

Address requests for reprints to Shirley Telles, PhD, Patanjali Yogpeeth, Maharishi Dayanand Gram, Bahadrabad, Haridwar, 249402, Uttarakhand, India.

Email: shirleytelles@gmail.com

Received: November 2, 2008; accepted May 1, 2009.

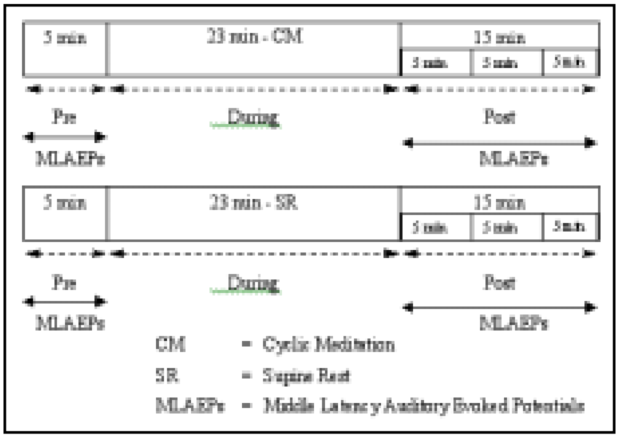

Figure 1.
Schematic representation of the design of the study and assessment schedule.

residing at a yoga center located in south India. Male subjects alone were studied as auditory evoked potentials vary with the phases of the menstrual cycle.[19]

All of the subjects were in normal health based on a routine clinical examination and none of them were taking any medication. Auditory deficits and the need for medication were pre-set conditions for exclusion from the trial. None of the participants had to be excluded for these reasons. The participants had experience of (1) the practice of CM and (2) of relaxation while supine, ranging from 6 to 48 months (mean experience 20.1 ± 14.9 months). The study was explained to them. None of the participants were involved in any other ongoing yoga research at the center. There was no attempt to determine the extent of each participant's knowledge about the effects of CM and SR. However, given the fact that they were residing in the yoga center they may have been aware of the effects of both the practices. However, it is to be noted that the participants would be unlikely to know how either practice could influence the variable studied (i.e., MLAEPs) in a way which was beneficial. This is because what constitutes a beneficial change in evoked potentials is less known for a person who is not well versed in neuroscience, compared to changes in the blood pressure or heart rate (for example). Nonetheless, this remains a limiting factor of the study. The approval of the Institutional Ethics Committee was obtained and the participants' signed informed consent was taken.

Design

The 47 participants were assessed in two types of sessions, CM and SR. All subjects underwent 1 month of supervised practice of CM and SR for 23 minutes on alternate days as a "refresher course" (orientation program), i.e., between 06:30 and 07:00 hours. On the day of recording participants were not given supervised practice of CM and SR. All assessments followed the 1 month orientation program. For some of the participants the CM session took place on the first day, with the SR session the next day, but at the same time of day. For the remaining participants the order of the sessions was reversed. Participants were randomly allocated to either schedule, to balance the effect of the order of the sessions. Hence, 23 out of 47 subjects had CM on the first day and 24 out of 47 had SR on the first day. There were no differences in results based on the order of sessions, following comparisons between post values (p>0.05, t-test for unpaired data).

All the participants were not studied at the same time of the day. For example, 11 out of 47 participants had the recordings between 06:00 and 9:00 hours, 23 out of 47 had the recordings between 10:30 and 12:30 hours, and 13 out of 47 participants had the recordings between 15:30 and 18:30 hours. There were no differences in results based on the timing of sessions. Post values were compared for those who had recordings between 06:00 to 09:00 hours, between 10:30 to 12:30 hours, and between 15:30 to 18:30 hours; in each comparison p>0.05, t-test for unpaired data, showed that the time of recording did not appear to influence the result.

Recordings of the MLAEPs were in four states, i.e., one pre- and three post-periods (i.e., Post 1, Post 2, and Post 3). The study design and assessment schedule have been schematically presented in Figure 1.

Recording Conditions

For assessments, participants were seated in a sound attenuated and dimly lit cabin with eyes closed. They were monitored on a closed-circuit television with instructions being given through an intercom, so that participants could remain undisturbed during a session. By observing the participants on the closed-circuit television, we were able to detect if the participants moved during a session or if they fell asleep. The temperature in the laboratory was maintained at 24±1°C. Humidity was, on average, 54% on the days the experiments were conducted. The background noise level of the acoustically shielded chamber was 26 dB. MLAEPs were recorded in the 100 ms, poststimulus time period without any pre-stimulus delay (Nicolet Bravo, U.S.A.). Recordings were from the vertex (Cz) referred to linked earlobes with the ground electrode on the forehead (FPz). The electrode placement was in accordance with the International 10-20 System.[20] The electrode impedance was kept below 5 kΩ at all sites. The preamplifier band-width was set at 10-1500 Hz, and 1500 responses were averaged for each assessment. The rejection level was expressed as a percentage of the full-scale range of the analog-to-digital converter. This level was set at 90%. Binaural click stimuli of 50 µs duration and alternating polarity at the rate of 5.0 Hz were delivered through acoustically shielded earphones (Amplivox, U.K.). The threshold of hearing was noted for each participant and the intensity was kept at 80 dB above the normal hearing level (nHL). The method to check the threshold of hearing was as follows: (1) by decreasing intensity in 5 dB steps until the subject could no longer hear the clicks, and (2) by then increasing the intensity in 5 dB steps until the clicks could be heard. Click threshold was taken as the midpoint between the intensities at which the clicks could and could not be heard. This maneuver was repeated twice to improve reliability.

Audiometry was performed using a computerized audiometer (Elkon Model EDA 3N3 Plus, Mumbai, India) in 15 out of 47 participants to compare with values of hearing threshold intensity obtained with the EP equipment. Assessments were made in the acoustically shielded room where evoked potential recordings were carried out. Participants were presented with pure tones of varying frequencies through acoustically shielded ear phones. The frequencies at which the hearing threshold was determined were: 250Hz, 500Hz, 750Hz, 1KHz, 2KHz, 4KHz, 6KHz, 8KHz, and 12KHz. The hearing threshold was obtained by gradually reducing the sound intensity from 40dB, in 5dB decrements, until the tones could not be heard. Then intensity was increased in 5dB steps until the tones could be heard. Using the EP equipment the group average ± S.D. threshold of hearing was 16.13 ± 2.47dB (right ear) and 15.13± 2.67dB (left ear), while using pure tone audiometry the threshold of hearing was 15.00 ± 2.67 dB (250 Hz; right ear) and 16.67 ± 3.09dB (250 Hz; left ear). The threshold of hearing was noted for each participant and the intensity

Table 1

Peak latency (ms) and peak amplitude (µV) of components of midlatency auditory evoked potentials before (pre) and after (post) Cyclic Meditation (CM) and Supine Rest (SR). Values are groups mean ± S.D.

		Cyclic Meditation (CM) [n=47]				Supine Rest (SR) [n=47]			
Components	Variables	Pre	Post 1	Post 2	Post 3	Pre	Post 1	Post 2	Post 3
Na	Latency (ms)	15.58±1.39	15.57±1.37	15.77±1.45	15.68±1.51	15.62±1.20	15.96±1.43	16.04±1.53*	16.09±1.75*
	Amplitude (µV)	0.61±0.64	0.55±0.62	0.50±0.51	0.56±0.75	0.56±0.66	0.65±0.78	0.59±0.67	0.64±0.81
Pa	Latency (ms)	32.08±3.66	32.95±3.17	33.51±2.77*	33.24±3.26*	32.38±2.99	33.06±2.54	32.62±3.04	32.92±3.34
	Amplitude (µV)	1.33±0.54	1.46±0.56	1.35±0.63	1.35±0.62	1.21±0.54	1.29±0.62	1.33±0.58	1.31±0.52
Nb	Latency (ms)	60.48±8.37	60.92±8.88	61.65±8.42	61.77±8.23**	60.94±9.23	60.36±9.14	60.78±8.88	60.66±9.05
	Amplitude (µV)	0.35±0.24	0.46±0.34*	0.39±0.31	0.37±0.28	0.40±0.31	0.38±0.34	0.38±0.26	0.37±0.33

*p<0.05, ** p<0.01, *post-hoc* analyses with least significant difference, "pre" compared with "post" of the respective session.

was kept at 80dB above the normal hearing level (nHL), based on the value obtained with the EP equipment.

MLAEP components

MLAEP components, viz., Na, Pa, and Nb waves, were measured from a zero DC baseline. Peak latency was measured from the time of click delivery. The peak latencies and peak amplitudes of the following components were measured: Na wave (a negative wave between 14 and 19 ms.), is the maximum negative peak preceding the Pa wave which is a positive component occurring between 25 and 32 ms. The Nb wave which is a negative component between 35 and 65 ms. is also the first maximum negative component immediately following the Pa wave.[21]

Interventions

Cyclic Meditation (CM)

During CM practice the participants kept their eyes closed and followed pre-recorded instructions. The instructions emphasized carrying out the practice slowly, with awareness and relaxation. The practice began by repeating a verse (0:40 min.) from an yoga text, the *Mandukya Upanishad,*[22] followed by isometric contraction of the muscles of the body ending with SR (1:00 min.); slowly coming up from the supine position and standing at ease (called *tadasana*) and "balancing" the weight on both feet, called centering (2:00 min.); then the first actual posture, bending to the right (*ardhakaticakrasana,* 1:20 min.); with 1:10 min. in *tadasana* for instructions about relaxation and awareness; bending to the left (*ardhakaticakrasana,* 1:20 min.); 1:10 min. as before; forward bending (*padahastasana,* 1:20 min.); another 1:10 min.; backward bending *(ardhacakrasana*, 1:20 min.); and slowly coming down in the supine posture with instructions to relax different parts of the body in sequence (10:00 min.); coming back to sitting position after deep relaxation (0:30 min.). The postures were practiced slowly, with awareness of all the sensations felt. The total duration of the practice was 23 min.[5-8,23]

Supine Rest (SR)

Supine rest was practiced as traditional *shavasana* yoga practice, which meant lying flat on the ground with the legs apart, arms away from the sides of the body, with the palms facing upwards, while the eyes were closed.[24] This practice lasted 23 min., so that the duration was the same as for CM.

Data analysis

Statistical analysis was done using SPSS (Version 10.0). Data were analyzed using repeated measures analyses of variance (ANOVAs). There were two Within Subjects Factors, i.e., (1) States, with four levels ("pre", "post 1", "post 2" and "post 3") and (2) Sessions, with two levels (CM and SR). *Post-hoc* analyses with least significant difference were performed and all comparisons were made with the respective "pre" states.

RESULTS

The groups' mean values ± S.D. for the peak latencies (in ms) and peak amplitudes (in µV) of Na, Pa and Nb components of midlatency auditory evoked potentials before and after CM and SR sessions are given in Table 1.

Repeated measures analyses of variance

There was a significant difference between States for the peak latency of the Pa wave (F = 3.067, df = (2.720, 125.102), p<0.05, Huynh-Feldt epsilon = 0.907). There was also a significant difference between Sessions for the peak amplitude of the Pa wave (F = 4.254, df = (1, 46), p<0.05, Huynh-Feldt epsilon = 1.000). The repeated measures ANOVA showed no significant difference between States and interaction between Sessions and States for the peak amplitudes of Na, Pa and Nb wave, or between States for peak latencies of Na and Nb waves.

Post-hoc analyses with least significant difference

Post-hoc analyses with least significant difference were performed and all comparisons were made with the respective "pre" states. Post CM there was a significant increase in the peak latency of the Pa wave (p<0.05) and of the Nb wave (p<0.05) compared to "pre". Also, there was a significant increase in the peak amplitude of the Nb wave (p<0.05) compared to "pre". Post SR there was a significant increase in the peak latency of the Na wave (p<0.05) compared to "pre". These changes have been indicated in Table 1.

DISCUSSION

Following the practice of CM there was an increase in the peak latencies of the Pa and Nb waves and an increase in the Nb wave peak amplitude. Following SR there was an increase in the Na wave peak latency.

Currently, the neural generators of the different components are as follows: the Na wave has been postulated to be due to activity at the mesencephalic or diencephalic level,[15] the Pa wave corresponds to the activity at the superior temporal gyrus,[25] and intra-cerebral recording in humans has demonstrated that the neural generators of the Nb wave are relatively localized in the dorso-posterior-medial part of the Heschl's gyrus, i.e., the primary auditory cortex.[26] A decrease in peak latency is considered as suggestive of facilitated transmission due to increased speed of conduction in the underlying neural generators.[27] Conversely, an increase in peak latency can be assumed to suggest inhibited transmission due to slower conduction in the underlying neural generators. With respect to changes in peak amplitude, an increase in the amplitude of an evoked potential component has been interpreted as being indicative of effective activation of the underlying neural generator.[16]

In the present study, the increase in the Pa and Nb wave peak latencies following meditation is contrary to earlier studies in which MLAEPs were recorded during and after meditation.[17,28] In particular, meditation on a syllable of significance (i.e., "OM") was earlier shown to significantly reduce the Nb wave peak latency.[29] A reduction in the peak latency of another component, i.e., the Na wave, followed an eyes-open meditation where the gaze was fixed on a point of light.[17]

The reason for this contradictory result (i.e., an increase in Pa and Nb wave peak latencies following CM) compared to decreased Na and Nb wave peak latencies following other meditations may be related to the fact that CM includes the practice of both yoga postures (*asanas*) as well as periods of meditation, rather than meditation alone. The relevance of this may be seen from a parallel-groups design study which demonstrated changes in brain gamma-aminobutyric acid (GABA) levels associated with an acute yoga *asana* session.[29] Yoga practitioners who completed a sixty minute session of yoga postures (*asanas)* were compared with subjects who completed a 60 minute reading session. Magnetic resonance spectroscopic imaging assessed GABA-to-creatine ratios prior to and after interventions. The yoga practitioners showed a 27% increase in GABA levels after the yoga session while the comparison group showed no change. The role of GABA in the central nervous system as an inhibitory neurotransmitter is well recognized.[30] Based on this a shift of gamma-amino butyric acid (GABA) receptor activation to excitation has been postulated to be involved in mechanisms underlying the generation and maintenance of pain.[31] Apart from the somatosensory pathway GABAergic inhibition in auditory sub-cortical and cortical areas is also known.[32]

Hence, the increase in Pa and Nb wave peak latencies following CM practice may be related to activation of inhibitory mechanisms in cortical areas within the auditory pathway. However, in the absence of simultaneous magnetic spectroscopic imaging assessments, this remains a speculation. The possibility of cortical inhibition following CM may be considered supported by the fact that changes following CM in this study were seen in the Pa and Nb components which have cortical neural generators unlike the change following SR where the Na wave peak latency increased and the Na wave is believed to be generated at the mesencephalic-diencephalic level. This suggests a possible difference in the level of change following CM and SR, with the change in the latter being sub-cortical. The exact reason for this difference is not known.

The Nb wave, which is a negative component between 35 and 65 ms. is also the first maximum negative component immediately following the Pa wave.[21] The Nb wave corresponds to activity at the dorso-posterior-medial part of the Heschl's gyrus, i.e., the primary auditory cortex.[25] Considering that an increase in the amplitude of an evoked potential component has been interpreted as being indicative of effective activation of the underlying neural generator,[16] this suggests that CM practice is associated with increased activity at the level of the primary auditory cortex.

The increase in the Nb wave peak amplitude following CM in the present study may be compared to another study, in which the practice of a meditation technique called Sahaja Yoga resulted in an increase in the Na-Pa amplitude.[18] However, there were certain important differences between the study of Panjwani et al.[18] and the present study. The earlier cited study was conducted on patients with primary idiopathic epilepsy (compared to normal individuals in the present study), and in the study by Panjwani et al., the longitudinal effect of 6 months of meditation practice was studied, whereas in the present study the immediate effect of practicing CM was assessed by comparing post practice recordings with recordings made before practice. The two studies also differed in the type of meditation practice. CM consists of periods of SR interspersed with the practice of specific postures (*asanas*). During Sahaja Yoga meditation participants think thoughts considered to be meaningful. In both studies none of the assessments were made during the practice of meditation. Despite these differences the two studies suggest that different meditation practices are associated with increased activation along the auditory pathway, though at different levels.

In attempting to explain the results, it may be speculated that during the SR sessions participants fell asleep and hence were drowsy during the post period. There were no recordings of the EEG during the practices and hence there is no absolute proof that the participants did not fall asleep while practicing the techniques. However, for assessments participants were monitored on a closed-circuit television, so that they could remain undisturbed during a session. By observing the subjects on the closed-circuit television it was possible to detect if they moved during a session or if they fell asleep. Detecting if participants fell asleep is relatively easy if participants are seated. However, in the present study since participants were supine during SR and the last part of CM, this was not of any use. Hence, the possibility that they were asleep could not be entirely ruled out based on observations made on the closed-circuit TV. In the case of CM practice, the last 10 min of the 23 min session were spent lying flat, while during the earlier 13 min the participants practiced yoga postures. Hence, if they were to fall asleep during CM, they would have done so in the last 10 min. However, for the SR session they lay flat for the whole period. Whether this would have increased or reduced the likelihood of them falling asleep after the session remains a speculation.

While there is no absolute proof that the participants did not fall asleep while practicing the techniques, there are three factors which may support the idea that the subjects did not actually sleep during SR. In a previous study, the high frequency (HF) power of the heart rate variability (HRV) increased during both CM and SR practice, which is considered to suggest increased vagal tone.[7] However, there was a marginally greater increase during CM (4.4 percent) compared to during SR (1.0 percent). In the same study, the low frequency (LF) power which is believed to correlate with sympathetic activity was significantly less during both CM (1.8 percent decrease) and SR (0.3 percent decrease). In another study, on the effects of CM and SR on oxygen consumption, while the oxygen consumption increased during CM, it reduced during SR.[6] However, following CM there was a greater magnitude of decrease in oxygen consumption (a 19.3 percent decrease) compared to following SR (a 4.8 percent decrease). Hence, based on the HRV, the practice of CM and SR was characterized by vagal dominance, which was marginally more during CM. Also, after (but not during the practices) the change in oxygen consumption suggested that after both practices there was a period of physiological relaxation which was more after CM compared to SR. In another study, whole night polysomnography measures and the self-rating of sleep were assessed on the night following a day in which 30 male participants practiced CM twice (approximately 23 minutes each time).[33] This was compared to another night when they had two equal duration sessions of SR on the preceding day. In the night following CM practice the percentage of slow wave sleep (SWS) was significantly more than the night following SR, whereas the percentage of rapid eye movement (REM) sleep and the number of awakenings per hour was less. A different trend may have been expected if subjects were asleep or had micro-sleep during SR sessions. However, the subjects in the three studies cited above (i.e., on HRV,[7] oxygen consumption[6] and polysomnography[33]) were different from the subjects of the present study and no direct extrapolation can be made. However, all of them were yoga trainees and had similar experience of yoga and similar working and sleep times. Another factor which may be considered to suggest that subjects may not have slept during the SR sessions, is that all of them were trained yoga practitioners and maintaining awareness is considered an important part of *shavasana* practice.[24]

Despite the factors mentioned above, the possibility that subjects did fall asleep in SR sessions cannot be ruled out and hence is a limiting factor of the study. Two other limitations of the study are: (1) the fact that the participants may have been aware of the effects of CM and hence have had certain expectations which would have influenced the outcome. Also, (2) participants were not debriefed to determine to what degree they felt that they had maintained awareness or fallen asleep.

The practice of CM in general appears to bring about a state of low physiological activation as described above with reduced oxygen consumption and a shift in the sympathovagal balance towards vagal dominance.[5-7] However, a study of the P300 following CM suggested that participants showed a better ability to discriminate auditory stimuli of different pitches in a P300 auditory oddball task.[8] The reason for this increased ability to perform sensory discrimination despite low physiological activation remains to be understood. The neural mechanisms involved in the performance of the auditory discrimination task included those parts of the brain concerned with executive functions and attention. P300 generation arises from interaction between the frontal lobe, hippocampal and temporoparietal function.[34] The primary neural generators for the P300 components are in the anterior cingulate when new stimuli are processed into working memory with activation of the hippocampal formation subsequently when the frontal lobe mechanisms communicate with temporal or parietal lobe.[9] As described earlier, the Pa wave corresponds to the activity at the superior-temporal gyrus[25] and the Nb wave corresponds to the primary auditory cortex and hence, different mechanisms may be involved compared to the P300 which showed a decreased latency following CM, compared to the Pa and Nb waves, which showed an increased latency following CM. Also, the level of change appeared to differ between SR (which produced changes in the Na wave) suggesting mesencephalic-diencephalic level changes, and CM, where the changes which followed the practice appeared to be at a cortical level.

ACKNOWLEDGMENT

The authors gratefully acknowledge H.R. Nagendra, PhD, who derived the cyclic meditation technique from ancient yoga texts. The funding from the Indian Council of Medical Research (ICMR), Government of India, as part of a grant (Project No. 2001-05010) towards the Centre for Advanced Research in Yoga and Neurophysiology (CAR-Y&N) is also gratefully acknowledged.

DISCLOSURE AND CONFLICT OF INTEREST

P. Subramanya and S. Telles have no conflicts of interest in relation to this article.

REFERENCES

1. Nagendra HR. Yoga Its Basis and Applications. Bangalore: Swami Vivekananda Yoga Prakashana; 2004.
2. Saraswati Niranjanananda Swami. Prana, Pranayama, Pranavidya. Munger, Bihar: Yoga Publication Trust, Bihar School of Yoga; 1994.
3. Taimini IK. The Science of Yoga. Madras: The Theosophical Publishing House; 1986.
4. Nagendra HR, Nagarathna R. New Perspectives in Stress Management. Bangalore: Swami Vivekananda Yoga Prakashan; 1997.
5. Telles S, Reddy SK, Nagendra HR. Oxygen consumption and respiration following two yoga relaxation techniques. Appl Psychophysiol Biofeedback 2000; 25(4): 221-227.
6. Sarang PS, Telles S. Oxygen consumption and respiration during and after two yoga relaxation techniques. Appl Psychophysiol Biofeedback 2006; 31(2): 143-153.
7. Sarang P, Telles S. Effects of two yoga based relaxation techniques on heart rate variability. Int J Stress Manag 2006; 13(4): 460-475.
8. Sarang SP, Telles S. Changes in P300 following two yoga-based relaxation techniques. Int J Neurosci 2006; 116(12): 1419-1430.
9. Polich J. P300 in clinical applications. In: Niedermeyer E, Lopes da Silva F, (eds). Electroencephalography: Basic Principles, Clinical Applications and Related Fields. Baltimore-Munich: Urban and Schwarzenberg; 1999: 1073-1091.
10. Brown DP. A model for the levels of concentrative meditation. Int J Clin Exp Hypn 1977; 25(4): 236-273.
11. Desiraju T. Neurophysiology and consciousness: an integrated non-dualist evolutionary theory. In: Garlick DG, Korner PI (eds). Frontiers in Physiological Research. Canberra: Australian Academy of Science, Cambridge: Cambridge University Press; 1984; 325-333.
12. Steriade M, Llinas RR. The functional states of the thalamus and the associated neuronal interplay. Physiol Rev 1988; 68: 649-742.
13. Pribram KH, McGuiness D. Brain systems involved in attention and para-attentional processing. Ann NY Acad Sci 1992; 658: 65-92.
14. Telles S, Nagarathna R, Nagendra HR. Alterations in auditory middle latency evoked potentials during meditation on a meaningful symbol "OM". Int J Neurosci 1994; 76: 87-93.
15. Deiber MP, Ibañez V, Fischer C, Perrin F, Mauguiére F. Sequential mapping favors the hypothesis of distinct generators for Na and Pa middle latency auditory evoked potentials. Electroencephalogr Clin Neurophysiol 1988; 71(3): 187-197.
16. Woods DL, Clayworth CC. Click spatial position influences middle latency auditory evoked potentials (MLAEPs) in humans. Electroencephalogr Clin Neurophysiol 1985; 60: 122-129.
17. Telles S, Naveen KV. Changes in middle latency auditory evoked potentials during meditation. Psychol Rep 2004; 94: 398-400.
18. Panjwani U, Selvamurthy W, Singh SH, Gupta HL, Mukhopadhyay S, Thakur L. Effect of Sahaja yoga meditation on auditory evoked potentials (AEP) and visual contrast sensitivity (VCS) in epileptics. Appl Psychophysiol Biofeedback 2000; 1: 1-12.
19. Yadav A, Tandon OP, Vaney N. Auditory evoked responses during different phases of menstrual cycle. Indian J Physiol Pharmacol 2002; 46(4): 449-456.
20. Jasper HH. The ten-twenty electrode system of the International Federation. Electroencephalogr Clin Neurophysiol 1958; 10: 371-375.

21. Morlet D, Bertrand O, Salord F, Boulieu R, Pernier J, Fischer C. Dynamics of MLAEP changes in midazolam-induced sedation. Electroencephalogr Clin Neurophysiol 1997; 104: 1437-1446.

22. Chinmayanada Swami. Mandukya Upanishad. Bombay, India: Sachin Publishers; 1984.

23. Sarang SP, Telles S. Immediate effect of two yoga based relaxation techniques on performance in a letter-cancellation task. Percept Mot Skills 2007; 105(2):379-385.

24. Muktibodhananda Swami. Hatha Yoga Pradipika. 2nd ed. Munger, Bihar: Yoga Publication Trust; 2004.

25. Kileny P, Paccioretti D, Wilson AF. Effects of cortical lesions on middle-latency auditory evoked responses (MLR). Electroencephalogr Clin Neurophysiol 1987; 66: 108-120.

26. Liégeois-Chauvel C, Musolino A, Badier JM, Marquis P, Chauvel P. Evoked potentials recorded from the auditory cortex in man: evaluation and topography of the middle latency components. Electroencephalogr Clin Neurophysiol 1994; 92: 204-214.

27. Malhotra A. Auditory Evoked Response in Clinical Practice. New York: Springer-Verlag; 1997.

28. Telles S, Desiraju T. Recording of auditory middle latency evoked potentials during the practice of meditation with the syllable ‘OM’. Indian J Med Res 1993; [B] 98: 237-239.

29. Streeter CC, Jensen JE, Perlmutter RM, Cabral HJ, Tian H, Terhune DB, et al. Yoga asana sessions increase brain GABA levels: a pilot study. J Altern Complement Med 2007; 13(4): 419-426.

30. Kandel ER, Schwartz JH, Jessell TM. Principles of Neural Science. 4th ed. New York: McGraw-Hill; 2000.

31. Henry JL. Future basic science directions into mechanisms of neuropathic pain. J Orofac Pain 2004; 18(4): 306-310.

32. Ma CL, Kelly JB, Wu SH. Presynaptic modulation of GABAergic inhibition by GABA(B) receptors in the rat’s inferior colliculus. Neurosci 2002; 114(1): 207-215.

33. Patra S, Telles S. Positive impact of cyclic meditation on sleep. Med Sci Monit 2009; 15(6): In Press.

34. Halgren E, Marinkovic K, Chauvel P. Generators of the late cognitive potentials in auditory and visual oddball tasks. Electroencephalogr Clin Neurophysiol 1998; 106: 156-164.

CLINICAL EEG and NEUROSCIENCE

Catherine Demeter
Editorial Manager
2568 E. Denton Lane
Phoenix, Arizona 85016, U.S.A.

Date Sent ____________________

Please Return By ____________________

Scheduled for the ______________ Issue

Proofing Information:

The attached page proofs of your article should be completely read, corrected, and corrections returned via mail (shown above) or email to clinicaleeg@aol.com within 10 (ten) days. Failure to return the proofs promptly, or notifying us that everything is ok as is, may result in your article not being published in the scheduled issue, and rescheduled for a later publication date. There is no charge for changes.

Reprint Information:

Official reprints will be an exact reproduction of the article as it appears in the journal, including page numbers and other identification. Refer to the tables below in figuring the amount to enclose. A PDF of your article in its final form may be ordered in lieu of hard copy reprints for a flat fee of $65. If you wish to order *both* hardcopy and PDF reprints, the PDF fee is $35.

Reprint orders must be accompanied by payment in U.S. funds, or an institutional purchase order.

Pages	100	200	300	400	500
4	75.00	120.00	170.00	210.00	260.00
5	90.00	150.00	210.00	260.00	320.00
6	110.00	180.00	250.00	310.00	380.00
7	130.00	210.00	290.00	360.00	450.00
8	145.00	240.00	330.00	410.00	510.00
9	160.00	270.00	370.00	460.00	570.00
10	180.00	300.00	410.00	520.00	640.00
11	200.00	330.00	450.00	580.00	710.00
12	220.00	360.00	490.00	640.00	770.00
14	260.00	420.00	570.00	740.00	890.00
16	300.00	480.00	650.00	830.00	1000.00
20	360.00	550.00	700.00	860.00	1100.00

- *Minimum order quantity for hard copy reprints is 100 copies.*
- *The above prices include U.S.A. shipping. Outside U.S.A. add the following percentage: Canada & Mexico = 5%. Elsewhere = 15%.*

All reprints are shipped or emailed immediately after current issue is completed. We cannot be responsible for delays or lost shipments outside the U.S. If special shipping instructions are needed, please indicate when ordering.

REPRINT ORDER FORM

I wish to order ____________________(quantity) Reprints

Article Name ____________________

Author's Name: ____________________

Shipping Address: ____________________

City, State/Province, Postal/Zip Code: ____________________

Country: ____________________

All reprint orders must be accompanied by credit card, check or money order in U.S. Funds made payable to CLINICAL EEG and NEUROSCIENCE. Institutional purchase orders are accepted. Please return your reprint order with corrected proof by mail or email to clinicaleeg@aol.com.

Credit Card No. ____________________ Exp. Date ____________________

Signature ____________________ Amount $____________________

☐ Check enclosed, made payable in U.S. funds to *Clinical EEG and Neuroscience.*

PLEASE RETURN THIS ORDER FORM WITH PROOFS TO:
Clinical EEG and Neuroscience, Catherine Demeter, 2568 E. Denton Lane, Phoenix, Arizona 85016, USA or fax 630-653-6233, or via email to clinicaleeg@aol.com.