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Effect of Sahaja Yoga Meditation on Auditory Evoked Potentials (AEP) and Visual Contrast Sensitivity (VCS) in Epileptics

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The effect of Sahaja yoga meditation on 32 patients with primary idiopathic epilepsy on regular and maintained antiepileptic medication was studied. The patients were randomly divided into 3 groups: group I practiced Sahaja Yoga meditation twice daily for 6 months under proper guidance; group II practiced postural exercises mimicking the meditation for the same duration; and group III was the control group. Visual Contrast Sensitivity (VCS), Auditory Evoked Potentials (AEP), Brainstem Auditory Evoked Potentials (BAEP), and Mid Latency Responses (MLR) were recorded initially (0 month) and at 3 and 6 months for each group. There was a significant improvement in VCS following meditation practice in group I participants. Na, the first prominent negative peak of MLR and Pa, the positive peak following Na did not register changes in latency. The Na-Pa amplitude of MLR also showed a significant increase. There were no significant changes in the absolute and interpeak latencies of BAEP. The reduced level of stress following meditation practice may make patients more responsive to specific stimuli. Sahaja Yoga meditation appears to bring about changes in some of the electrophysiological responses studied in epileptic patients.

KEY WORDS: epilepsy; meditation; visual contrast sensitivity; auditory evoked potentials.

INTRODUCTION

Yoga, an integral part of Indian culture and heritage, is said to bestow the practitioner with good health: physical, mental, and spiritual. There are various types of yoga involving postural exercises (asanas), breath control (pranayama), and meditation. We reported earlier that practice of Sahaja yoga, a simple form of meditation, reduced seizures and led to EEG changes in epileptic patients (Panjwani *et al.*, 1996a). The effect of meditation was attributed to a reduction in the level of stress as evidenced by changes in skin resistance and levels of blood lactate and urinary vinyl mandelic acid (Panjwani, Gupta, Singh, Selvamurthy, & Rai, 1995).

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The present study was carried out in order to understand further the electrophysiological mechanisms by which meditation could possibly act. It aimed to evaluate the effect of meditation on some other electrophysiological parameters: Auditory Evoked Potentials (AEP): Brainstem Auditory Evoked Potentials (BAEP) and Mid Latency Responses (MLR) and the Visual Contrast Sensitivity (VCS).

The AEP of clinical importance can be separated into three types on the basis of their latencies: (a) short latency potentials, which include cochlear potentials and BAEP, which occur within first 10 ms after presentation of an auditory stimulus; (b) middle latency potentials (MLR), which occur at latencies between 10 to 50 (or 100) ms; and (c) long latency potentials also called event related potentials, which are elicited at latencies between 100 to 300 (or 500) ms (Jacobson, 1994).

Of the BAEP, the prominent wave forms are (labelled) waves I, III, and V. The absolute latency (AL) of these waves is calculated from the onset of the stimulus to the respective positive peaks, and the interpeak latency (IPL) is the interval between the peaks. These waves represent the sequential activation of the auditory nerve, cochlear nucleus, and the ascending auditory pathway between the cochlear nucleus and inferior colliculus (Moller, 1994).

The MLR form a part of the bioelectric events associated with auditory stimulation of the auditory pathway, which include very early components resulting from electrical events in the cochlea and components with latencies of several hundred ms, associated with cortical and cognitive functions. Within the continuum of components comprising the scalp-recorded auditory evoked responses, the MLR follow the BAEP and precede the late auditory evoked potentials (i.e., beyond the brainstem upto the thalamo-cortical auditory pathway; Kraus, Kilney, & McGee, 1994). The time domain of MLR overlaps with myogenic response arising from post-auricular and inion regions. However, MLR is a neurogenic auditory evoked response that is unaffected by neuromuscular blocking agents (Kilney, 1983). The most prominent, robust, and stable component of MLR is the vertex positive peak Pa and its associated Na/Pa complex (Kilney *et al.*, 1987) of which Na (the negative peak preceeding Pa) is believed to be generated subcortically and Pa bilaterally within the primary auditory cortex (Deiber, Ibanez, Fischer, Perrin, & Mauguirre, 1988).

Auditory evoked potentials are reported to be altered in epileptics as well as in patients on anti-epileptic medication. An increase in wave I, III, and V AL; I–III; and I–V IPL is reported following phenytoin (PHT) and carbamazepine (CBZ) monotherapy. The MLR components Na and Pa AL, wave V-Pa and Na-Nb IPL is also reported to be prolonged following CBZ monotherapy (Japaridze, Kvernadze, Geladze, & Kevanishvili, 1993; Panjwani *et al.*, 1996b). Na-Pa amplitude is reported to be increased in intractable epileptics following anterior temporal lobectomy (Jacobson, Privitera, Neils, Grayson, & Yeh, 1990), a surgical procedure carried out for seizure reduction. It is reported to be reduced in patients with cortical lesions (Kilney, Paccioretti, & Wilson, 1987). The practice of yoga is reported to bring about changes in AEPs (Telles & Desiraju, 1993). The BAEP wave V AL was found to decrease at 55–70 dB stimulus intensity following meditation practice (McEvoy, Frumkin, & Harkins, 1980).

Visual Contrast Sensitivity is a broad and sensitive test of spatial vision that measures visual response to objects at varying levels of contrast. It is a separate aspect of central visual function (Campbell & Green, 1965), which provides a comprehensive measure of visual efficiency (more than a standard visual acuity score, which does not specify the effect of contrast upon the power of spatial resolution; Bodis-Wollner & Diamond, 1976). The contrast sensitivity technique is analogous to audiometry. Temporal frequency is replaced by spatial frequency and intensity by contrast. A series of gratings consisting of fuzzy light and dark bars, for which luminance varies sinusoidally, is presented to the subject. Contrast is defined as the difference between the maximum and minimum luminance divided by the sum of the two. Visual Contrast Sensitivity is the reciprocal of the contrast at threshold.

In patients of pattern sensitive epilepsy who encounter seizures when they view particular type of images, especially stripes, certain spatial frequencies of VCS are associated with maximum epileptogenicity (Chatrian, Lettich, Miller, & Green, 1970a; Chatrian, Lettich, Miller, Green, & Kupter, 1970b). Epileptic discharges have been reported to occur maximally at the spatial frequency of 5 Cycles/Degree (C/D) (Soso, Lettich, & Belgum, 1980). Elevated and more variable contrast thresholds are reported in epileptics (Soso & McCutchen, 1978). This is also true of patients with cerebral lesions (Bodis-Wollner & Diamond, 1976).

METHODS

Thirty female and two male epileptic patients in the age group of 15 to 35 years, mean (SEM) age 22.5 (1.18) years, participated in the study. The patients were kept on regular anti-epileptic medication, which was maintained constant throughout the study. Criteria for inclusion in the study were: (a) patients clinically diagnosed as having primary idiopathic epilepsy (clinical seizure; CT scans or MRI did not reveal any abnormality), (b) greater than four seizures in three months and (c) awareness of every seizure episode by self or family member. Table I gives the participants' details including the anti-epileptic medication. The participants were patients attending the neurology clinic at the Lady Hardinge Medical College and Smt. S. K. Hospital, New Delhi. An informed and written consent was obtained from each participant prior to enrolment in the study. The study was approved by the Ethics Committee of the Institution. The participants were randomly assigned into three groups: Group I ($n = 10$) consisted of patients who practiced Sahaja yoga for 6 months; Group II ($n = 10$) consisted of patients who practiced mimicking exercises for 6 months; and Group III ($n = 12$) were patients who did not practice Sahaja yoga or mimicking exercises but served as controls. The participants in groups I, II, and III were comparable in age, seizure frequency, and duration of illness. Statistical analysis using one-way analysis of variance (with the dependent variables being age, seizure frequency, and duration of illness and independent variable being the membership of groups) revealed no statistically significant difference between the three groups of participants at the commencement of the study.

Group I participants practiced Sahaja yoga twice daily for 20 to 30 minutes under the guidance of a trained "Sahaja yogi" or an instructor. They reported to the Department of Physiology on all working days for the first month and twice a week thereafter for the remaining period. On the day of the weekly Neurology Clinic, the patients practiced Sahaja yoga in a room in the Medical Out Patient Department.

Meditation sessions were conducted in a quiet, well-illuminated room with the participants sitting in a comfortable posture and loose clothing. A typical session of meditation consisted of questions and assertions by the subject as described in Table II. Thereafter, the

Table I. Clinical Characteristics of Subjects

	Group I ($n = 10$)		Group II ($n = 10$)		Group III ($n = 12$)	
Age (yrs.) (Mean ± SEM)	24.6 ± 2.1		23.7 ± 2.5		19.7 ± 1.4	
Gender	Females	9	Females	9	Females	12
	Males	1	Males	1	Males	0
Level of education	Primary school	3	Primary school	3	Primary school	4
	Secondary school	4	Secondary school	4	Secondary school	4
	Senior school	2	Senior school	2	Senior school	3
	Graduate	1	Graduate	1	Graduate	1
Type of seizures	GTC	7	GTC	8	GTC	10
	CPS	1	CPS	1		
	P c SG	2	P c SG	1	P c SG	2
Duration of illness (yr.) (Mean ± SE)	7.3 ± 1.1		5.6 ± 0.9		4.2 ± 0.7	
Anti-epileptic drugs	PHT	1	PHT	1	PHT	1
	PB	1	PB	3	PB	1
	PHT + PB	5	PHT + PB	3	PHT + PB	4
	CBZ + PB	2	CBZ + PB	2	CBZ	3
	Primadone + CBZ + PB	1	PHT + CBZ + PB	1	CBZ + VPA	2
					PHT + CBZ + PB	1

GTS—Generalized tonic clonic seizures (primary generalized).
P c SG—Partial with secondary generalization.
CPS—Complex partial seizures.
PHT—Phenytoin.
PB—Phenobarbital.
CBZ—Carbamazepine.
VPA—Valproate.

participants practiced silent meditation. If a thought came into the mind, they were instructed to simply "witness" it but not to flow deeper into it. Gradually, with regular practice the participants reported to be in a state of "thoughtless awareness." Meditation was also practiced at bedtime by sitting in "silent meditation" with the feet dipped in warm saline water.

Group II participants who practiced mimicking exercises were provided with the same environment and attention as group I. However, actual meditation was not practiced. The participants were instructed to simply place their hand at different positions as during meditation practice and thereafter sit quietly with their eyes closed.

The recordings were carried out in a quiet, air-conditioned laboratory, at the same time of the day (commencing 10.00 hrs). The AEP were recorded using Nicolet Instruments (USA) Model Compact IV Evoked Potential System. The participants rested in supine position. The active electrode (impedance below 5 kohms) was placed over the vertex (Cz), the reference over the earlobes (A1 and A2 for left and right ears respectively), and the ground electrode over the forehead (FPz).

For recording of BAEP, monoaural auditory stimuli consisting of clicks of 100 μsecs duration, square wave pulses were delivered through electrically shielded earphones (TD11-39P01288 Telephonics 296 Doo-4) with 35 dB pure white noise contralateral masking. The stimuli were delivered at the rate of 11.4/sec, 75 dB above the click hearing threshold. The evoked electrical activity was amplified 10,000 times with a band pass of 150–3000 Hz and averaged over 2,000 sweep presentations. Mid-latency response was recorded using

Table II. Procedure for Sahaja Yoga Practice

	Placement of Right Hand	Question/Assertion
Position 1	On the heart	Am I the Spirit? 3 times
Position 2	Above the stomach	Am I my own master? 3 times
Position 3	Below the stomach at the interface between the body and the left leg	God! Please give me pure divine knowledge 6 times
Position 2	Above the stomach	I am my own master 10 times
Position 1	On the heart	I am the spirit 12 times
Position 4	Behind the neck turning the head to the right side	I am not guilty 16 times
Position 5	On the forehead	I forgive everyone (even my ownself) To be repeated till the subject forgives everyone
Position 6	Behind the head raising the head upwards	God! If I have made any trespasses, please forgive me 1 time
Position 7	Top of the head with fingers parted, rotating the hand slowly clockwise, seven times	God, please give me self-realization 7 times

monoaural auditory stimuli consisting of clicks of 100 μsec duration, delivered at the rate of 9.7/sec, 60 dB above the click hearing threshold, with the band pass of 10 to 250 Hz, and averaged over 1,000 click presentations. At least two trials were obtained to ensure reproducibility of responses. AEP were plotted on an X-Y plotter (Hewlett Packard, USA).

Visual Contrast Sensitivity was recorded on CS 2000 Nicolet Biomedical Instruments. Each participant was tested for spatial frequencies of 0.5, 1.0, 3.0, 6.0, 11.4, 22.8 C/D, presented in the form of sine wave gratings at a viewing distance of 3 m in a dark room. The recordings were taken on a full screen with a mean luminance of 100 cd/m^2, surround luminance of 5 cd/m^2, and visual angle of 4.2×5.5 feet. After a brief “Preview,” which enabled the participant to view the grating that was to follow, the particular grating appeared with the contrast increasing gradually until such a point that the grating became visible and was indicated by pressing a button. The procedure was carried out four times at each spatial frequency; the mean values of contrast sensitivity and contrast threshold were obtained.

The data was subjected to statistical evaluation by using Friedman two-way Analysis of Variance by ranks for changes at 3 and 6 months in each group. For inter-group comparisons, the Kruskal Wallis One Way Analysis of Variance by ranks was applied.

RESULTS

BAEP: Figure 1 shows a typical waveform of BAEP. There were no significant changes in BAEP waves I, III, and V AL and I–III, III–V, and I–V IPL at 3 and 6 months in groups I, II, and III (Tables III and IV).

Table III. Brainstem Auditory Evoked Potentials (Absolute Latencies (ms)) at 0, 3, and 6 Months

	Absolute Latencies (ms)		
Group I			
0 Month	1.89 (0.09)	3.98 (0.15)	5.81 (0.14)
3 Months	1.82 (0.01)	4.02 (0.15)	5.77 (0.12)
6 Months	1.73 (0.07)	3.88 (0.12)	5.90 (0.13)
Group II			
0 Month	1.87 (0.36)	3.81 (0.09)	5.72 (0.07)
3 Months	1.85 (0.05)	3.82 (0.11)	5.67 (0.14)
6 Months	1.78 (0.04)	3.74 (0.08)	4.86 (0.13)
Group III			
0 Month	2.03 (0.12)	4.08 (0.08)	5.76 (0.09)
3 Months	1.89 (0.04)	3.99 (0.06)	5.72 (0.07)
6 Months	1.88 (0.04)	4.10 (0.09)	5.77 (0.08)

Values are Mean ± SEM.

Table IV. Brainstem Auditory Evoked Potentials (Interpeak Latencies (ms)) at 0, 3, and 6 Months

	Interpeak Latencies (ms)		
	I–III	III–V	I–V
Group I			
0 Month	2.09 (0.08)	1.93 (0.10)	3.92 (0.09)
3 Months	2.20 (0.13)	1.75 (0.13)	3.89 (0.08)
6 Months	2.24 (0.32)	1.75 (0.19)	4.14 (0.09)
Group II			
0 Month	1.95 (0.09)	1.76 (0.06)	3.73 (0.13)
3 Months	1.98 (0.10)	1.77 (0.09)	3.83 (0.13)
6 Months	1.96 (0.39)	1.84 (0.11)	3.91 (0.13)
Group III			
0 Month	2.12 (0.09)	1.69 (0.08)	3.80 (0.12)
3 Months	2.16 (0.08)	1.92 (0.15)	3.83 (0.08)
6 Months	2.14 (0.07)	1.91 (0.20)	3.89 (0.07)

Values are Mean ± SEM.

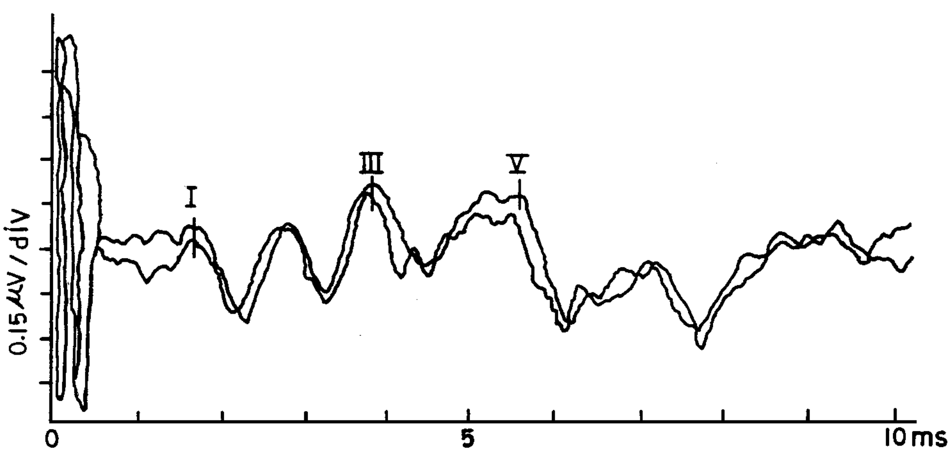

Fig. 1. A typical Brainstem Auditory Evoked Potential tracing, showing the prominent wave forms.

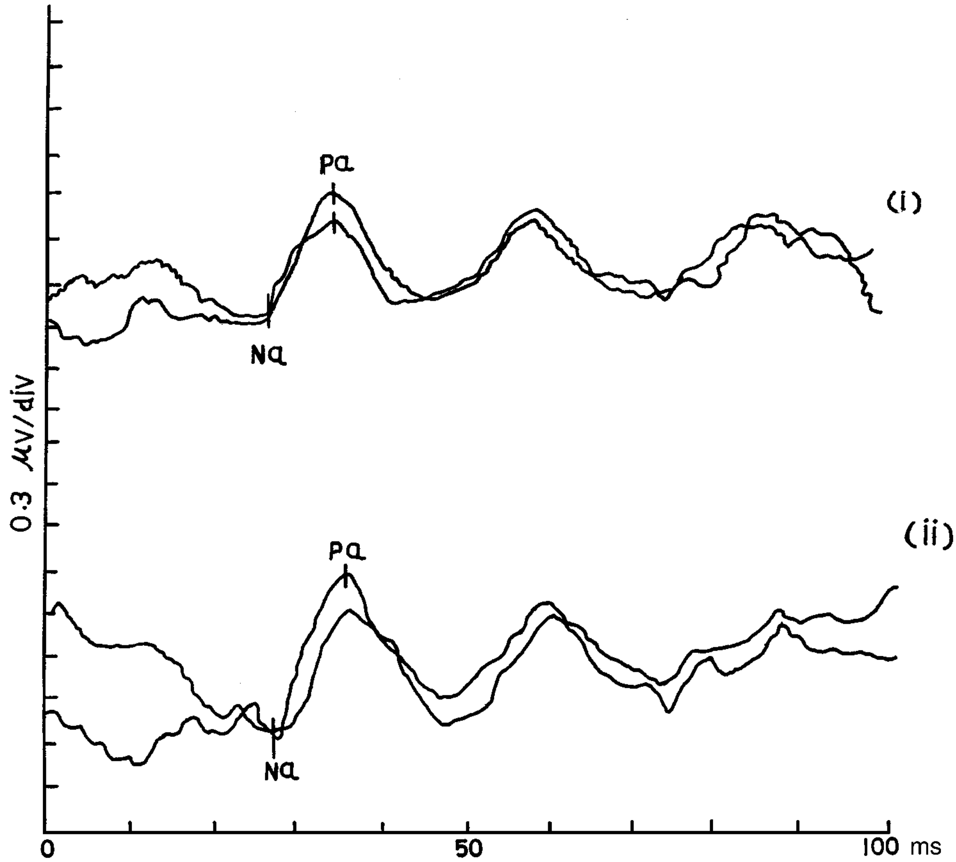

Fig. 2. Middle latency response of a subject (i) recorded at baseline and (ii) after 6 months of meditation practice. Note the increase in Na-Pa amplitude after meditation practice.

There was a significant increase in Na-Pa amplitude following meditation practice in group I ($p < 0.05$), but not in group II and III. Figure 2 shows the MLR response in a group I participant recorded at baseline and after 6 months of meditation practice. There was a significant increase at 6 months as compared to 0 month ($p < 0.05$). However, there were no significant changes in MLR latencies Na and Pa at 3 and 6 months in group I, II, and III participants (Table V).

VCS: As shown in Figure 3, there was an improvement in VCS following Sahaja yoga practice in group I but no significant change in groups II and III (Figs. 4 and 5). In group I, there was a significant change at all the spatial frequencies: 0.5 C/D ($p < 0.01$), 1 C/D ($p < 0.01$), 3 C/D ($p < 0.05$), 6 C/D ($p < 0.05$), 11.4 C/D ($p < 0.05$), 22.8 C/D ($p < 0.01$). As compared to the initial values, at 0.5 C/D, VCS increased significantly at 6 months ($p < 0.01$), at 1 C/D it increased significantly at 3 months ($p < 0.05$) and at 6 months ($p < 0.01$), at 3 C/D, it increased significantly at 6 months ($p < 0.05$), at 6 C/D, it increased significantly at 6 months ($p < 0.05$), at 11.4 C/D, it increased significantly at 6 months ($p < 0.01$), at 22.8 C/D, it increased significantly at 6 months ($p < 0.01$).

Table V. Middle Latency Response at 0, 3, and 6 Months

	Latency (ms)		Amplitude (μv)
	Na	Pa	Na-Pa
Group I			
0 Month	25.25 (1.83)	37.20 (0.09)	0.53 (0.08)
3 Months	25.65 (1.61)	36.85 (1.16)	0.63 (0.06)
6 Months	25.52 (1.72)	36.85 (0.67)	0.84 (0.13)[a]
Group II			
0 Month	22.83 (1.28)	34.74 (0.86)	0.84 (0.15)
3 Months	22.06 (0.92)	34.29 (0.87)	0.83 (0.09)
6 Months	23.60 (1.80)	35.40 (0.98)	0.94 (0.14)
Group III			
0 Month	25.30 (0.99)	34.98 (0.93)	0.67 (0.07)
3 Months	25.07 (0.95)	34.98 (0.73)	0.64 (0.07)
6 Months	25.04 (1.05)	34.71 (0.74)	0.65 (0.07)

[a] $p < 0.05$ as compared to 0 month value.
Values are Mean ± SEM.

DISCUSSION

Meditation practice led to an improvement in VCS in group I at all the spatial frequencies tested. The Na-Pa amplitude of the MLR increased. However, there was no significant change in BAEP. There was no significant change in any parameters in groups II and III participants.

Visual Contrast Sensitivity is a separate and important aspect of central visual function (Campbell & Green, 1965), which provides a more comprehensive measure of visual efficiency than a standard acuity score, which does not specify the effect of contrast upon the power of spatial resolution (Bodis-Wollner & Diamond, 1976). An improvement in VCS could be explained by a better relaxed state and a decrease in the level of stress as found following meditation practice (Panjwani *et al.*, 1995) combined with better attention, which may make the individual more responsive to specific stimuli. These findings could indicate a beneficial effect of meditation on CNS factors underlying perceptual and sensory processing.

Similar findings were reported in practitioners of Buddhist meditation who had an enhanced visual sensitivity after 3 months of meditation practice. They could detect shorter single light flashes and needed a shorter interval to differentiate between successive flashes correctly. Meditation practice enabled the practitioner to become aware of some of the preattentive processes involved in visual detection indicating changes in perception (Brown, Forte, & Dysart, 1984a; Brown, Forte, & Dysart, 1984b).

We found a significant increase in Na-Pa amplitude of MLR following Sahaja Yoga practice. A similar increase in Na-Pa amplitude correlating with seizure reduction in patients of intractable epilepsy has also been reported following anterior temporal lobectomy (Jacobson *et al.*, 1990). On the other hand, a reduced Na-Pa amplitude is reported in patients with cortical lesions (Kilney *et al.*, 1987).

Recent magnetoencephalographic studies have pointed to the primary auditory cortex as the neural source of MLR (Makela, Hamalainen, Hari, & McEvoy, 1994, Yoshiura Ueno, Iramina, & Masuda, 1995). On the other hand, some electroencephalographic studies have suggested that the neural source of some MLR components may be the ascending

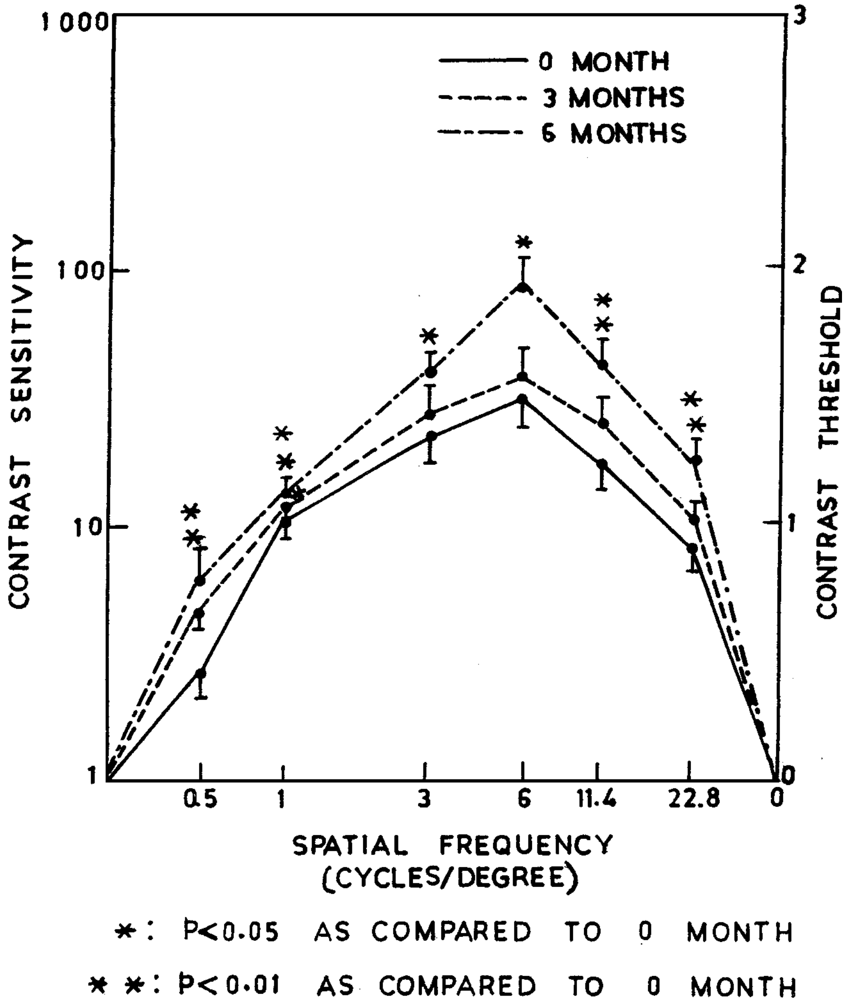

Fig. 3. Effect of Sahaja yoga practice on the Visual Contrast Sensitivity in group I participants. Note the significant improvement after meditation practice.

reticular activating system (Erwin & Buchwald, 1986) or other subcortical structures (Cacace, Satya-Murti, & Wolpaw, 1990). The involvement of multiple generators including the auditory thalamo-cortical pathway, mesencephalic reticular formation, and inferior colliculus has also been suggested (Kraus, 1994). In humans, the MLR response may actually consist of overlapping potentials originating from the primary auditory cortex and ascending activating system and/or other subcortical structures (Ninomiya, Onitsuka, Chen, & Kinukawa, 1997). It is possible that meditation may bring about changes in neural processing at some or all of these levels. Moreover, MLR has important cortical components which are affected by attention (Kraus *et al.*, 1994), which is expected to improve after meditation practice.

No significant changes in BAEP following Sahaja yoga practice were observed indicating that meditation practice did not appear to significantly alter neural processing upto the

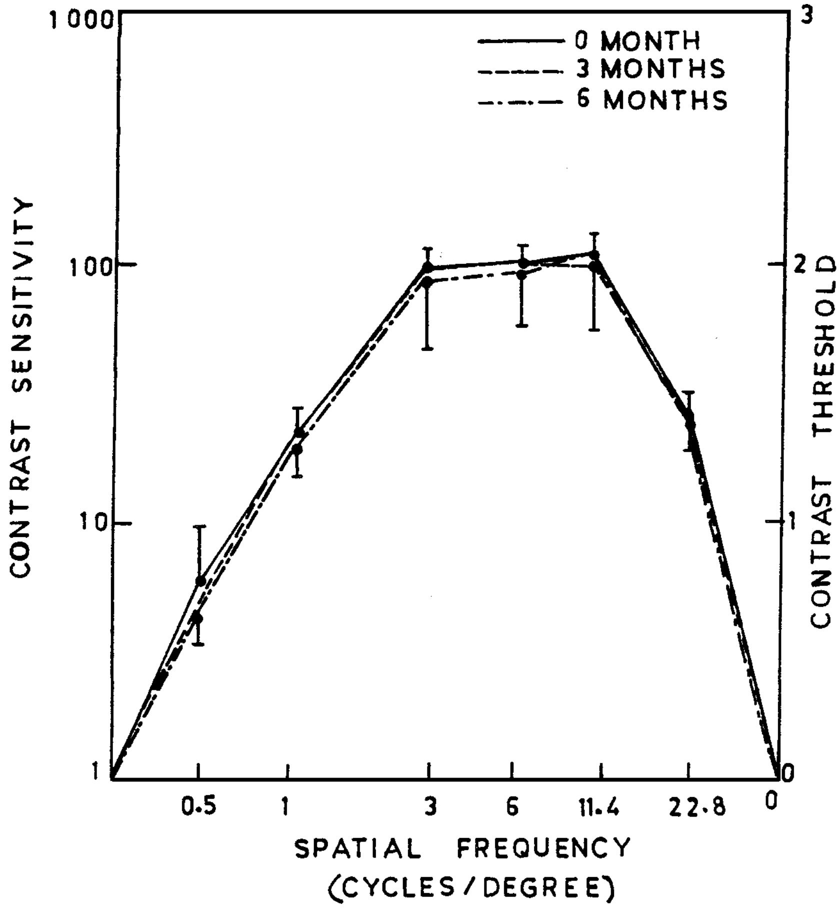

Fig. 4. Visual Contrast Sensitivity following mimicking exercises in group II participants. Note the lack of any significant change.

level of the brainstem. One possible explanation would be that the participants were patients and not "advanced" practitioners and that the duration of meditation practice was relatively short. Two previous studies, which have evaluated the effect of meditation (McEvoy *et al.*, 1980, $n = 5$, duration of practice 6 to 9 years; Telles and Desiraju, 1993, $n = 7$, duration of practice = 5 to 20 years) have reported changes in wave V latency of BAEP. Reduced auditory threshold and increased auditory acuity have also been reported (Clements & Milstein, 1977; Pirot, 1977). These studies were carried out by highly advanced practitioners who had been practicing meditation for several years (although the sample size was small), which would explain the differences in the findings.

It appears that behavior modification has an important role in the changes observed. The ability to sit quietly, to focus attention, to be motivated and other psychological variables are important. An altered life style with a reduction in stress may be significant for the clinical and electrophysiological changes (Panjwani *et al.*, 1996a). The present study indicates that the meditation practice as an adjunct to anti-epileptic medication may bring about changes in some of the electrophysiological functions studied.

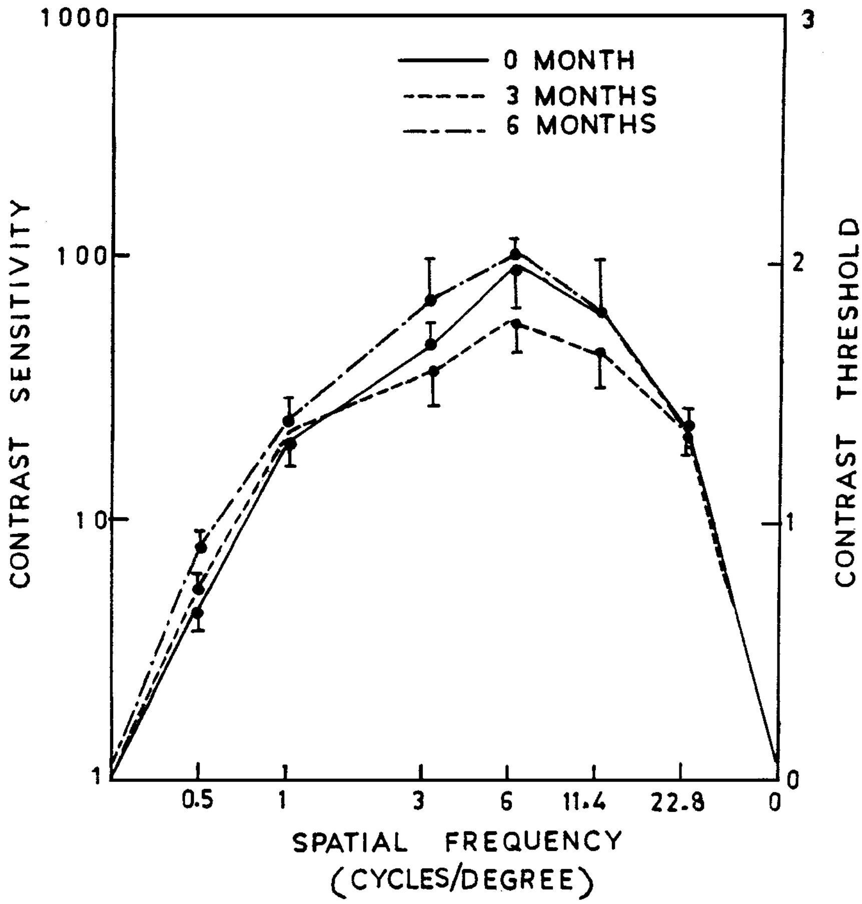

Fig. 5. Visual Contrast Sensitivity in control group participants (group III). There was no significant change at 0, 3, and 6 months.

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